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WESTERN DAM ENGINEER

Julian Hinds

Completed under the auspices
of the
Oral History Program
University of California
Los Angeles

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[photograph of Mr. Hinds was furnished by the Photography Department of the Metropolitan Water District]

Errata: page 185 does not exist.

INTRODUCTION

Julian Hinds, the son of James Monroe and Sarah Elizabeth (Ferguson) Hinds, was born in Warrenton, Alabama on December 22, 1881. In 1884, he and his family moved to Tyler, Smith County, Texas, where he attended grammar and high school.

Mr. Hinds enrolled in the University of Texas at Austin and graduated in 1908 with a B.S. degree in Civil Engineering. Upon his graduation, he remained at the University and taught civil engineering. The following year he left for Chicago, where he worked in the bridge building department of the Chicago, Milwaukee and St. Paul Railroad, designing reinforced concrete railway bridges.

In 1910, Mr. Hinds joined the U.S. Bureau of Reclamation. He was first assigned to the Yakima River Project in the state of Washington (1910-1911), and then to the Elephant Butte Dam Project in New Mexico (1912-1915). In 1915, he was assigned to the newly established Denver, Colorado office of the Bureau, and during the next eleven years, he rose from a position of general designer to that of Assistant Chief Designing Engineer, directing the preparation of structural plans for the Bureau's various irrigation

projects throughout the West.

In June 1926, Mr. Hinds resigned from the Bureau and accepted a position with the J. G. White Engineering Corporation, which was then building various irrigation projects for the government of Mexico. He was in charge of engineering work for the Calles Irrigation and Dam Project in the state of Aguascalientes. While in Mexico, he also assisted on the designs for the Don Martin Dam at Nuevo Laredo.

In March 1929, Mr. Hinds joined the Los Angeles City Department of Water and Power as an hydraulic designs engineer. He was engaged in the preparation of studies for extension of storage work, the preparation of preliminary designs for several earth dams, and the preparation of preliminary designs and estimates for the Colorado River Aqueduct.

In May 1930, Mr. Hinds transferred to the Metropolitan Water District of Southern California when the newly formed District took over the aqueduct studies from the City of Los Angeles. He was named Chief Designing Engineer of this project that was to bring Colorado River water to Los Angeles. In 1932, he became Assistant Chief Engineer of the District, in charge of all civil engineering functions, and Assistant Administra-

tor of the entire Colorado River Aqueduct Project. In August 1941, he became General Manager and Chief Engineer of the District, in charge of all engineering and administrative work. Mr. Hinds retired on December 31, 1951, at the age of seventy.

Upon his retirement, Mr. Hinds joined the United Water Conservation District of Ventura County, California, as General Manager and Chief Engineer. He was principally engaged in directing the construction of the Santa Felicia Dam and Reservoir. He left the District upon the completion of the project in 1955.

Since 1955, Mr. Hinds has devoted his time to work as a consulting engineer, with an office in Santa Paula, California. Today (1971), now in his ninetieth year, he continues to actively pursue his consulting business throughout California and the West. The major private and governmental agencies for whom he has accepted assignments include: U.S. Engineers, Department of the Army, Northwest and Sacramento divisions; Mississippi River Commission, Department of the Army; U.S. Bureau of Reclamation, Denver, Colorado; Bechtel Corporation, San Francisco (more than sixty dams); State of California, Feather River Project and the Department of Water Resources, Safety of Dams Division. In addition,

he has done consulting work on various county and municipal projects for the State of California and for other western states.

Mr. Hinds' numerous honors and awards include Life Member of the American Water Works Association. In 1956, he received the Beavers' Inc. Golden Beaver Award. He was a Life Member, later an Honorary Member (1959), of the American Society of Civil Engineers. In 1926, he received the Norman Medal from the society for his pioneering work on the Tieton Dam (Washington), and in 1954 received the James W. Rickey Medal for his paper, "Continuous Development of Dams since 1850," delivered originally at the ASCE Centennial Convention in Chicago in September 1952. He was National Director of the ASCE from 1948 to 1950. In 1960, he was presented the Distinguished Alumnus Award from the University of Texas. He received an honorary LLD from the University of California, Berkeley, in 1957. On April 21, 1967, the Hayfield Pumping Plant on the Colorado Aqueduct (near Indio) was officially renamed the Julian Hinds Pumping Plant by the MWD.

Mr. Hinds is the author of many technical papers and articles which have appeared in the publications of the ASCE and the AWWA, in the Engineering News-Record,

and in miscellaneous other technical journals. He is a co-author of Engineering for Dams (John Wiley and Sons, 1945) and a contributor to Handbook of Applied Hydraulics (McGraw-Hill, 1952). He has also been a contributing author to the Encyclopedia Britanica's section on dams.

In the following pages, which consist of a transcription of tape-recorded interviews with the UCLA Oral History Program, Mr. Hinds recalls his early life and education and the various aspects of his long and continuing career. The interviews were conducted under the auspices of the Water Resources Center at UCLA as one of a series dealing with the history of water development in California and the Southwest. Records relating to these interviews are located in the office of the UCLA Oral History Program.

INTERVIEW HISTORY

INTERVIEWER: Donald J. Schippers, Interviewer-Editor, UCLA Oral History Program. B.A., History, UCLA; M.A., History, Occidental College; M.L.S., UCLA.

TIME AND SETTING OF THE INTERVIEW:

Place: Julian Hinds' office, 810 Railroad, Santa Paula, California.

Dates: February 6 - April 4, 1967. The first session was conducted in February and the last in April. The other three were done in March at weekly intervals.

Time of day, length of sessions, total number of recording hours: The interviews were recorded in the afternoon and each session lasted about one hour and twenty minutes. This manuscript represents a total of approximately seven hours of recording time.

Persons present during the interview: Hinds and Schippers.

CONDUCT OF THE INTERVIEW:

The respondent was asked to recall his family background and education leading to his career and was then encouraged to comment in greater detail, chronologically, on the various projects on which he was closely involved before joining the Metropolitan Water District, his work on the development and construction of the Colorado River Aqueduct, his tenure as General Manager and Chief Engineer of MWD, and his consulting assignments since his retirement from the District.

EDITING:

Editing of the manuscript was begun by the interviewer, continued by Ronald Barr, Editor, UCLA Oral History Program, and concluded March 28, 1970 by Bernard Galm, Supervising Editor, UCLA Oral History Program. The verbatim transcription of the interviews was thoroughly checked against the original tape recordings. Only slight changes in grammar and syntax were made; correct spellings and punctuation were supplied. Proper names

were verified either by the editors or the respondent. The edited transcript was returned to the respondent who reviewed it and made significant additions and changes before returning it to the Program in September 1970. The material in the following manuscript has been retained in the order that it was actually spoken on the tape. Bracketed words or phrases were not spoken by the respondent on the tape.

The index was prepared by Winston Wutkee, Interviewer-Editor, UCLA Oral History Program.

SUPPORTING DOCUMENTS:

The original recordings of the interview and the edited transcript are in the University Archives and are available under the regulations governing the use of permanent noncurrent University records.

TAPE NUMBER: I, SIDE ONE

FEBRUARY 2, 1967

SCHIPPERS: I guess we can start by you giving me some vital statistics on your place of birth and your parents' name and a little bit about your family background and where you grew up.

HINDS: Well, I was born in Warrenton, Alabama. It was a little town then; I don't know how big. I left there when I was about three years old and went to east Texas. I notice in the present-day atlas that Warrenton has seventy-seven people, so it couldn't have been very big then.

My father's name was James Monroe Hinds; my mother's maiden name was Sarah Elizabeth Ferguson. They were both natives of Alabama. My father was a farmer and did some carpenter work, and other odd jobs. Sort of a hard life. We had some relatives in Texas, and he thought he'd do better there. So some time in 1884 (I can't give you the exact date), we bundled up, went down to the bank of the Tennessee River, which we lived quite near, and tried to hail a steamboat. This I know from hearsay, not from actually remembering it. But the steamboat didn't respond and didn't come in, so we got a team and drove down somewhere (I don't know where) and got on a train.

The only thing I remember about the whole trip was

walking alongside the locomotive which was standing on the track. You know how those old-fashioned steam engines sounded. I was supposed to walk alongside of it. My father had my hand, and when I got real close to the engine I began to cringe along like this. My father jerked me around and made me walk right past it.

So we went on out to Texas. We lived in some rented places for a while, and then we finally bought a farm near the little town of Bullard in the southern part of Smith County, about sixteen miles from the county seat of Tyler. We worked along and paid for the farm in three or four years.

My father raised quite a big family, four boys and three girls. I was the oldest. We lived in days that were very different from now--1967. We never had any money to speak of, but one thing we always had was plenty to eat, good wholesome food. Nothing fancy. But we had our own cows, our own milk and butter. We also had our own chickens and eggs, and we raised our own hogs and slaughtered them. We always had a smokehouse full of seasoned meat, and we had jars and jars of preserved sausages, fruit, vegetables, and all that sort of thing. In the summertime we had all kinds of vegetables, and we had fresh fruits galore. My father was quite a believer in plenty of fruit, and so we had a home orchard, with

peach trees, for example, of several kinds, some ripening every month of the summer. We always had fresh peaches, almost from frost to frost, spring, summer and fall. We grew tomatoes, peaches, watermelons and cantaloupes commercially; but our principal money crops were cotton and corn, as has been the custom in Texas to this day.

We lived in the country where there were no automobiles, and it was a long time before I ever rode in an automobile. It was after I was graduated from college. Of course, I saw a lot of them when I was in Austin, but I didn't get a chance to ride in one.

Going back, I can remember that when I was seven years old, I was walking three miles through the backwoods of northeast Texas to a little red schoolhouse that wasn't painted, if you know what I mean. I was very much in love with my teacher, and I got along all right. Then for quite a few years, I went to various little country schoolhouses. Then I went over to the town of Bullard, where there was an "almost high" school. I never got into a real high school, but I went to the best they had. I had to drive three and a half miles a day to get to it (I'd walked pretty near that far to my first school). Then I quit going to school for a while. I did go over to the little town of Omen to a country high school six months. Then I came home and worked on the farm for a while.

I soon tired of this, so I went over to town and got a job in a store. I worked in this store for twenty-five dollars a month and my board, and I stayed around there quite a while. My hobby was mathematics, and I was always solving people's mathematical problems for them.

Then a preacher came along. He had been down to the University [of Texas]. He hadn't graduated but he had been to summer school there. He was obsessed with the idea that I ought to go to the university and study engineering. I hadn't heard of a university before, much less engineering. Finally, I made up my mind to go. I took what little money I had and went down. I wanted to go two years, but at the end of the first year my money was pretty near gone. I had planned to get a summer job to help out, but I didn't get one. The next fall I still didn't have a job. In desperation, I spent my last ten dollars for a railroad ticket, went back to Austin, wrote to the man I had been working for in the store, and asked him if he could furnish me some money. He could, and he did. So I went through another year, paying my way.

Then just at the end of the year, before I had my final exams, I got a telegram from somebody that I had been soliciting the summer before for a job. He wanted to know if I could come immediately. If I could, I could have a job. I sent a telegram back and said I could. It

was on a Saturday, and I couldn't get anybody at school. I said, "What the heck, I can't go back anyway." So I got on a streetcar to go to the depot. As luck would have it, the dean of engineering was on that same streetcar, out of all the streetcars on the line. He asked, "Where are you going?" I told him. He knew this fellow. He just said, "Well, you're making a mistake." That's all. That ended the conversation. Then before we got off the streetcar he said, "I want to talk to you." He gave me a telegram to send to this fellow I was going to work for and said, "You get back on the streetcar and go back to the university. Come around to see me Monday."

When I went to see him on Monday, he got me a job for the summer and made arrangements whereby I could work in the dormitory for my food the next year. Also, he got me an assistantship in mechanical drawing. It paid me $15 a month, which was quite a little money in those days. Out of that, I had to pay for my room rent at the dormitory. That didn't come free if you were working there, but it cost me the whole big sum of $2.50 a month.

Then the teachers found out that I needed money. They began sending people to me that needed tutoring. I began tutoring the students in mathematics, and I had quite a little success with it. I would take somebody who had had hardly any mathematics at all, or who had

forgotten all of it, and I could get them straightened out, usually quite successfully. Several students that I had were the best mathematics students in the school, but they also had other things to do, so they would get me to help them cram for exams. Then I had a few that shouldn't have been in college at all. Those I ditched as graciously as I could. But, at any rate, I went along for the next two years, got my diploma, and left school with as much money as I had when I went there for the second year, which was a little more than nothing.

After I got out, I began looking around for a job. That was 1908, and the 1907 depression was still on, and jobs weren't too plentiful. I could go and get some job working around a farm or a sawmill or a cotton gin or something like that, but I wanted to get into engineering. Along towards the end of the summer, I had a telegram from the dean. He wanted to know if I would be interested in coming back to the university for an instructorship. I didn't say it to him this way, but what I felt like saying was, "Would a duck like to go for a swim?" So I went back and stayed there for a year, taught in civil engineering, surveying and drawing, and also some "descrip." I had a real good time. I liked it. I thought at the time--and I still think--that I would have liked a career in college teaching. But I had noticed, while I was in school, that

the engineering professors and instructors that we had the most respect for were those who had actually been out and worked at something, in addition to what they had learned in books. So I thought I wanted to do that. I talked to the dean about it, and he agreed.

With his help, I found a job. I went to work out in west Texas on a railroad construction job. I worked there a short time, two or three months, and then I snagged a job in Chicago on the Chicago, Milwaukee & St. Paul Railroad. They were revamping the bridges on lines in the metropolitan Chicago vicinity. They had built them quite a few years ago, using all wooden trestles. These trestles were beginning to go to pieces, and they had started to replace them all with concrete.

There I got the best education of all my career in concrete design. They were doing something that was unheard of then--building bridges in the yard, precast, and hauling them out and setting them up ready to go. I had a part in designing these structures. The design of everything had to be such that it could be built in the yard, taken out to the job, and put in place without stopping trains. We put them in under traffic conditions. Oh, I don't mean that you absolutely couldn't stop a train, but you couldn't have a train out of service for more than a couple of hours at a time. Precast concrete

was in its very infancy at that time (1909), and to use it on a big job like this was unheard of. The plan worked beautifully and I got some wonderful experience.

My next job grew out of that one. On the Yakima Project in Washington, the Bureau of Reclamation had taken over and was revamping an old private irrigation project that had more or less run down and was in financial troubles. One thing they wanted to do was replace a lot of their old wooden irrigation structures with concrete. I was recommended to them as a concrete expert by a classmate of mine, who happened to be there. So I went to Yakima to work as a concrete expert, and got my feet wet in the water business for the first time. That was in 1910, and I've had my feet in the water ever since.

On this project I ran into a new bundle of good experience, mostly in hydraulic design--all kinds of irrigation structures: canals--big and little, lined and unlined; flumes--concrete, steel, wood, stone; pipelines--concrete, steel and wood stave; check, turnouts, and all kinds of auxiliary structures. Thus I started in hydraulic engineering in Yakima, Washington in 1910, and it looks like I'll probably finish my career in this field.

SCHIPPERS: Did you have any course work to prepare you for hydraulic engineering while you were at the university?

HINDS: Nothing special. I didn't take any special courses.

I studied just the hydraulics specified as a part of the general courses. At one time I planned to write my thesis on hydraulic experiments. I always liked fooling with water and to see what it was doing. But as to a thesis, that was a little difficult to arrange. It would take money that I didn't have, and money the school didn't have to invest in experiments, so it just didn't work out. Actually, I wrote my thesis on bridges. Quite accidentally, the first work I went into was the designing of bridges for the Milwaukee Railroad. I would hate to see anybody try to build that old bridge that I designed for my thesis. It got me a diploma, anyway. In the university I, of course, studied a treatise on reinforced concrete, which was relatively new in those days. It was just coming into its own. It came in handy on my first two jobs. Nobody ever mentioned precast railroad bridges until I got to Chicago.

Of course, I studied all of the standard subjects of the times. Surveying was one important course, and bridge building and dam building were others. I got my job in designing railroad bridges in Chicago on the basis of something I did in a study of dams at the University of Texas. As an assistant instructor, I was monitoring a course on dams, using an old Wegeman book, in which he had some quite complicated formulas. He didn't prove them.

He would just say, "It can therefore be shown," and our professor asked the class to prove them. None of us ever had seen them before. I went home and worked them out in one night and brought them all back to class. I found a little trick in working them out. None of the others who had been working on them for three or four days had gotten them exactly right.

So, at the time that I asked for a job with the Milwaukee Railroad, there was a classmate of mine up there that knew about this dam business. He happened to be present when the man I would finally work for got my letter. He just pitched it over to my classmate and asked, "Do you know this fellow?" The classmate picked it up and said, "Hell, yes. Give him a job. He worked out the Wegeman formulas in one night." [laughter] So it had something to do with my getting the job. Then after that, I got my job with the Bureau of Reclamation because I was a concrete expert, nominally speaking.

SCHIPPERS: How would you size up your university training? Was it high calibre?

HINDS: Yes. Yes, it was good. Compared to present day training in universities, though, it lacked depth and breadth and volume, but the things that we got, we got well. We got the fundamentals, and we understood those fundamentals. But you know that the actual things that

I learned (that was sixty years ago) are used very little now--I mean the facts used for designing a structure and so on--because everything has been developed so much and it has changed so.

But I learned how to reason towards an engineering objective. And I was impressed with the fact that you've got to keep your learning up to date. The old professor of mine would say, "You've got to read the engineering journals and, above everything else, just as soon as they'll accept you, join the American Society of Civil Engineers." That was his plea to all of us. We didn't all do it, but I did. So I would say that, as of that day, my engineering education was good.

One thing I might mention is that when I went to Chicago, I occupied the desk next to a fellow from MIT--a real sharp fellow. I didn't feel any inferiority to him in tackling the work that came to us. It was all very new to me as it was to him. But one thing about this job, which is common to most construction jobs, was that it had an eventual end. We had to work ourselves out of our jobs. Finally, we were warned the end was drawing near and were told that if any of us found good jobs floating around, he had better consider taking it.

So my roommate from MIT and I began "canvassing" for jobs. That's when I realized the benefit of going to a

school of note, because when he'd say he was from MIT, all the people we talked to would perk up right away. Well, I would say, "from Texas," and they'd say, "Oh," like that. But he didn't feel any superiority over me, and I didn't feel any inferiority. As you get on in the field, the school that you went to has very little to do with it. I don't think that he had any better education in the fundamentals of engineering as they existed in those days than I had. But, of course, either one of the schools now would be teaching things that weren't even dreamed of in 1909.

I almost wish I could live down close to UCLA now, so that I could take some of the courses they are offering, just because I want to keep abreast of the times. I have all of these periodicals here. [Points at pile.] I'm not able to keep up with them, but someday I'm going to read them! You know I never will, but I do try to keep up with the things along my line of work. I was well taught and I had a good mathematics teacher, and I had an excellent teacher in chemistry. I didn't get much chemistry, but the University of Texas Chemistry Department was widely recognized as one of the best. Their premed school in particular was considered wonderful. I had a brother who finished there. He put in an application for admission to the four top medical schools in the country,

including Chicago, Stanford, Johns Hopkins, and the other one might have been Columbia--I don't remember. He was accepted in all four of them, due to Dr. Harper's standing in chemistry.

SCHIPPERS: What was your position in Yakima?

HINDS: Well, I started in under the title of "surveyor," because I didn't have a civil service rating. They put me under this title so that they could hire me without a civil service examination. My work there was in design. I was a designer of irrigation structures of every kind. At the end of 1911 I transferred from Yakima to the Elephant Butte Dam, a large concrete structure across the Rio Grande, near Engle, New Mexico. My title was still "surveyor," but again I went into the design office. This was my first dam. A short time later I took an examination down in Las Cruces, New Mexico, and passed it. Then I was given a civil service rating. I don't remember what my new title was, but it probably was designer or junior engineer.

I stayed there throughout the construction of the Elephant Butte Dam. Sometimes I would take the place of the outside survey man, but most of the time I was in the office designing equipment of various kinds--concrete handling equipment, buildings, and so on--but not for the dam proper. I just did general design work, concrete forms and all that kind of stuff that goes with office work

around a big construction job.

SCHIPPERS: Who was your superior at the Elephant Butte Dam?

HINDS: Well, my immediate superior there was L. J. Charles. He was the office engineer. But the man in charge of the job there was E. H. Baldwin. He's long since passed away. I don't know if Charles is still living. He went to Minneapolis, and I don't know what happened to him. But Baldwin was the man that was in charge of the job. He was field project engineer. All of the design work on the dam itself was done in Washington or at El Paso.

Then in 1915, it was decided that Washington was a little too far away, and that it would be better to get the control center closer to the jobs. They would still need an office in Washington, headed by a director, to look after the political end of it, raising funds and things like that. But the chief engineer, who was supposed to be building all these things, should be closer to the work; so they organized a chief engineer's office in Denver, Colorado. Well, in 1915, I was working myself out of a job again. Elephant Butte was nearing completion, and the work I was doing could be easily turned over to somebody else or merged with another job. It was slacking off.

Mr. Baldwin, who was my top boss, was sent to Denver to organize the office there and to be chief engineer; so

I told him that I'd like to get into that office when they organized it. So, in a short time I had a request to come to Denver, and I went in a hurry! I wasn't the first engineer there, because Baldwin was there and another engineer in a higher echelon. But I was the first working engineer in the Denver office of the Bureau of Reclamation.

Others came, of course. I wasn't the boss. The man who had been my boss in Yakima on my first project finally came and was the chief designing engineer. Then two or three others were brought in. I worked for my old chief (Baldwin) there for a long time, and then he was transferred away somewhere. They had a shakeup and changed everybody around and brought in new people. The big chief was a man named Williamson, who had been at Panama. Baldwin, who had taken me to Denver, was chief of construction. That was his title instead of chief engineer.

Finally, Dr. Hubert Work came to the Washington office. He kind of stirred up everything. Finally, Work went out and there was another general change. Baldwin was removed from his post as chief of construction and F. E. Weymouth took his place. I didn't know Weymouth at the time. Baldwin was a very good friend of mine, but Weymouth later was just as good a friend. He came into the office and ran it for many years. All during the time that Weymouth

was there, A. P. Davis, a very noted early man in reclamation was director.

Finally, for some reason--political reasons, I don't know--they put Davis out and replaced him with Elwood Mead. Some way or another they didn't just exactly like Weymouth, or Weymouth didn't like them; so Weymouth quit and went back to Philadelphia. He joined in the formation of an organization known as Brock & Weymouth. They were doing photographic surveying, contour work and things like that. It was quite out of Weymouth's field. Why he went, I don't know, but he did. He stayed in Philadelphia for several years, and then he went to Mexico. Eventually, I joined him there, which will come out later.

But during my work in Denver, I started in as the first of the designers there, and I wound up in 1926 as chief assistant to the chief designing engineer. I was assistant to J. L. Savage who was the designing engineer. During my time in Denver, I can't think of any kind of engineering work that I wasn't involved in. I started on designing concrete siphons, concrete canals, dirt canals, small pumping plants, small power plants, highways, railroads, camps, buildings, architectural work, and lots of bridges. I remember that I designed one bridge for a forty-foot deep snow load, up in the Cascades. My work ran the whole gamut of irrigation works--everything that could be

used on an irrigation project, I designed. And I was quite thoroughly familiar with all phases of irrigation practices except that I never was an hydrologist. We had a good hydrologist, so I didn't need to bother with that.

I particularly remember one thing that I designed was the Tieton Dam. It was not a large, nor was it a particularly important dam, but it was an outstanding one. It had a type of spillway that never before had been completely and fully analyzed. I started into the design of it on the usual basis, but when I got to figuring it out, I decided that the design should be based on some of the theories that I had developed about hydraulic jumps, surges, waves, and one thing and another, that occur in canals. When I did that, I found a complete new theory of the hydraulics for a "side channel spillway." In such a spillway, the water runs in from one direction and then runs off down another way. I found that several such spillways that had been built up to that time were theoretically incorrect, although I didn't find any of them in the Bureau of Reclamation projects that were dangerously incorrect, because they all were designed for more overcapacity than they would ever need. I worked out the theory and published a paper. It won the Norman Medal, which was the most coveted medal that the American Society of Civil Engineers was issuing at the time.

There are a lot of other things about that dam that were unusual that we don't need to go into here. One thing was that it was one of the last of the hydraulic-fill dams. Prior to that time, lots of earth dams had been built by washing the earthen materials into them in a flume and letting them settle. This was called a hydraulic fill. Well, that was a comparatively cheap way, compared to other ways of constructing them at that time, but they had trouble with some. They eventually came into disfavor.

About the last big dam of this kind was the Fort Peck Dam. The Army Engineers in building it had a partial failure during construction, not afterwards. They fixed it and now it's a hydraulic-fill dam that's working well. After they are finished and have stood a few years, they are wonderful.

I have had no actual experience with the failure of such dams, but a few have failed. Some have failed during construction. The method of construction is to locate a source of suitable gravel material near, and preferably above, the dam. After the foundations are cleared, the materials are sent to the outer edges of the dam in flumes. The coarser particles drop out at the edges, and water and the finer particles are guided to the center. As the fines settle, the water is skinned off, leaving the fines to

form a watertight core. The central pool, until settlement is completed, is a heavy-weight semi-fluid. It sometimes bursts the shells, causing a partial failure, which is usually repairable.

At Tieton it was thought prudent to provide the "mud and water" center with a concrete diaphragm, although concrete cores were more or less out of date. But Tieton was founded on a deep bed of gravelly material, which needed a cutoff, all the way down to bedrock. So we went down with a deep well to bedrock, and then we dug a tunnel out sideways along the top of the rock. We'd make the tunnel fairly high, then half fill it with concrete. Then we'd make the tunnel higher, then half fill it with concrete again. We just kept doing this until we reached the surface. So, we got a concrete core down through that material without having to excavate out any more material than we were replacing in concrete. It was quite an ingenious procedure.

I think that Frank Crowe, who built Boulder Dam, figured it out. It worked fine. The wall was extended to the top of the dam. This upper part, in the fill, had its troubles. You had to be awfully careful with the hydraulic fill, keeping just the same height on each side of the concrete. If you got a little too much on one side, the concrete would begin to wave. It was a high

wall of concrete, you see, several hundred feet long, two or three hundred feet high, and thin enough to be flexible.

I worked on one or more of every kind of dam there is in the world, I think, while I was with the Bureau, including arches and hollow concrete dams, multiple-arch dams, and what have you.

SCHIPPERS: How did you get the knowledge for this? Did you do a lot of reading?

HINDS: Oh, yes, I got all the books there were on it at the time, and I read them.

SCHIPPERS: And when you were given these assignments were you primarily the person that was responsible for them?

HINDS: Yes, I would say so. I had the help of others working for the Bureau and the guidance of Jack Savage, who was accepted as one of the world's most outstanding designing engineers. He lived for many years after I left the Bureau, but toward the last he more or less lost his mental capacity. According to engineering vernacular, "He lost his button." He was one of the world's finest men, with lots of "buttons" to lose. He was there as my guiding spirit. When I cooked up an idea myself, I presented it to him, and he either okayed it or didn't. He usually did. We didn't have any trouble. We got along fine.

I originated a lot of things. If you go around a bit you'll find that the Bureau of Reclamation is recognized as quite an authority on the design of arch dams. We developed in Denver a method of figuring stresses in such dams. Prior to that time, an arch dam was assumed to act as a portion of a complete cylinder, a foot-thick slice at any level taking all the water load that comes upon it, and no more. Unfortunately, it isn't that simple. Restraints at the abutments and between arches and verticle slices introduce problems.

It was necessary to work out a way of allowing for these restraints, which we did as follows: An arch dam was considered as consisting of two sets of elements--a series of thin horizontal slices, stacked one above another; and series of thin, wedge-shaped, vertical slices, stood up around the arch circle. The problem was to find out how these systems interact. To do this for all possible arches and slices was impracticable. Hence, we proceeded on the basis of samples--a system of horizontal slices, say fifteen, twenty, or thirty feet apart, one above the other. Similarly spaced thin vertical slices were chosen.

At each point on the dam where a horizontal and a vertical element intersect, a trial estimate was made of the portion of the total water load that would probably be taken by the arch, the remainder being assigned to

the vertical slice or cantilever. The deflections that would result from such a load division were computed. If the assumed load division at all points were correct (they never are for the first trial), then the computed deflection for the two systems would be identical at all points of intersection. If not, make a new trial division, and try again.

This procedure is repeated until acceptable conformity is acquired. Back in the mid-1920's, when this scheme (referred to as the trial load method) was worked out, it was no picnic. It was frequently referred to as the method of "most work." It has subsequently been perfected and computerized, until it has become respectable.

In those days we had no electronic computers. We had calculators like this old Marchant on my desk [pointing], but none of the modern ones. It really was quite a job to run through even a single set of trials. Even after a complete first adjustment was completed, and deflections at all intersecting points were consistent, a point might appear where total stresses were excessive. This meant that the basic design had to be changed, and the procedure started all over again. The labor was colossal.

Now, with a computer, it can be done much more rapidly. I am not up to the minute on all the new stuff, but I am proud to have been in on its beginning--as sort of a

midwife, that is.

SCHIPPERS: Did you get a lot of discussion from people? Did they get involved in the design work with you?

HINDS: Oh, I had plenty of smart fellows around to work with, and they didn't take what you said as gospel. They talked back to you, and thank goodness, because that's what I wanted. The consulting engineers were there, too, and did plenty of talking. It was good for me.

SCHIPPERS: Then you were assigned problems, and it was up to you to develop a solution?

HINDS: Well, let's put it this way. The problems came into the office. When they came into the office they usually came to me. I took them myself, then I'd take them over to someone and say, "Bill, you go ahead with this and analyze it." But I was the fellow who took them and assigned them, and I was the fellow who was responsible for how they were done. Above me, I had Jack Savage who would come around and look every problem over, particularly after we had it pretty well along. He would say whether he thought we were doing it right or not. He trusted us. The problems came in over his desk and he would write my name on the paper and send it down to me. I couldn't push them off like that. I had to handle them or see that they were handled.

SCHIPPERS: So the engineering solutions to the problems

were made in the regional office.

HINDS: No, in the Denver central office. I mean my group created the solutions, and we not only handled technical problems, we handled any kind of reports on anything that had to do with engineering. They might be financial reports--anything that would belong in an engineering office. Somebody would come in and suggest that we ought to build a project in such and such a place. Someone out in the field would gather the necessary data and send it in. We'd analyze it to find out whether the project would pay out or whether it was any good, whether it ought to be built or not. And we did many things of that kind. It was very general. That was the most general experience anyone could have.

SCHIPPERS: So then you did influence planning?

HINDS: Oh, yes. We didn't work only on structures; we also worked on general plans.

SCHIPPERS: And you made recommendations, let's say, for regional development for water distribution.

HINDS: That's right, but I'll say that my responsibility in regard to hydrology was a little less final and complete than in regard to the structural design and purely engineering things. But to get out a feasibility report took the cooperation of a group, the administrative group and others. For example, we had a water supply man, a

fellow by the name of Debbler. If he told us that the flow in Podunk Creek, anywhere, would average "x" acre feet a year, we didn't look it up. We just took it, because he had been found right so many times. His judgment about some things was rather broad. We'd call him a little bit liberal now, but he was an excellent man for the job that he had, and nobody could have been better.

Finally, the problem went to the people who handled the finances. Can we afford it? Is there any chance of getting the money to build it? Eventually, we all got together, and somebody would write a report. Chances were about two to one that I would write it. Savage would sign it, and it would come out of the office as Savage's report, which was proper. He was the boss.

SCHIPPERS: Would you say that the development was rather piecemeal or was there a good overview in the planning?

HINDS: Well, the picking out of projects to develop involved a lot of politics, as it does in any governmental thing. But once a project was selected and it was started, it was carried through in a systematic way.

SCHIPPERS: And yet you do say that you gave recommendations in developments of areas?

HINDS: Oh, yes indeed.

SCHIPPERS: So they would present a general problem, and

then you would come up with a solution?

HINDS: Not I alone. I did it in conjunction with the people I was working with.

SCHIPPERS: Do you think that, overall, the Reclamation's office in Denver operated efficiently through those years?

HINDS: I think that for the whole time that I was there--and even today--that operation was just as efficient as it would have been if the Edison Company or PG & E or anybody had done it. Everybody there was trying to get the most for every dollar in the project he was building. Sometimes it used to seem kind of silly to me. But I believed in it. That was my philosophy. And it was the philosophy of the others that were working there. But sometimes it seemed kind of silly that the engineers worked their heads off to save $100,000 on a project that was going to cost $10 million, and which perhaps shouldn't have been built in the first place. We worked out our "project reports" as sincerely as we could. If we recommended against a project, and Congress overruled us and told us to build it, we had no choice. Whether we believed it was worthwhile or not, we believed it was incumbent upon us as engineers to get all we could for the money.

SCHIPPERS: What are some of the projects you think shouldn't have been built?

HINDS: I couldn't go into that. There were some up in

Wyoming that later turned out to be duds. I know of one project that did.

SCHIPPERS: The Jackson Reservoir?

HINDS: No. No, I don't remember anything definitely about the Jackson Lake Reservoir, except that it's a beautiful place for a vacation. Something might have happened to it.

But there was one project--I can't remember the name of it--that every year we were requested to make a study of its feasibility. Year after year, we showed that it wasn't feasible. It got to be monotonous. Then one year, Congress acted on it and said, "Build it. We don't want any more reports." Well, what could we do? In a case like that, you build it. I wasn't there. I left right about then. I don't mean I left because of this project, but I happened to leave just after that to go to Mexico. I can't remember whether they ever built it, but I know it was a stinker.

SCHIPPERS: You think, though, for the most part the projects were worthy projects, needed projects, and that the Bureau's response to legislation was good.

HINDS: What do you mean by the Bureau's response to legislation?

SCHIPPERS: Well, withdraw that part of the question. Were most of the projects worthwhile as far as the

development of the area was concerned?

HINDS: I would say most of them, yes, but not all. It's unavoidable that some political interest should get in and get something done that was not too good. It happens right here in our county (Ventura). You know, somebody gets a lot of pull, and something kind of popular with the people may be put over. As an engineer you know darn well it's not worth what it cost. You could resign and quit, but what good would that do? They would hire another engineer, and he would build it just the same. So you don't accomplish anything by resigning in a huff.

SCHIPPERS: Did you have any more contact with A. P. Davis after he left the Bureau?

HINDS: Yes.

SCHIPPERS: Since he is an important figure in the field, I wonder if you'd give me a little more description of him.

HINDS: Well, I would just like to give you one little story about him. When I was working out the spillway for the Tieton Dam I was trying to explain the side-channel spillway theory to some of the brass.

One theory was that they had always been designed on what we call the energy theory. You would have so much energy, so you would figure the energy equation of the water as it goes down the channel, as you do for a

canal or anything like that. It's the old Bernoulli theorem. I figured out that that theory wasn't good enough. You must use momentum theory. Well, he [Davis] was doubtful. He had been fairly well involved in the side-channel spillway at Arrowhead Dam, a dam which is amply big enough. But he couldn't quite get the difference between the energy theory and the momentum theory. Nobody else could either. So I was trying to explain what happened to the lost energy. I said, "The energy is dissipated in raising the temperature of the water in all these swills in the side channel." He said, "Oh, I wouldn't think that it would get the water hot enough to bother." [laughter] But that wasn't what I was worrying about at all. It's funny how you remember a little thing like that. Every time I think about A. P. Davis I remember that story.

My connection with him later was only brief. I had some connection with him as chief engineer of the East Bay Municipal Utility District. You know, it is the outfit that serves water to Oakland and all the towns around it. Then, when we started work on the Colorado River Aqueduct, we employed a group of consulting engineers to go over the project at regular intervals to see what we were doing and to advise us. Davis was one of the group.

SCHIPPERS: But he was a very capable man in your estimation.

HINDS: Oh, yes, indeed, and he was one of our valued consultants. That's when I really got to know him personally better than I ever had in the Bureau. That seems strange for me to say, because in the Bureau, every time I turned around somebody would say, "A. P. says this and A. P. says that." He just seemed like he was an ever-present personality. It was all favorable. They all thought very highly of him. But, as a matter of fact, I didn't see him too often there. But, on the aqueduct I saw him fairly frequently.

SCHIPPERS: Were you still with the Bureau when he turned in the famous report for the Hoover Dam, and did you work on that?

HINDS: I don't think so.

SCHIPPERS: You resigned from the Bureau in 1926, but you did some preliminary work on the Hoover Dam.

HINDS: Yes, I had done preliminary work on the Hoover Dam. It was one of the last things I did there. I and a friend of mine worked on a section for the dam. They thought they wanted a gravity dam. I don't know why. But Sam Judd and I worked our heads off and finally worked out a section that was figured safe. I wasn't satisfied with it, so I decided that they should do some

testing, not just hydraulic testing but mechanical testing. We looked up a lot of sites in a lot of places where we thought the tests could be accomplished--some local sites close to Denver and some at the University of Colorado. So I wrote a letter (not for my signature--I was a ghost writer then as I've always been), setting forth why we should make some structural tests of a model of that dam. I sent it to Savage; he okayed it and put it through the office. It was also okayed in Washington. I had recommended a $50,000 nonreimbursable appropriation. And, believe me, such things were hard to get in those days. Just before I left the Bureau, the approval for the appropriation came through. So I left really kind of heartbroken because I couldn't go through with the project, but I had decided to go to Mexico and I didn't change my mind.

SCHIPPERS: What would your overall evaluation be of the Bureau in those days?

HINDS: I think that the overall evaluation of it--that's taking the politics, the economics and everything into account--was favorable. As to the engineering office in Denver (perhaps I'm prejudiced), I don't think there was ever a better institution. I still think it's good to this day. But some liberal philosophies that have

gotten into the Bureau have so impregnated the whole organization that some of it may be drifting over into the engineering part, too.

SCHIPPERS: What do you mean by "liberal?"

HINDS: Oh, they want to build things for the sake of building them, and for fish or wildlife or for wild turkeys or tadpoles, etc.

SCHIPPERS: And you think they've gone kind of "dam-mad?"

HINDS: I would think so. But you know the funny part of that is, they are still instilled with the desire to save money on the dams after they have been given the job and told to do it. Then they turn it over to the planning department and let them plan. Can I use a more modern case in point?

SCHIPPERS: Sure.

HINDS: For years the people of Ventura County have wanted to develop the waste waters of Piru and Sespe creeks. The need is desperate. I tried to do it when I first came to Santa Paula, but the people wouldn't vote for a two-dam plan. They wanted to start with one. I said, "Okay, if you want to build one, and in a few years build another one, that's fine. I can't tell you that you need them both the same day." They approved going along that way, and we built one dam. Then they got crossed up a bit and got afraid to ask the people to vote a bond issue for the

other dam. So they decided to bring in the Bureau of Reclamation, because most people on the street think if the Bureau of Reclamation does it, it doesn't cost anything. No matter how much money the Bureau spends, the layman thinks it comes off the trees in Washington. Finally, the Bureau did come in and outline a project with everything in it, including the proverbial "kitchen sink." Its estimated cost was fabulous. The people had to vote on it. It just barely missed passing. I voted for it, hoping that my idea of money trees was wrong.

In my opinion we desperately need to conserve the 30,000 or 40,000 acre-feet of Sespe water that is wasting into the sea. That could be done for a lot less than the Bureau's estimate, which including a whole mess of other things. Swimming, boating, water skiing, fishing, etc. are all desirable, but they could come later. Flood control is more urgent. But let's put first things first. I respect the engineers who made this plan, but I do not agree with them. (I've been working for the Bureau of Reclamation comparatively recently. You may or may not know that.)

SCHIPPERS: No, I didn't know that.

HINDS: But we've got 31,000 acre-feet of water up there that's salvageable. I have a theory that you're wasting money if you build a $100,000,000 tub to save 30,000 acre-

feet of water. This water doesn't come regularly, you know. It comes in big wads. So you have to build for a lot more storage than for just an average year's flow, so you can spread out the big year's. But there is a limit as you go up further and further. You could finally build a dam where it never would overflow. Then if you build it ten feet higher, you wouldn't get any more water. So if you would come down just a little bit where it would overflow just a little every fifteen or twenty years, the amount of water you would lose would be so small that it wouldn't pay to try to catch it. I always figured that the cutoff point was when you got to where the additional water you save isn't worth the additional cost.

Well, they didn't buy that at all. Save every drop! It makes no difference what the last drop costs. I don't go along with that theory. But if the plan had gone through, those engineers from Denver would have been down here, trying to save every possible dollar on this extravagant plan. One item in the Bureau plan above bare economic water conservation was flood control. That's needed too, but it could come later.

SCHIPPERS: Did you feel that there were undue political pressures when you first worked in the Bureau?

HINDS: Well, not really--some--but it wasn't a devastating

element then. I think it's much more so now. One thing that happened in the decade after I left--they began to look for projects for the Bureau with a prime purpose of keeping their organization going. That didn't originate in the Denver engineering office, but with the politicians. A new director, Mike Strauss, came along who was absolutely hepped on getting contracts signed and money for starting them obligated. After that, Congress would have to dig up money to finish them.

This story has been told to me. I can't prove it, but this director would ride along in a plane, look down and say, "Gosh, there's a good damsite." Then he'd go to the boys in Denver and say, "There's a damsite over at such and such a place." "Yes," they'd say, "but we have no data on it, and getting data will take money and time." He'd say, "Go on over there and get out an advertisement for it. You can do your investigations and design afterwards."

SCHIPPERS: You're not talking about the Department of the Interior under Harold L. Ickes?

HINDS: I believe it was under Ickes, but the trouble came from that awful liberal director. Their liberalism went beyond trying to be generous in their attitude towards development and benefitting people. Their meaning of liberalism was to spend the money so they'd have something

to do.

SCHIPPERS: When you worked for the Bureau, did you look at things primarily from a regional developmental viewpoint, or did you look at them in terms of needs in individual areas?

HINDS: No, mostly we looked at it project by project. There wasn't much pressure for anything different at that time. The river valley concept came later. It is good, within limits.

TAPE NUMBER: I, SIDE TWO

FEBRUARY 2, 1967

SCHIPPERS: Who are some of the outstanding men you worked with that deserve mention?

HINDS: Well, I think perhaps the easiest way to do that is to take them chronologically. When I went to work for the Bureau of Reclamation in Yakima, Washington, in 1910, my boss there was Ernest Moritz. He continued with the Bureau until his retirement not too many years ago. I got all my early experience in practical hydraulics from my work under him. He didn't have the title of chief engineer, but as far as I was concerned he was the chief engineer on that project, the Sunnyside unit of the Yakima Project.

I went on from there to Elephant Butte Dam in New Mexico. When I arrived there, the man in charge of the office work was L. J. Charles. He was a very fine man. He didn't stay with the Bureau too long. He left and went to Minneapolis and went into highway work. I don't know just what happened to him after that. Another man there was "Smally" Smallhausen, who was the chief of construction. He was very good as a real honest-to-God construction man. The general supervisor, as I said before, was E. H. Baldwin, who had been with the Bureau for quite a while, in several different jobs.

Now I've got to slip back a bit. When I first arrived at Elephant Butte, H. J. Galt was the man that was in charge of the job. For some reason I don't know, he was later replaced by Baldwin. Galt stayed in the Bureau of Reclamation in other capacities for many years. Baldwin stayed to essentially finish the Elephant Butte job, and then was transferred to Denver to assist in the establishment of the Western engineering center, previously mentioned. He remained in Denver until replaced by F. E. Weymouth. Then he returned to Columbus, Missouri, where he had come from, and went into the hardware business.

Frank Weymouth, who replaced Baldwin, was one of the most outstanding engineers I've known in my career. I'd almost say I'd have to put him second to John L. (Jack) Savage, but I don't think so. They were in different fields--one managerial and one technical. Weymouth was very farsighted, saw further into the future, and he could anticipate more troubles, particularly in the engineering and managerial fields. He depended on people like Jack Savage, myself, and others to do his technical work, while he looked after the other things. He kept us moving, you see, but he stood back of us, and all that sort of thing. Then as assistant chief engineer, he had R. H. Walter who later took his place as chief engineer. There were two assistant chief engineers. One

was named C. P. Williams. I knew him better than Walter. He went to Mexico also, but not with the group of us that later came to the Metropolitan Water District.

Jack Savage, my immediate boss in the Bureau, had no superior in reputation or ability as a designing engineer. Along towards the end of his career with the Bureau of Reclamation, he was doing consulting work on the side all over the world on the most difficult projects. I think his standing exceeded that of many of the famous French and Swiss engineers. André Coyne, for example, was an engineer of great international repute, and I think Savage stood above him. I don't mean, when I say that, to depreciate Coyne's standing at all. He was a really great man, and a personal friend.

I didn't start the discussion of the Bureau men with A. P. Davis, as I should have. He was the most worshipped superchief that I ever had. He was very competent. He wrote books on the design of dams and other things. He was very broad in his attitudes. He started originally with the United States Geological Survey. But as the Bureau of Reclamation grew, it absorbed his full attention.

SCHIPPERS: What were the qualities that made him so admired?

HINDS: I don't know. He was a man of great integrity, great foresight, and great technical ability, a high intellect. He was very honest and very firm in his opinions.

He was all of those things, and yet he was a man that everybody liked. He was one of these people that could make you do it and like it, if you know what I mean. That was his great source of strength. You know, I was only there about sixteen years; so that about covers the notables.

The Bureau men so far discussed were some of my superiors. There were many notable contemporaries. Among them were men like J. B. Bond and J. L. Burkholder, who were later to help with Metropolitan. And there was Frank Crowe, the renowned construction superintendent, who was later the superintendent of construction on Hoover Dam. Also Walker Young, project engineer for Hoover Dam. This list could easily get tedious, but I do want to just mention our chief electrical and mechanical engineers--electrical: J. M. Gaylord, Barry Dibble, and L. N. McClellan; mechanical: Bill Beatty, Mort Day, and Sam Judd. Before we break, I must mention our consultants. These were specialists we called in for special problems. A few names: D. C. Henry, of Portland, Oregon; A. J. Wiley, of Boise, Idaho; L. C. Hill, of Los Angeles, California; et al. Also, W. H. Nalder, who took over my work when I went to Mexico.

SCHIPPERS: Quite a lot of people from that office, or attached to it, later came to California water agencies.

Harold Conkling, for example. Did you know him?

HINDS: Yes.

SCHIPPERS: I think he was on the Elephant Butte Project for a while.

HINDS: Well, if he was I don't remember it. I later saw so much of Harold around here, it seems like I would remember. He was with the Bureau, I know that, and I knew him at Denver; but I don't remember him at Elephant Butte. Maybe he was there before or after my time. He was in hydrographic work. So if he was there he would have been helping to decide if there was enough water for the reservoir that I was there to build. He might have been on some other feature of the project. But anyway, the woods are full of ex-Reclamation people.

SCHIPPERS: How did you go about joining with the J. G. White Engineering Corporation?

HINDS: Well, they had contracted with the Mexican government to design and build some rather extensive irrigation works. It was stipulated that they use only Mexican engineers, except in special cases, or people from the Bureau of Reclamation. So the first thing that J. G. White did, really, was to fix it so we were working nominally for the Mexican government, but for pay purposes, we worked for J. G. White. But I didn't have anything much to do with J. G. White. They paid my salary

and they did come down once in a while, to look things over. But, really I was working for the Mexican government. The fiction that I was working for White simplified the risks. It removed the risk that maybe they wouldn't pay me, or something like that.

Weymouth was one of the first ones they hired, and when he went down, I wrote him. I was looking for more money. They didn't pay much around Denver then. I wrote and asked him for a job, and he gave it to me. I was associated with him all the time I was down there. He was in the Mexico City office, and I was out in the field. I was given the job because of the work I had done on arched dams with the Bureau. I was to be assigned to the Calles Project in the state of Aguascalientes.

They had begun what then promised to be one of the biggest arch dams in the world. It was right down in the lower end of a canyon where the dam could look out over the whole valley and everybody could see it. I was asked to come down with the idea that I would be in charge of the building of the largest arch dam in the world.

When I arrived and looked around a little, I immediately found a new site which cut the arch dam to about one-quarter of its volume and still stored twice as much water. That's one of these things an engineer will do.

He'll cut himself right out of some notoriety that way. I moved the dam to a place where there was a good reservoir. That's one thing about a good damsite--it isn't worth much to you unless there is also a reservoir site above it. The reason the original dam had to be so big was because it was down in the lower end of a canyon. To get any storage you had to first fill the narrow canyon and then back more water up above the top of the canyon.

Well, I just moved the dam up to the other end of the canyon. I found a damsite which was just as good--maybe a little better--with a much better reservoir site, shaped something like an oak leaf. Let's say we cut the cost at least in half and still had an arch dam. It was one of the first fully "trial-loaded" arch dams. The trial-loading theory we were using at the time wasn't quite complete, but we did go through the whole tedious computations using Mexican designers and engineers, and no present-day computers.

The site we chose had been previously investigated by former American engineers and discarded for a number of reasons, which on careful examination didn't "hold water." For example, the upper site was farther from the railroad, and the cost of hauling cement over eight kilometers (five miles) of very poor road was thought to be

prohibitive. We fixed that by building a new road. Other arguments in favor of the big dam were similarly ruled out.

I enjoyed my work in Mexico very much. I used practically all Mexican help. We were trying to do the work in a hurry, and doing things in a hurry in Mexico is a bit unusual, you know. They don't understand "hurry." We asked Grant Bloodgood, whom you know, and a fellow by the name of McCoskey to do the topographic work. They were buddies who had been doing a big survey job somewhere in Nebraska for the Bureau. They had finished with that and I told Jack Savage I had some surveying to do down there and that there were no USGS maps like we now have to start from. All you had was a wide plain and no way to know where to build a canal or anything else. The first thing we had to do was to get topographical maps. I put the problem up to Jack Savage and he said, "Get Bloodgood and McCoskey. They'll do it for you." And I got them. They came down and they did a whale of a job of it.

When we got through, McCoskey came on back, but I kept Bloodgood to take Bob Diemer's place. Diemer had gone down with me as my locating engineer. He's the best locating engineer the world's ever known. After he had been there a year or so they wanted him for another job. Our project was going so well that every time a new project was started they wanted to rob ours. They finally wanted

to rob me of Diemer. Well, we talked it over and decided Grant Bloodgood could take over Diemer's work and we could let Bob go down and run a project of his own, which he did. He did very well with it. I was a little afraid that he might be a bit shy on design work (he hadn't done much). They sent a lot of the designs up to me to look over at first, but not for long. He was doing such good work that he didn't need to send his plans to me for inspection. He was doing better than I was.

Grant Bloodgood stayed there until we finished the project. We did all of our computation and design work with Mexican engineers. Some of them were the best young engineers I ever put on anything.

I had one young chap there that hardly spoke English, but he did speak a little. He was just out of the University of Mexico in Mexico City. I put him on designing canal structures. I had specialized in the designing of canal structures in the Bureau and had written some fairly important articles on the subject. Well, I found he had read my articles; so I put him to designing these structures. They're a bit tricky if you don't know how. Designing an intake to a tunnel for a highway is not quite like designing an intake for a water tunnel. There's a lot of the theory involved, also a lot of art. You need to know what it should look like, and then you try it out by theory

to see whether it's going to work right. I gave him such jobs, and he proved to be an artist at it. He could get his trial designs out looking so good you just knew the water would run through them without a ripple. He was a young fellow and very competent.

Finally, after I was back in the United States, he got married and came to Los Angeles on his honeymoon. We took them to a movie over in Hollywood. One thing that he did really floored my wife. We walked into the theater, got ready to sit down, and he took his topcoat off and handed it over to his bride. [laughter] I told my wife that's the way I was going to do it after that. She said, "You just try it." At any rate, he was a good engineer and there were several others that were excellent. I made some very good friends down there. I still have some of them.

SCHIPPERS: About how many men did you have under you in that project?

HINDS: I couldn't tell you exactly, but excluding the construction men, leaving the engineers and office people, I would put the number at about one hundred.

SCHIPPERS: How did Weymouth fit into all this?

HINDS: He loved it. He was the chief of all the projects. He was in the Mexico City office. I was working for him as field engineer on the project. I only saw him once a

month.

SCHIPPERS: That was it?

HINDS: Yes. All my drawings and things had to go to him for approval. Weymouth and I always got along just beautifully. We never had any squabbles. We might get into a little discussion now and then, but we always came out of it together.

SCHIPPERS: There must have been a few little interesting incidents?

HINDS: Well yes, on the Calles Project I recall just one. After we had computed the stresses in the dam to a fare-you-well and had the construction well under way, we ran into a bum piece of rock. For an arch dam this is bad. We couldn't build on it and it was hard to go around, but we hit on a scheme. We pushed the unbuilt dam at this particular height upstream, to miss the poor rock, leaving both the top and bottom arches in their designed position. Intermediate arches were moved enough to give smooth transition surfaces. The result was a hollowed-out appearance on the downstream face. It didn't look bad, but at that time it was unusual.

To be safe we rechecked the stresses. We found that both the stresses and the volume of concrete were slightly reduced. We had accidentally hit a "double curvature arch," later to become standard practice. But it did look a

little funny at the time. When Weymouth saw it, he hit the ceiling and said, "I didn't know you were doing that. If I had, you wouldn't have done it." I said, "Well, I'm sorry, Mr. Weymouth, but you signed the drawings." We both laughed, and left it standing.

SCHIPPERS: Did you write up what you had done?

HINDS: Oh, I wrote up the dam, but I didn't write up that particular phase of it.

SCHIPPERS: Were you married at that time?

HINDS: Yes.

SCHIPPERS: Did you have your wife down there?

HINDS: Oh, yes. My wife and daughter. It wasn't my present wife though; it was my first wife. I've been married twice. My family was down there and enjoyed it ever so much. I remember that my thirteen-year-old daughter, when we were having a real good time doing something, all at once looked up real serious and said, "Wouldn't it be awful if we got to liking it down here and stayed?" [laughter]

Well, she had a pony and she was the ridingest little kid you ever saw. That little old pony was kind of cranky and was taken care of by a Mexican. I remember one time that the Mexican boy brought the pony up, and it was acting kind of funny. The Mexicans were afraid to get on him,

but my daughter went up and said, "I'll get on him. Princie won't hurt me." And she got on him, and away they went. She rode him around a little ways and then gave him to the Mexican, who took him off to the pasture. But she just wasn't afraid of that pony. She had a theory that he was not going to hurt her, and he didn't. She was a good little horsewoman.

SCHIPPERS: You did some other work down there during that three-year stay, didn't you?

HINDS: Yes. I designed another dam a little ways further down river. We called it the Jocoqui Dam. I don't know what they call it now. Jocoqui means buttermilk. Why they called it that I don't know. But it was an unusual dam. It's the only one of its kind in all the world, so far as I know.

They have a lot of old dams in Mexico, mostly built out of rubble, just rough stone, not hewn stone, but roughly squared. And they call it monposteria. Some of these old dams have been in existence three hundred years and are perfectly all right. They are built out of monposteria, and they always wanted us to use some of it. They were built before the days of portland cement, using hydraulic lime--that is lime that, when it is burned, has enough impurities in it so that it will set up in water, like concrete. And they wanted us to try building something

with it. Well, we just couldn't find enough of it to build a dam. We went to all the plants in the vicinity, but none of them would offer to furnish it in anything like the quantities that we needed. So we made a compromise with a special multiple arch dam. A multiple arch dam consists of piers or buttresses surmounted by arches--a sort of washboard type of thing. We built the piers out of monposteria, laid up by hand, but using cement mortar instead of lime, which we couldn't get. The piers were then surmounted by arches of conventional concrete. It was a perfectly good dam.

SCHIPPERS: What would you say about the Calles Project as a whole down there?

HINDS: Well it was a badly needed project, and I have an idea that it has been successful, but I haven't been back to see it. Last fall I was down at the Amistad Dam on the Rio Grande, and some Mexican engineers and a lot of officials from Mexico were there. I talked to one fellow who had been to the Calles Project, and he spoke very favorably about it; so I imagine it has turned out all right. It's about a 50,000-acre project.

They have somewhat the same kind of a climate as here, except that the seasons are reversed, and it is above 6,000 feet of elevation. The wet season is in the summertime and is fairly short. They need enough irrigation to get

their crops planted, and then enough in the fall to assure their maturing; but in the middle of the summer season, the rains largely take care of things. The rain comes in the summertime when you need it instead of in the wintertime, as it does here, when you don't need it. But they can't quite make it on the rain alone. They have a little more rain than we have here. It comes in too short of a period to fully mature the crops. There are certain crops you can mature. They can grow fairly good corn, Mexican beans and pepper, also fruits and vegetables and avocados.

I'm sure this project has been a success. It was a needed project, and if I do say it myself, I think it was well planned. And it was done with largely Mexican engineering help. They were all very faithful and industrious.

I remember one thing that the J. G. White people warned me about. We had a tunnel to build, and the J. G. White people had had some trouble somewhere with a tunnel. It didn't meet in the middle. They started at each end and it didn't meet. They said, "Whatever you do, don't turn that tunnel over to a Mexican." I said, "Okay," and they went on their way.

I had already given it to a Mexican engineer, and so the next day I said, "Ortiz," (Ortiz Davala) "I want a word with you." And I just gestured by passing my hands across

each other. He said, "I know, you want one tunnel, not two tunnels." [laughter] And I said, "Well, just to make sure I want to send someone to check." (It was some other American we had down there.) I said, "I don't want you to give them any of your data or anything at all. I want them to come down and make a few shots and just come back and tell me if they think you are going to come out all right. They're not going to be checking your work in detail. They will just look at it for me and see if you're going in the right direction on both ends."

When they came back, they said, "Don't you worry about that boy. He's doing fine." And the holes came out that close [holding up a Kennedy half-dollar], which is good in anybody's country. Of course, for a water tunnel, if you miss by ten feet, it doesn't matter too much. You just swing it around. But they didn't miss it at all. Poor Ortiz died a few years later. He was an awfully good engineer, a wonderful man, and a fine gentleman. He was only a young chap when he died. He came from Guadalajara.

SCHIPPERS: Is there anything else you'd like to say about it, about any of the men that you worked with on the project, other Americans?

HINDS: On that project I had three Americans under me. One of them was Grant Bloodgood. I don't need to say any-

thing to you about him. He finally went back to the Bureau of Reclamation, became chief engineer of it, and later was chief engineer of Morris and Knudsen Company in San Francisco. And there was Donald McCoskey who came back and went to work for the Corps of Engineers with a very good position. I imagine he's retired by now, but I've lost track of him. And then I had another man there, named Walter Drager, for office engineer. He was really very helpful. As I mentioned previously, Diemer was there with me. My Americans were very well liked by the Mexicans. That makes a lot of difference in a foreign country.

We had one Mexican engineer there that worked with me, and his wife was there on the job with him. His first and only child was born while they were there. His wife went out to a hospital, of course. He was very, very good in the office or field, and he became a close friend of mine. I had quite a lot of contact with him afterwards. He passed away in Houston, Texas, not long ago. His name was Agustin Valdez. When we finished at Calles, he returned to Mexico City, went into the contracting business and made a lot of money. When I was down there again about 1950, he had a big new home out in Chapultepec Heights, which is the same as Bel-Air in Beverly Hills. His house covered about a quarter of a block, a lovely place. I never saw anything nicer. He seemed to have money running out

of his ears and he was having a good time and being very successful.

We were having a convention down there for the American Society of Civil Engineers, and he invited the whole board of directors out to his home, where he put on a party for us to end all parties. He had a cop in front of the house guarding everything, you know, and all that kind of thing. And in the backyard, he had a cockpit, [laughter] and he showed us a cockfight. Along about midnight, after we had eaten all night, he went out and turned on the fireworks, right out in the middle of this neighborhood. Can you imagine someone doing that in Bel-Air? He just started shooting them all over everywhere. But the houses down there don't burn. (I remember once in a little town I lived in down there, I came home one night, and I saw a fire going along on the top of the buildings. I got all excited and somebody said, "What's the matter?" I said, "Well, those houses are burning down." And they said, "Oh, that's just the grass burning off the roofs.") But getting back to Valdez, we went to the bullfights and to the horse races and everything, and really had the time of our lives, and had a nice visit with the President.

SCHIPPERS: Did you have any problems with equipment down there while any of these structures were being built?

HINDS: No. We used American equipment altogether. We

had plenty of equipment, all the equipment we needed. On a lot of the structures, around the ends of siphons and things like that, we used some monposteria, hand laid. We would smooth it off with mortar you know. We needed very little equipment; we just needed Mexican workers. I wouldn't say we didn't have any equipment problems, but there was nothing in particular. We had a regular cableway for building the arch dam, and draglines and bulldozers for canal work. They all worked well.

The operators for all these things were not under my control. They were under control of the superintendent of construction. The operators were mostly Americans because they could get more out of the American machines. The Mexicans had few trained operators at that time; so we were permitted to use imported help on construction work but not on engineering. They have plenty of trained operators now.

SCHIPPERS: Did you have anything to do with the actual construction?

HINDS: No, I didn't, except I was the boss and told them how it ought to be built and was required to see that the plans were followed.

SCHIPPERS: This would be something that would probably be best to start talking about next time, but that project was a good training ground for your work on the Colorado

Aqueduct.

HINDS: Well, perhaps. But my training for the aqueduct came mostly from my work in the Bureau of Reclamation, because the aqueduct was more similar to the big canals and big conduits to be found on projects of the Bureau of Reclamation. It was good experience, but I would consider that I could have gone on to the aqueduct without the Mexican work a lot easier than I could have gone to it without my Bureau work.

SCHIPPERS: Two little questions I want to ask you that should have been asked way, way back: one, what religion was your family?

HINDS: My family were excessively religious. I grew up in a very religious atmosphere. It's sort of an unusual thing, but my mother was a very devout Methodist and my father was a Baptist. They didn't squabble about it. They got along all right and they went to the same churches lots of times. But in his later life, my father became more or less a lay preacher. If some church in the community found itself suddenly without a minister, he'd go over and do the preaching for them. I never heard him preach, because it was after I left home that he started. But I understand he did a pretty good job of it.

Then I got off on construction jobs, but still retained my membership in the Methodist church at home. I

kind of got out of the habit of going to church. But when I married the second time, I changed my membership. My second wife was an Episcopalian, brought up in that church, and quite a devout Episcopalian, and I said, "Oh, what's the difference?" I changed over and began to go to church with her. I've been in the Episcopalian church now as long as I was a Methodist, and to me they have the same ideals and the same goals. They have a slightly different way of going at it, but I still say, "What's the difference?" After all of these years I am glad that I am an Episcopalian.

SCHIPPERS: You mentioned you grew up in a large family. How many children were there?

HINDS: There were seven; I had three brothers and three sisters.

SCHIPPERS: You also mentioned that you didn't complete high school before you went to the university.

HINDS: Well I had six months in a country high school.

SCHIPPERS: How did you enter the university? By way of examination?

HINDS: Well, I didn't get to the university until I was past twenty-one. At that time there was a regulation that anybody over twenty-one could go to the University [of Texas] and apply for special courses. Maybe you still can do it now; I don't know. If you were past twenty-one and

could get somebody on the faculty to recommend you, you could get in. Well, I went down and was interviewed by the dean and he recommended me, and I got in. I started taking a regular engineering course, but I couldn't register for a degree until I had met all entrance requirements. But there was another way out. If you did well in any course that you took, that was considered prima facie evidence that you were prepared in that subject.

SCHIPPERS: I see.

HINDS: When I got through my third year, all I needed was entrance credits in history, because I had taken no history in the university. I could have taken a course in history and I would have gotten by on it, but I didn't. And at the beginning of my last year, in order to qualify for a degree I had to take an entrance examination. That was in history, and right at that time I think I knew more history than I ever will know again. I spent the whole summer boning up on it. And, boy, you could ask me almost anything. I'd hit you right in the eye with it. I can't do that now.

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MARCH 2, 1967

SCHIPPERS: Last time we were discussing some of the men who worked down in Mexico, and one of them we didn't get to discuss was Clay[burn C.] Elder.

HINDS: That's right. I should have mentioned him. There were a dozen or so of other close Americans I haven't mentioned. The list would be too long.

SCHIPPERS: And Clay Elder, did you have direct contact with him on your Mexico project?

HINDS: Very little direct contact on the Calles Project, but much previous and subsequent contact in the United States.

SCHIPPERS: I think we can now start on the story of why you decided to come to California.

HINDS: Well, in 1928, my wife became seriously ill. I came up with her and went to Johns Hopkins, in Baltimore. They did everything they could for her, but in about three months she passed away. My daughter had been with us in Mexico and when my wife became sick, I sent her up to my sister in Beaumont, Texas. When my wife passed away, I just left my daughter there, and my sister put her in school. But she and I very much wanted to be together again. I couldn't very well bring her back to

Mexico, with no one to take care of her. That was one reason that I wanted to quit.

Another reason was that my project was about ninety percent complete, and the boys that were there were plenty competent to carry it on through to the end. In fact, that's been my life history. I've almost always pulled out and gone to another job just before the one I was leaving was finished, while someone else was there to take it over. I always tried to have somebody on the project who could step into my shoes. And for that reason, I was beginning to look toward something in the United States.

Frank Weymouth happened to be a good friend of W. B. [William Burgess] Mathews and Bill Mulholland who were the "daddies" of the Colorado River Aqueduct. They became very much interested in getting Weymouth here to help promote it and to do the administrative work on it. He had talked to them about it back in Washington when he was there on some business for the Mexican government. The series of jobs that we had gone down to Mexico to do were just about finished; so he thought that coming back to the aqueduct would be a better opportunity for him. And when he said that he was coming back up here to take that job over, I asked, "Can't you take me along?" He said he would.

If there was any day that I ever wanted to be twins, it was on the day that he had wired me that he had submitted

my name to the commissioners of the Los Angeles Water and Power Department, and that they had approved it. On that same day, I had a wire from Jack Savage, asking if I would come to Denver to design Hoover Dam. I desperately wanted to do both, but of course I couldn't. I chose the Aqueduct.

I don't know if I told you why we had to work for the Water Department at first.

SCHIPPERS: I want you to go into that.

HINDS: Well, it was not an unusual situation. Bill Mulholland, Mathews, Harvey Van Norman, and many others in the Water Department had started looking for a route to the Colorado River two or three years before. But the City of Los Angeles didn't feel that they could or should do it alone. They felt that they should share it with their sister cities. I think they could have done it alone. It would have been difficult in those times, but they probably could have done it alone. But whether they could have or not, they didn't think it was good policy. They thought it was better to bring Pasadena and Santa Monica and San Marino, plus several other cities, into the deal with them, so they could make a bigger project and do more good for the general area. And, of course, this was done with the understanding that anything that caused the surrounding areas to prosper was good for Los Angeles.

In order to accomplish this, they had to organize a water district, which they proposed to call the Metropolitan Water District of Southern California. But the District had no money. And even after you get such a district organized and have authority to levy a tax, you have to wait for tax levy time to come around, and then, after you levy it, you have to wait quite a while before the tax money begins to come in. Well, they didn't want to lose a lot of time, so the City of Los Angeles just continued to run it. They put all the people on the city payroll to work exclusively on the Colorado River Aqueduct Project.

SCHIPPERS: Who do you think were the prime movers in the organization of the District. Some say it was the Los Angeles Chamber of Commerce. Do you think that the Water Department itself was responsible?

HINDS: I think that the primary leaders were Mulholland, Mathews--there were others--too many to mention. A very active, early advocate of the project was Franklin Thomas of Pasadena. Then after they brought the idea into being, they got the support of many more people. I'm just talking about the ones that thought about it and got it started.

SCHIPPERS: How about Mr. Chase?

HINDS: I know Mr. Chase very well, but I have no knowledge of Chase being in on the origin of the Colorado River Aqueduct. Quite likely he was. Ransom Chase is now, and

has been for many years, a member of the Board of Directors, representing Los Angeles. He's a good man, and a good director, but whether he was in on the initial discussions, I don't know. But there were many more than the ones that I have mentioned. There were many from all around Southern California, chambers of commerce of all the cities that were involved.

SCHIPPERS: Right. Now to pursue this a bit. There is sometimes talk that there has been some competition between the Metropolitan Water District and the Los Angeles Department of Water and Power. Some date that back to the time that the first plans for the Colorado Aqueduct were made. In fact, some have even said that the MWD took the project "away" from the Department of Water and Power.

HINDS: I was there, and that is wholly inaccurate. They took <u>over</u> from them, but they didn't take it <u>away</u> from them. It was all under an agreement. To cover preliminary cost before the District had funds, the City issued a little quickie bond issue for $2 million to get money to start the work.

SCHIPPERS: Has there been competition between the two agencies?

HINDS: No, nothing that I would classify as competitive trouble. Let me go back to the very beginning. I went to work for the City, and there was no feeling at that time

that it was wrong for us to come in with a new organization and take over. They were very cooperative in going ahead and financing the work, and then when funds became available, the Metropolitan Water District repaid them for the work that they had financed.

The District actually bought all the material that the City had accumulated--all the maps and drawings and the designs and everything pertaining to the project. The City could have done it all on their own, you know. They could have set up a separate branch to do the aqueduct work. But they did it this way and then they just sold the work back to the District. I was there in a position where it wouldn't have been unreasonable for some of the city employees to have felt, "Well, hell, we ought to have built that ourselves."

They knew that financially they could do it themselves, but they knew it wasn't politically advisable. And I never felt one bit of jealousy against my incursion into the organization. There might have been a little, particularly after the Depression started. Here I was an outsider who came in and grabbed a good job while a lot of local people were out of work. I never heard a word of complaint. It was an entirely cordial thing.

Now, in recent months (I don't know if this is the place to go into this or not), some of the [Los Angeles]

City Council have felt that some way or another the District ought to charge all expenses (including capital expenses) to water. That would be wrong in my opinion, entirely impracticable. As to operating expenses, yes, but the capital investments they have made in the past, and are still making, belong to everyone, and all should pay accordingly. These investments are for the future. Los Angeles is going out and getting water from their own new aqueducts. They built one of them soon after the Colorado Aqueduct was started, and now they are bringing in another one.

The City keeps reaching out and getting water someplace else. I approve of this because we are going to need it all, eventually. But Los Angeles still claims her share of ownership in the Colorado River Aqueduct, and should help pay for it. Los Angeles can't have Santa Monica and San Marino and a few towns like that pay for the City's equipment for the future. That's something that has got to be paid for by some means other than the sale of water. You can't put it all on the day-by-day sale of water.

If Los Angeles would take their share of the water, you might be able to pay it all with water, but since they're not taking any or very little Colorado River water, you can't put it all on water. To do so would make the

prices so outrageously high that nobody could afford it. Los Angeles should pay at least the part of the cost of the works that are being built for her future. Originally, Los Angeles was scared to death that they were going to give the little cities a free ride, because they were small and didn't have much assessed valuation. Well, now, they are trying to get the small cities to give Los Angeles a free ride. But they're not getting away with it.

SCHIPPERS: So when you got here in March 1929, did you first start to work on the topographical reconnaissance program?

HINDS: No, that was essentially completed. And, at any rate, I was no topographer. I started working on structural designs for the aqueduct. The City had an awfully good crew of topographic engineers. They were just about finishing their job. We did organize our own survey crews for field location and construction.

SCHIPPERS: Were you in on any of the decisions for the selection of the Parker [Dam] route?

HINDS: Oh, yes, definitely.

SCHIPPERS: Tell me about that.

HINDS: Well, as you know, we had a large variety of routes. The one chief thing was that among a lot of people, particularly laymen, there was an aversion to

pumping. They didn't want to pump the water. And there was one fellow, an engineer of considerable renown, who was dead set against pumping. He was a former USGS man. He wasn't a consultant and he wasn't working for us. He was working against us. His name was E. C. LaRue.

But it was just an example of many things that we were up against. This kind of a project always draws a lot of public attention, and if a fellow thought he had a bright idea, he had to have his say about it. Well, this fellow, E. C. LaRue, was dead set on going up to Bridge Canyon to build a 900-foot high dam and bring the water over from there without pumping. (One of the earlier trips that I made was down to that canyon to look at the site. I went down by horseback. It was quite a trip and took a couple of days.) LaRue wanted to bring the water through an eighty-mile tunnel and then across the Colorado River in the vicinity of Needles. Then, it would come by a fairly expensive, mixed-type route, but mostly tunnel, through to Los Angeles, all by gravity flow. The siphon across the Colorado River at Needles would have been under something like a 1,000-foot head--a very rugged place to build a pipeline. The whole thing was out of this world for expenses. We just couldn't afford it. Still, a lot of people argued for it until they were blue in the face because they felt, "Well, you don't have the expense of

pumping forever," which was true.

But we analyzed it from every way in the world. There were a lot of hazards about that eighty-mile-long tunnel from Bridge Canyon over to Needles. There were hazards other places. We estimated the cost backwards and forwards, and came to the conclusion that you would save money, if you wanted to build Bridge Canyon, by converting the full fall of the river into power, transmitting the power by wires down to Needles or Parker, and pumping the water from there. Do you see what I mean? You could have accomplished that same thing by building the high dam and getting the power out of it to pump the water back up to the elevation you wanted. And it would avoid a lot of hazards of the LaRue line.

So, we started in comparing that possibility with other possibilities, including a Parker diversion. Also, we had a lower river diversion which took the water out down near Blythe. It brought the water around the north edge of the Salton Sea. It had about the same amount of pumping eventually, but it was distributed differently. But that didn't pan out because the diversion was difficult and storage was limited.

Boulder Dam wasn't in then, and you had the problem of getting the silt out of the water. Parker afforded quite a lot of room for that, enough to take care of silting

for many years (certainly until some other dam upstream was built). Of course, Boulder Dam (Hoover Dam now) was being proposed at the time, but it hadn't really gotten underway.

There were other alternatives. I'm not going to try to mention all of them. But there was one that appealed to me from an operating point of view. There was an engineer named Gordon, who had lived at the Biltmore Hotel for years. He was a pretty smart old boy and a good fellow. His alternative was just to make one straight tunnel right from Boulder Dam to a point in Monrovia or Arcadia. There would be nothing else to construct--only one control at the upper end and then do any pumping at the lower end, as required to reach areas at elevations higher than the outlet. It sounded perfectly feasible.

But, you see the tunnel lay deep under the Mojave Desert, which looks dry as a bone. But if you go down a few hundred feet, you strike great pools of salt water. It's good for nothing--bad for tunnels. We would have had to go 400 or 500 to 1,000 feet beneath the surface to keep the tunnel straight. We anticipated all kinds of trouble and the expense of it would have been colossal. We didn't use that term, but it was out of this world. We figured the whole plan out and got comparative figures with other plans. Then I went down to the Biltmore and

laid the figures all before the "old boy." He looked at it and he said, "Well, that's all I wanted to know. I just wanted to be sure whether this wasn't the best way." And he didn't mention it again.

So, after going through all of these things, making all possible comparisons, estimating the costs of the aqueduct, the cost of the pumps, the cost of running the pumps in perpetuity, trying to figure out sources of power, and all that sort of thing, we picked the Parker route as being the best. I don't believe there is any remaining question about the choice of route. I don't think anybody questions it now.

SCHIPPERS: No. And you certainly got the full support of the board.

HINDS: Oh, you mean the district board?

SCHIPPERS: The board of consultants.

HINDS: Oh, the board of consultants. Oh, yes, we did.

SCHIPPERS: Now should we go on to the matter of determining the size of the aqueduct or is there something else you would like to explain?

HINDS: No, that's all right. The capacity of the aqueduct was determined before I got here. The City had filed on a fixed amount of water. And so far as I was concerned, that was it. We gave Clay Elder and his assistant the job of checking the City's figure. We found it was not enough

for the District's needs, but all that was available to us. It was about the best we could do, but we felt that it would last us twenty-five years, and it just about did. And there was no possibility of getting a right to any more. That was fought out in great detail. It was determined not by any one person or one agency, but we had the Colorado River commissions and the Colorado River boards and all that sort of thing; they were made up of people from all of the states of the Colorado River Compact region. The problem was studied, worked over, and worried about. We did our best to get all the water we could, but we couldn't get more than the City had already filed on. And, in addition to that, the City of San Diego had filed on a flow of 150 second-feet. When they eventually came into the District, we added that on to the Metropolitan's water right. At first, San Diego was dead against joining the District. They had bought a certain flow right in the All-American Canal, and they had been given the right to transport their water through it to the coastal mountains. At first they thought they'd pump it themselves, but they finally decided that wasn't practical, that it would be better for them to come in with the Metropolitan Water District, which they did.

SCHIPPERS: But the size or the initial capacity of the aqueduct was disputed by some people. They felt that it

could have been built for one-half capacity at first and one-half later, right?

HINDS: Yes. In some particulars they were right, in some wrong. We worked out a compromise. As you know, when you start to build an aqueduct, a long one like this one particularly, you can't build it for just today's needs. If you did, it would mean a small line, maybe a 24-inch pipeline all the way to the river, which wouldn't bring much water. The day after tomorrow you would have to put another one beside it, then another and another and so on. That's completely impractical; so you have to build for a reasonable time into the future in order to get a reasonably economical-sized unit. And there was never any question but that we should figure eventually on taking all the water we could get out of the Colorado River, all we had a right to, and any more if we could get it.

A lot of people thought that future demands would grow so slowly that it would pay to build the whole aqueduct half size from stem to stern--build it all the way at half capacity. They said half size, but they meant half capacity. And there was a great deal of pressure put on us by engineers, as well as by all sorts of lay people. And some of the leading engineers were insistent on it and thought we were crazy not to do it. We went

into the plan in great detail.

There was one compromise that we made to begin with. There were parts of the aqueduct that would be built in duplicate units, even with initial full-capacity construction. An example is the pumping plants. You wouldn't in any event use just one big pump at each plant. You'd need several units for a number of reasons. The practicability of building a tremendously big unit for such high lifts was perhaps impossible at that time. It would be difficult even now. In addition, you need to have a number of units so that if one goes out, you can shut it down and repair it and use another one without being thrown too far off base. So, we decided on nine units per plant, with about 200 cubic feet per second for each pump.

As to pipes, the manufacturing business hadn't progressed as far then as it has now. As a matter of fact, our project kind of put the manufacturer of big pipes on the map. But it hadn't gotten started then. Some of the long siphons and long, concrete, pressure pipelines that are three or four miles long could have been built big enough to take the whole flow of water, but it wasn't exactly convenient then to do that. Precast pipes, in particular, were just beginning to be built in large sizes. Even if we had been building to full size, we would have

built these features in duplicate units because of the cost, expense and difficulty of building one big enough.

What we had proposed right off was that all of these separable parts initially be built at half capacity. But on the tunnels, cut-and-cover conduits, canals, and other nonseparable items, it just wouldn't pay. The idea was that if you build a half-capacity tunnel you save lots of money and, therefore, a lot of interest on the unspent money. Then, when at some future time you build a second barrel, you will have saved enough in interest to build it. But our engineers couldn't figure it that way; so we went to bat. We had about ninety miles of tunnel on the main line. We went round and round and round on it.

One difficulty with laymen, and a few non-hydraulic engineers, is the idea that two "half-sized" tunnels will carry as much water as one full-sized one. Actually, after allowing for increased flow resistance, an 8-foot tunnel will carry less than one-fourth as much as a 16-foot one. A "half-capacity" tunnel, neglecting differences in friction, needs a diameter 71 percent as large as for double the flow in a larger one. Also, within limits, working conditions are better in a large tunnel. Allowing for these extras, our engineers thought a half-capacity tunnel should cost at least 75 percent as much as a full-capacity one. Our opponents, mostly influential people,

thought we were wrong. They actually created doubts in our Board of Directors.

So when our first tunnel came up to be advertised for construction, we were instructed to call for alternative bids, for half capacity and full capacity. The bid on the half capacity was 83 percent of the full sized, not enough saving to be profitable.

This procedure was repeated on a couple more tunnels, with similar results. One of the leaders of the opposition said, "Cut it out! I am satisfied." They wouldn't believe us; but they believed the contractors. So we built all the tunnels for full capacity.

We also built all open canals full capacity, as it didn't cost an awful lot more. It didn't cost anywhere near twice as much to build a canal for 1600 second-feet as it would have to build it for 800. Nobody asked us to build these at half capacity. Also a large percentage of the siphons and pipelines that were under pressure were built to half capacity.

As previously mentioned, each pumping plant was planned for an ultimate of nine pumps per plant. They were manifolded together in groups of three pumps to each of three penstocks, fanning up the slope. Only one of these groups was installed initially--three pumps and one penstock. I believe in this procedure, and I'd do it again, but in

this case the idea was dampened because prices escalated so rapidly. The price increases more than offset the amount of interest saved in some cases.

SCHIPPERS: Yes.

HINDS: The interest you saved was lost in the escalation of prices, but that you couldn't have foreseen. But at any rate, we built it that way. We built the pipelines at half capacity, the pumps at a third of capacity, the tunnels and the canals and the cut-and-cover conduits at full capacity. Cut-and-cover conduits are very similar to tunnels. You just dig a ditch and put a big concrete structure in it and then cover it back up. Everything east of Lake Mathews was built on that basis. And we had the full support of the engineers and all the people after we proved our position, but they had to be shown, which was proper. Everybody has a kind of feeling, you know, that a contractor knows a lot more about costs than an engineer, but it isn't always true.

SCHIPPERS: It being a young organization, there must have been a remarkable esprit de corps between the men.

HINDS: Well, you say a young organization. It was a new organization, but the people in it weren't all young.

SCHIPPERS: I meant new, yes.

HINDS: It was a new organization, but most of us had been friends and had worked together elsewhere. It's natural

on a new job that you collect people that you know. They were people that Weymouth knew who had delivered the goods in other places; so he brought them there. And they continued to deliver the goods. He got some new ones, of course, like Carl Rankin. He had been up at Hetch Hetchy. They were about finished with that job. They had had a lot of trouble with tunnels up there. We were beginning to have trouble with our San Jacinto Tunnel, so we went for Carl Rankin to come down and help us. We had a good man, B. C. Leadbetter, on the job. Carl was to help him.

I could continue to mention men without end. I particularly want to mention James Munn and Lester Branch, who I do not believe are mentioned elsewhere. They were experienced men of the highest quality. They worked in and out of the office, as contract coordinators.

SCHIPPERS: That was an important factor in getting the job done, wasn't it?

HINDS: What's that?

SCHIPPERS: The good cooperation between the men.

HINDS: Oh, yes. Well, another favorable factor was that this organization was built up during the Depression. You got good cooperation from everybody then because every fellow wanted to keep his job. Jobs were scarce and hard to get--good jobs. We didn't have any trouble with anyone from that point of view, even right on down to the lowest

employees. They all cooperated. They all liked their jobs and they all wanted to keep them. Of course, I don't say there was no difficulty. It was just like any family--brothers and sisters fight and scrap and all that kind of thing, but they get along together on the whole. It was a cooperative group. It was as good a group as you could hope to work with. We could pick and choose. For example, during that period we employed men like Bob Skinner. He was a local man, working for the city engineer. Things were a bit slow there, so we employed him. And I can name a dozen more that we employed like that.

SCHIPPERS: How about the cooperation of contractors.

HINDS: Absolutely marvelous. There was only one serious contract difficulty. It is discussed elsewhere.

SCHIPPERS: Who was really the power in the decision-making process? Mr. Weymouth?

HINDS: Yes. Oh, absolutely yes.

SCHIPPERS: What was the relationship between him and the board in those early years?

HINDS: Well, his relationship with the board was just the same as Skinner's relationship to the board is now. He was the man that they had chosen for their executive officer, a man they had chosen to build the aqueduct, and they gave him a free hand. We had some awfully good board members in those days, as indeed we still have.

SCHIPPERS: Mr. Whitsett was the first chairman.

HINDS: There was Whitsett, Richards, and Franklin Thomas, and, oh, too many of them to name. But they were very good and there was never any politics, as such, involved. There was a little political maneuvering sometimes within the board as to who was going to be given this job and who was going to be given that job and so on and so forth, but they never played any politics with the selection of people. Of course, after the Depression got into swing, they put in a rule that you couldn't employ anyone that didn't live within the District, unless it was somebody that had special qualifications for something you needed and that you couldn't get locally. And that's the only way you could bring in outsiders after the first year.

SCHIPPERS: I see. Would you say that, compared with the early years of the operation, the relationships within the organization have changed?

HINDS: Fundamentally, no. There is a little difference in the problems that come up. But, fundamentally, I would say there isn't much difference between then and now. We had a good board then; we have a good board now. Sometimes a staff member may disagree with a board member, but that's never disasterous. The board doesn't mind you telling them that you disagree with them, and that's about all you can expect. Some of them at times might like to run things, but

they aren't bad about it. Joe Jensen, as an example, may argue and fight for something, but if you can convince him he's wrong, he will soon think that it was his idea in the first place. He comes around, fully cooperates, and helps you. When--and if--he gives up, he doesn't give up still fighting; he gives up helping. And it's always been that way so far as the board is concerned.

There was some friction at first as to whether or not the chairman should be the general manager. Jensen doesn't want it to be that way. But Mr. Whitsett (he was my best friend) in the beginning kind of had the opinion that you shouldn't have an engineer for a manager, that you should have a businessman. And he was a businessman; therefore, perhaps he, as chairman of the board, should be the manager. They finally got that definitely settled. Being the chairman of the board gave you no managerial authority at all. The only special privilege you had was that you presided at the meetings of the board. There was nothing to keep the board from deciding though that they could make the chairman general manager if they wanted to. But I think if they had, he then would have ceased to be the chairman of the board.

SCHIPPERS: As general manager did you have any difference with board officers?

HINDS: None at all. I at first was a bit timorous. Paul

Whitsett called me in one day and suggested that we should have an understanding. So we worked out a modus operandi, that turned out fine. This entente cordiale continued with Jensen.

SCHIPPERS: And what was that modus operandi?

HINDS: The modus operandi was this: he called me up to his office one day and said, "Well, now that you're in, do you think you and I can get together and have an understanding? Then we can kind of run this thing like it ought to be run." I said, "Well, Mr. Whitsett, you know and I know I'm working for the board. I can't live with myself if I don't do what I think I ought to do unless I'm ordered by the board to do otherwise. So far as I'm concerned, I'll certainly give consideration to anything you want done, but I'll have to handle it through the board. I just can't do it otherwise, because if I come in here and you tell me on the side to do something and I'd refuse to do it, and then if it turned out that you were right, I'd be in a hole. But if I did do it, and it turned out to be wrong, then I couldn't go to the board and say, 'Well, I did it because the chairman said so.' I'd be in a hole either way. Anything that you've got that you want done, if you give me a letter telling me to do it, I'll either just go ahead and do it or else I'll present it to the board and say, 'Mr. Whitsett thinks it

ought to be done this way.'"

He thought a minute and didn't say anything. He never responded to that at all. But that's the way we got along after that. He never wrote such a letter, but still he talked things over with me.

SCHIPPERS: Did the board pretty well follow the engineers' advice about the original development?

HINDS: The board accepted the advice of the engineers on all technical matters. There was an engineering committee that went over all important matters and approved or offered suggestions. Important plans were also revised by our consulting board. By the time a problem got to the Board of Directors, it was pretty well worked out. They were also at liberty, of course, to turn down our recommendations but they seldom did. All committee meetings were entirely informal. If a committee member didn't like a proposal, he could tell me I was crazy, and I would come back with "you're crazy." We never had any differences that were not finally and equitably settled. We always got together. A staff member might be a little bit disappointed because he had to give in a little and do something in a way he didn't like, because that's the way the engineering committee thought it ought to be done. But we always got so close together that all of us would realize that the little things left were unimportant. When

we put it up to the board, as a whole, it never was with an adverse recommendation by the engineering committee. Anything that we put up to them, with the approval of the engineering committee, had a 100-to-1 chance for approval.

SCHIPPERS: As the chief designing engineer in those early years, what were some of the things that stand out in your mind that were either extra big challenges or problems?

HINDS: Well, I'll tell you the first rule that I decided upon. I went to the aqueduct with a modest reputation of being an engineering mathematician, not a high-powered mathematician. I found that I could more or less discard the integral sign and take up the dollar sign. Let's say, as an example, that you wanted to excavate a tunnel across a street 200 feet long. You could just go out and dig it with what you have, letting a few inefficient dollars fall here and there, or you could spend time and money designing new specialized equipment so that you could excavate more efficiently. In all probability, the cost of the new equipment would far exceed the saving in excavation on a 200-foot tunnel. But that wasn't true on the Colorado Aqueduct. Everything you did, you did so darn many times that it paid you to work it out and get it just right. A dollar per foot meant very little on a 200-foot tunnel, but on a 90-mile tunnel it meant just a lot. So that's how I figured that most of my work was going to be done

with a dollar sign instead of an integral sign.

One thing that gave me a lot of pleasure was a system we devised for determining the economic size of all the various conduits. A conduit, of course, has to have a "slope," to provide fall to keep the water moving through it. As an example, suppose you are required to build a canal, say, 60 miles long. Such a canal would require appreciable fall from end to end. Such fall, on this project, can be supplied only by pumping. This costs money, both the cost of the plant and the capitalized cost of perpetual operation.

If you were lazy you might "just build it big." This would minimize pumping, but the canal cost would be high. If you were excessively "present cost" conscious, you might say, "Oh, let's cut it down to guard our present bank account." If carried to extreme this might result in an undesirably steep slope with a lot of fall, and a ruinous pumping cost.

We worked out a system of balancing construction costs against operating costs, to give the best overall efficiency, not only for canals, but for all types of conduits, for all physical conditions along this line. Thus, we could avoid, say, building a tunnel too small and a canal too big, and all that sort of thing.

I would like to describe this system in detail, but

it is too technical. This was a very useful tool. It's still useful.

They are using it on the California Aqueduct. But when I was up there helping them on it, we ran into a little trouble. We had to extend it because of different conditions. That aqueduct is so long and has so many variables. There were some conditions that we hadn't had to take into consideration when we built the Colorado River Aqueduct. So they had to bring those in. I wrote a paper on the system we worked out for the aqueduct and got quite a bit of recognition. This pleased me, of course. The system saved us a lot of money. It represents a combination of the integral sign and the dollar sign, having them working together.

SCHIPPERS: How much of your work did you do in the field?

HINDS: I didn't do any in the field. Oh, I went to the field frequently, but I went out to go over the work of others in the field. I didn't work in the field, really. My work was in the office, but I could go to the field any time I wished. I had an automobile, and I didn't have to ask anybody for permission. When I thought I ought to go to the field, I went. I frequently did go, because looking at a job sometimes helps you. You can get helpful ideas. And, of course, I was only helping. I didn't need to take too much responsibility wherever Bob Diemer was on

the job. There is nobody better. I had him to rely on, but if anything special came up, he usually would want me to come up and look at it. Of course, the damsites I inspected many, many times and went over all testing, discussed what should be done, watched what was being done, and many things of that kind. Nevertheless, I wasn't a field man.

SCHIPPERS: What did Mr. Weymouth do mostly?

HINDS: Well, he would stick his nose into anything that any of us was doing, and he did a lot of it. He was very interested in going carefully over the work in the field, the location of dams and the building of dams and all that sort of thing, and inspecting them frequently. He was useful for that, but his primary usefulness was in his work with the Board of Directors, the Chamber of Commerce, the state agencies, the federal government and things of that kind.

Of course, you know that the federal government didn't have anything to do with financing this project except for a little bit of money we got from the WPA. We did sell our bonds to the RFC (Reconstruction Finance Corporation), just like we would sell them to a bonding company. Back in the Depression days, nobody would buy them. First they sold to RFC as big block bonds, not definitive bonds. They bought them from us at an interest rate of 5 percent.

Well, nobody wanted to pay 5 percent interest. Too high in those days. If we had sold them to a private outfit at an agreed 5 percent rate, we would have paid 5 percent interest forever. But Jesse Jones, who was running the Reconstruction Finance Corporation, when he got ready to put them out for sale to the public, he cut the interest rate to about 4 percent. That was a reasonable price for those days.

And another thing that he gave us a good break on was that he let us sell the bonds to him as we needed the money; so we didn't have a lot of bond money drawing interest during construction. Usually when you sell bonds to a private dealer you have to sell a big block at once. Well, Jesse would take them just as we needed the money.

When he finally put them out to the public, he made a profit for the government of $13 million. That always bugged some of our Board of Directors. They were always trying to figure some way of getting that money back. But Jesse was a practical banker and he said, "I bought those bonds when you couldn't sell them to anyone else, and I reduced them from 5 percent to 4 percent for you. And then I sold them to the public at a price that yielded the RFC a profit of $13 million. I lost money on a lot of the other bonds that I bought at the same time, and I need this $13 million to make up some of these losses. I conducted

a perfectly straightforward business transaction." He just wouldn't talk about it.

But you know Victor Rossetti, as long as he lived, he kept hoping we'd find some way to get that $13 million back. We never did. I never had anything to do with that. That was in the financial department, out of my purview. After I became general manager, I had a little to do with it, but it was too late then. And besides I just didn't see how we had a leg to stand on. If we could talk the government into giving it back to us, well and fine, but it was a perfectly straightforward deal. They bought the bonds from us and sold them at profit.

SCHIPPERS: It must have taken some super-colossal optimism to build this big projcct right in the middle of the Depression, not knowing how the finances were going to turn out.

HINDS: I wish I had had that much optimism myself about my own business. If I had, I'd be a millionaire now. I could have begun buying stuff when it was down to nothing. With the little bit of money that I had, I could have had a lot of it by now. But it did take courage on the community's part. It was not altogether just Mulholland and Mathews and Weymouth and the Chamber of Commerce and a few like that. It took a lot of courage on the part of the people to vote that $220 million in bonds. A lot of

it!

SCHIPPERS: Were there any particular spots along the Colorado Aqueduct that stick out in your mind that were problems? Obviously the tunnel was one of the big undertakings.

HINDS: Yes, well the San Jacinto Tunnel was a lot worse than we thought it was going to be. I think now that we should have expected it to be "a lot worse than we thought it was going to be, but not quite as bad as it was."

One thing that sticks out in my mind about the aqueduct was the design of the pumps. When we got ready to begin designing the pumping plants--starting to figure out what we were going to do, what kind of pumps we were going to use and so forth and so on--we got an idea that we needed to do some testing. We flirted around a little bit with Cal Tech. They had some awfully good men out there like Robert L. Daugherty, Theodore Von Karmen and Bob Knapp--very high-class hydromechanics and very good people for testing work. As a matter of fact, I always said that Bob Knapp was the outstanding gadgeteer of the world. If there was something that he needed to find out and there was no instrument suitable for the task, he'd design one. And it was never a "Rube Goldberg" thing, you know. It was good, and it always worked.

So we worked up a scheme. We merged our mechanical

division, under the supervision of Bob Peabody, with that of the school. I don't know if you've run across any mention of Peabody. He was a wonderful mechanical engineer. The whole job was under the guidance of James M. Gaylord, the District's chief electrical engineer. And between us, we decided that the tests should be made, using Cal Tech's laboratory and equipment. Well, of course, the pump manufacturers weren't very enthusiastic about it. They said, "We know how to build pumps. How are a bunch of schoolteachers going to come around and in a little while, tell us how to do it better?"

They proposed a multistaged one for the Hayfield Plant, for example. It's the highest lift we had. Well, as the manufacturers envisioned it, it would have been a multistaged, horizontal, double suction pump, taking up a lot of floor space, you see. The efficiency they could offer was a guarantee of 85 percent. That left 15 percent to play with, you know. And as I say, the manufacturers said, "Oh, we know how to do this. We're not going to put our pumps in there to be tested by Cal Tech or anyone else, giving away our secrets," and so on and so forth.

That sounded reasonable to some members of the Board of Directors--these fellows have been building pumps all their lives; why should we start trying to tell them how

to build them? I joined in with Bob Peabody, and we fought like tigers to get the pump testing program through, and we did. After we had gone on with it a while and had begun to get favorable results, there was nobody as enthusiastic as the pump manufacturers.

Let's consider the Hayfield Plant. It has a static lift of 441 feet, and required nine pumps, each with a 200 second-foot capacity. Although there are bigger ones now, it was unprecedented at the time. The results surprised us.

Did we come out with a multistage, double suction, horizontal pump, spread all over the place? Not on your life. We were able to go all the way--vertical shaft, single suction, single stage. And an efficiency of 92 percent. That's a lot better than 85 percent. The full-size pump, when built, achieved the laboratory efficiency. They were outstanding for the time and still rate high.

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HINDS: [continuing discussion of the pumps for the Hayfield Plant] They pumped more water to a greater height and at a greater efficiency than ever had been accomplished before. I don't say they hadn't pumped water higher than that. They had. And they might have pumped bigger flows to lower heights with that much efficiency, but I don't think so. They became more or less standard in the pump field--the big pumps that the Bureau of Reclamation was building up at Grand Coulee, for example. The government came down and took over our pump equipment at Cal Tech. I think they paid us for it. We owned the test equipment. We could have given it to Cal Tech, and it finally did go to them. They followed the general principles of design for the big pumps at Grand Coulee Dam.

The same design has been used a lot elsewhere. I was in Scotland in 1967 and saw some pumps with a lift of about a 1200 foot, that looked just like ours. I don't know how efficient they are, but they look just as simple as ours. They hadn't been tested for efficiency in the field.

SCHIPPERS: Was there a little dispute over about how many pumps to install initially?

HINDS: If there was I don't remember it. I have no

recollection of that. Wait a minute. Do you mean how many to install initially, or how many should be in a plant as a whole?

SCHIPPERS: I mean initially.

HINDS: Oh, I know we put in three pumps. You mean was there somebody that thought we ought to put in more?

SCHIPPERS: Right.

HINDS: I don't think so. You had to put them in, in groups of three because three pumps use the same penstock. It was logical to install all units on a small penstock. You wouldn't have to, but we did. And I don't think anybody clamored for six pumps instead of three. I don't think there was any dispute about it. It's quite possible that somebody around somewhere said that was the wrong way to do it. They always do. But there was no pressure to do differently.

SCHIPPERS: During the construction of San Jacinto Tunnel, there was a strike.

HINDS: Yes.

SCHIPPERS: Is there anything that you can say about it?

HINDS: No. Working conditions in that tunnel admittedly were bad, and some of the people came in and wanted to hold an election for joining a union. Well, we didn't oppose it. They could do it anyway, if they wished. So they organized a union. After a little while, they came

in with a list of demands based on working conditions. They talked to the board. The board recognized that conditions were bad, and didn't mind giving them what they were asking. But then they soon came back asking for a lot of fringe benefits that had nothing to do with working conditions. And the board wouldn't concede, and they struck.

They made a mistake. By that time the District had annulled the original contract and were building the tunnel themselves. They went ahead as if nothing had happened and nothing did. The miners posted pickets all around the place so that no union man could go in. They said, "You fellows are crazy; you can't run the job without us. There aren't enough miners around here that don't belong to the union to do it." Well, for the first month there was a little dropoff in progress. Every month after that, we had more progress than they'd been getting before the strike, because the workers were already squabbling among themselves, you know. We just ignored them and went ahead and built the tunnel. I don't recommend that as a general practice. It's kind of hard to do, but we did it then and got away with it.

SCHIPPERS: One other thing about this tunnel, was it later to cause trouble with the Hemet area because there was so much seepage into it?

HINDS: Well, let me first mention how we finally took the tunnel over. The tunnel was let to a contractor: Wenzel and Henoch of Milwaukee. When we began getting out specifications for various jobs, quite a few of the board members were interested in financial matters. They were financiers. They thought that this was such a wide-spread job that we could save money by taking our own risks.

So, we decided that we'd take our own risk on all contracts. San Jacinto was the first to come up. I remember saying to the board, "This business of not getting bonds, not having your contractor furnish a bond, is something new to me. I always have required a performance bond." And I said, "It may be all right; it sounds good. You fellows know a lot more about that kind of thing than I do, but one thing I want to urge: don't do it on this tunnel and then not do it on the others, because this is the worst one. If any of them ought to have a bond, this is the one." But, no, they were going to do it on all jobs. So they went ahead and did it on this one.

Then, when they went to underwrite the material and labor bond which is required by law, they couldn't carry themselves. The law required a qualified licensed underwriter. They found that the underwriters charged almost as much for a material and labor bond as they would for both. So they dropped the idea and finally did just what

I warned them not to do: carry their own risk on that one tunnel alone. But they made the contractor put up $300,000 in government bonds as surity.

But, anyway, the contractor, Otto Seafelt, who was operating it, was a real smart and ingenious sort of a fellow. He had been doing a lot of work in places where he could go around and get old machinery at a low price, fix it up and work with it. He put up quite a rehabilitation shop in Banning and gathered up quite a lot of used tunnel equipment, including pumps and everything else. Well, the truth of it was that San Jacinto was a difficult tunnel, and even new equipment wasn't good enough. So they were in trouble from the start. They lost the tunnel two or three times due to flooding of their pumps. It took months to get them unwatered and going again. It got so bad that the District had to take the job over and operate it themselves. (This happened before the strike.) When we went in, we went "hell for broke" in fixing it up. The pumps were down at the bottom of an 800-foot shaft. We sealed them off in a cavern where, if the tunnel broke and filled with water again, it wouldn't stop the pumps; they'd still run. We did a lot of stuff like that.

But we had to take it over from the contractor by edict, you know, by court action. And then, of course,

the contractor swore that he could still have completed the contract and have made money on it. So he brought suit against us for damages of several million dollars. (They always do make such claims big.) The District admitted that we owed him something. We owed him for his last estimate and a little for usable equipment. He wanted a lot more, but after a great deal of trading he was willing to settle for about $100,000, and the District got up to about $75,000.

There both sides got their necks bowed. The District thought they had stretched the lawyers' prerogative of a payment to avoid litigation as much as they could. So negotiations stopped. The contractor went on with the suit. He didn't get a dime. We felt real bad. Aside from the superintendent, they were nice people. But we couldn't do anything about it. They had played poker and lost. And being a public organization, we couldn't go around and say, "Here, we owe you some money, why don't we pay you this?" We couldn't do that.

And we still had the $300,000 in government bonds, but we couldn't even give that back. The lawyers did come up with that old gag of payment to avoid litigation. So we gave them back half of the bonds. Of course, that litigation cost us quite a bit of money, but we saved a

lot of money.

SCHIPPERS: Now, the seepage problem later grew into a lawsuit by the City of Hemet against the Metropolitan Water District.

HINDS: I don't remember the details of that very much. I know that it existed. The reason for it was that we were draining water out of the mountain in substantial quantities (60 second-feet or more) for a long time during construction. That kind of dried out the mountain, and finally the seepage got down to 8 or 10 second-feet and a lot of springs up on the mountain were dried up. Well, we made financial settlements with the people that were directly affected. The pre-construction flow of the springs was known, and from that, we could tell how much the flow of each one had been reduced. We just determined how much the yield of the spring flow had been reduced and settled on that basis.

But, in the case of Hemet, all that was known was that there was still a small flow escaping from the tunnel. It had to be coming from someplace. Hemet contended that it was draining from their watershed. Some of it did come from there, but hardly all of it. There were other drainage areas adjacent to the tunnel. It could never be definitely determined.

An area containing Hemet finally annexed to Metropolitan, and we settled the drainage water problem by turning over to them without charge, at tunnel outlet, a flow equal to the remaining tunnel drainage. To determine the amount of the drainage the tunnel is shut down from time to time and the residual flow measured.

Hemet is no doubt getting more water than is being drained out of their watershed. On the other hand, if it were left to come to them naturally it would arrive at a higher level than the tunnel outset. So they have a little more pumping to do. They wanted us to pump it back up to where they would have gotten it from natural runoff. That was too much. But when they joined the District, some agreement was reached about it.

SCHIPPERS: Yes, I think they got a bargain on getting into the District because of it. Besides the San Jacinto Tunnel and the pumping plants, were there any other really difficult spots?

HINDS: Well, there were no difficult spots in connection with the pumping plants. That is where we were making history. There were no difficulties with the structure sites anywhere. There were some difficulties on the Casa Loma siphon, but they occurred gradually over the years. By the time I left there, we hadn't gotten into appreciable trouble.

The flat country north of Hemet is all a deep plug of soil or dirt of one kind or another in between two faults that are about three or four miles apart. There is a gradual creeping on these fault faces. Every once in a while, if you are driving in this area, you may encounter a little hump in the road. Every two or three years they smooth them out. Well something like that is happening in the siphons. They have been having some repairs, but nothing outstanding, no threat of a catastrophe. So, just from a construction point of view, I don't think of anything that was particularly difficult.

One thing that occurred when we were building our lined canal was that the contractor left the canal unprotected against drainage for quite a long distance (during construction). Well, one week we had as much rain as we usually get in a year, and all that flat country just got like a sea of water, because the arroyos aren't big enough to take such drainage away. They don't have water like that very often. This time it got in under the canal lining and floated it. We had a little trouble there, but we were able to take care of it without difficulty.

SCHIPPERS: Besides the pumps and the largeness of the conduit, what other innovations in design do you think the aqueduct contributed to the advancement of engineering?

HINDS: Well, the job as a whole made quite a contribution to the development of automatic welding for steel pipes. When we began the project, riveted steel pipes were still common. By the time we finished, a riveted pipe was "old hat" because we were welding them so successfully and so efficiently. Particularly for shop welds. They called it shielded welding, and they were doing it so well that the weld was stronger than the pipe. All the pipes that we were using were shop welded in the longitudinal joints.

But on the penstocks, Bob Peabody still wasn't buying field welding for the roundabout joints. It was, at the time, hard to use nonoxidizing shield equipment in the field. So Bob insisted on riveted roundabout joints for all penstocks. I don't know whether they used rivets on the new sections they have just built. I have an idea that they went to welded field joints, because they have perfected such welding so thoroughly in recent years.

The aqueduct really served to put two things on the map. (That wasn't so much from a design point of view, but it was from a practical construction point of view.) One was that of welding big heavy steel pipes, both in the field and in the shop. Another was the development of and ability to manufacture and handle large diameter, reinforced concrete pipes. That had not previously been

practiced so much. We put the first one in over on the Coachella division, in a short canyon with steep slopes on both sides, for a trial installation. When bids were called for, the United Pipe Corporation was low, and they put it in successfully.

In coming from Lake Mathews to Pasadena, we used pipes of that kind almost exclusively. They were large for that time--ten or twelve feet in diameter, precast, concrete pipe. Out on the main aqueduct, all of our big concrete pipes were cast in place except the trial one mentioned above. On the distribution system, we had long distances without turnouts. At that time we weren't retailing water in that area. We were bringing the whole half capacity of the aqueduct to Pasadena for distribution as needed.

SCHIPPERS: How much contact did you have with Mulholland?

HINDS: With Bill Mulholland? I didn't have too much contact with him. But had known him for many years.

SCHIPPERS: Could you describe him?

HINDS: Oh, my gosh. I couldn't describe my father.

SCHIPPERS: Oh, you couldn't. [laughter] Not physically. What kind of man was he?

HINDS: Well, he was a man of great self-confidence and great force, and a man of very good judgment and great courage. He had the courage of his convictions and he

was a man of great foresight. He began the construction of the Owens River Aqueduct in 1907, because he realized that Los Angeles was going to have to have more water. They had a lot of water, but not enough. They were pumping it from wells in the Los Angeles River basin. They had an old Spanish grant giving them all the flow of the Los Angeles River. This included both groundwater and surface flows. Mulholland estimated they had water for ten or fifteen years. So looking ahead he started for more. The town was small; it might not have grown, but he thought it would--and it did.

He was a man, as I said, of exceptional vision. He could express himself very well and forcefully, and he could command the respect of the public. When he decided that in a short time they were going to need more water because the town was going to grow, the people believed him. He had something of a battle in selling bonds for the project. He won it. Then, when he finished this job in 1913, he immediately turned his eyes to the Colorado River for future needs.

I have a picture of him that I think a lot of. It was taken in 1923, just ten years after the completion of the Owens River Aqueduct. Here he has a pack on his back and a sleeping bag, heading for the Colorado River. By 1929, when I came here, he had, with the help of others,

put over the idea of going to the Colorado River. He not only sold it to Los Angeles, but also to the surrounding cities. He had already gotten a $2 million Los Angeles bond issue to finance the preliminary work.

He had the preliminary work pretty well along when this new bunch that he picked came in. (I mean he picked Weymouth, and Weymouth picked the rest of the bunch.) Mulholland was ready for them to take hold and begin the definitive estimating of the different routes. It took a man of all of his qualities to have foresight and courage and confidence in himself, and confidence in the future of the town, to do this. And he had all these things and the ability to convey his confidence to other people.

SCHIPPERS: Did you ever hear him talk about one of his projects that broke--the San Francisquito Dam?

HINDS: No, I never discussed that with him. That broke him. You see, that dam failed in 1927, a year before I arrived here. It was very hard on Mulholland. I never broached the subject with him. I talked to a lot of other people about it, but never with him.

SCHIPPERS: He really felt personally upset about it?

HINDS: Oh, yes he did. He couldn't help it. Any engineer that had been in charge of a thing like that would

feel personally upset about it. You know this area right here in Santa Paula was devastated by it. The whole Santa Clara Valley of Ventura County. He took the blame.

SCHIPPERS: Yes, he did.

HINDS: He said that he, and he alone, was responsible for it. He shouldered the load and it almost killed him. He had lived a long and useful life though, and Los Angeles and Southern California owe much to his memory.

SCHIPPERS: They certainly do. How much contact did you have with Mr. Mathews?

HINDS: Relatively little. My knowledge of him is mostly hearsay, but I knew a lot <u>about</u> him, at that. And I knew what he was doing. But I don't think I ever went into his office and sat down and talked to him. I have talked to him in other places, say, in Washington or someplace like that where we'd be off on a trip together. But I never got intimately, personally acquainted with him. I did get well enough acquainted that we were good friends. We knew and trusted each other.

One of his sons, I found, is a doctor down in Los Angeles. Sam Mathews. I've had him do a little for me--I mean, <u>on</u> me.

SCHIPPERS: Did you ever have any contact with Ezra F. Scattergood?

HINDS: Well, I had much more to do with Scattergood than

I had with Mathews. But my contact with Scattergood wasn't too direct. I only got some contact with Scattergood through the fact that I was assistant chief engineer of Metropolitan, which resulted in some managerial contacts. We had to work together on getting the contract for power from the Bureau of Reclamation. The technical parts of that was all in J. M. Gaylord's hands in our department but, nevertheless, I got in on it as assistant to the general manager. And Weymouth, of course, was personally in on all of it.

There was one thing where we hit head on with Scattergood. The City was one of the contractors for power from Hoover Dam, as was the District. The District had contractural rights to a third of all the firm power, plus first call on secondary power. The City, the Edison Company and Cal-Electric had the remaining firm power. Scattergood had designed the transmission lines for Los Angeles, and he used a special kind of patented transition conduit. It was, in effect, a hollow tube made up of small laminar strips twisted together. It was supposed to have some electrical advantage; I don't know what. But it was expensive and our people didn't think it was worth the cost.

Another kind of conductor that was more or less new

at the time, but that was pretty well established, was a twisted cable of aluminum wires over an untwisted steel core. The aluminum carried the current, and the steel kept the line from sagging. We found that by using this, we could save a lot of money.

But Scattergood took it upon himself to be dead set against it. It wasn't his affair really, but he fought us like everything. He even went back to Washington and every place else and fought us. And it looked like, for a time, that we were going to have to give in because of political influence, but we went ahead with our aluminum line. It worked out all right and is still good. Scattergood's line was also good. That's about the only time that I ever really came to grips with him. (He was with the City you know.)

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SCHIPPERS: You started to talk about the Parker Dam site and it sounds so interesting I thought we should put it on tape.

HINDS: Well, the Parker Dam site was half in Arizona and half in California. Arizona was opposed to the project. It would have been impossible, at that time, for the Metropolitan Water District to get a permit to build the half of the dam in Arizona. So, we made a contract with the Bureau of Reclamation whereby we would furnish the money in advance, and the Bureau would design and build the dam for us. We still retained the right to sit in on the designs and the construction plans.

When we got started on the designs, the question came up as to what kind of a dam it should be. Obviously, because of the great depth of porous gravel above bedrock, the site was not particularly suited to being a gravel- or a rock-fill dam with an earthen core, because it meant clearing the deep channel for such long distances up and down stream. The total depth of bedrock was about 235 feet, giving it the title of the deepest dam in the world. (I think it probably still holds that title, for whatever it's worth.) The damsite rock was excellent.

So it seemed that, in view of the enormous excavation and other items involved, it should be a concrete dam.

Then the question came up whether it would be a straight gravity dam, where the dam goes straight across the river with the back side sloped so that the water goes over and then slides down and goes off fairly smoothly downstream, or whether it should be an arch dam. Well, the reason that we thought first of a straight gravity dam was because we thought that the straight overflow crest would give a smoother flow in the river channel downstream and less disturbance to the power outlets. Water flowing over the curved crest of an arch, we thought, would cause more disturbance. We made models and tested. To everyone's surprise, the curved dam was better. So it was an arched dam.

We found that the arch was not only the most economical from the point of view of concrete (an arch dam takes less concrete than does a mass gravity dam), but it was also far superior as to turbulence. The reason for the latter was the great depth of the downstream water, affording a deep pool for the overflowing jets to plunge into. They all came together in the middle of the stream and rather neutralized each other.

SCHIPPERS: Did you ascertain that on the model?

HINDS: On the model, yes. We took pictures of it, numerous

pictures, and then we took pictures of the dam when it began spilling after it was built. It was hard to tell one picture from the other. The prototype ran so true to the model that it was quite surprising. Of course, it would be wrong to assume that this would always be true of any dam you might be building. It was the deep pool that did the trick.

SCHIPPERS: Did the Bureau do the final design work on it?

HINDS: Yes, they did, but the designs were all checked in my office because we were putting up the money, you know. I knew that the Bureau people knew more about it than I--or certainly as much--but two heads are usually better than one. It's just as well to have somebody look over your shoulder. We had no differences of opinion about any of it at all, not even about the large 50-foot square spillway gates. After the matter of the shape of it was settled, there was no difficulty about the design. It was checked as a matter of routine, more or less, but we <u>really</u> checked it. We didn't find anything wrong with what they had laid out.

When the Bureau began construction, the State of Arizona was still opposed to it. But an interesting situation developed. A group from Arizona went down to Parker Ferry (highway traffic then was carried across the rivers in

ferries), charted a ferryboat and put some armed soldiers on it. Then they steamed up to the damsite, to close it down.

SCHIPPERS: Were you there?

HINDS: I wasn't there. The Bureau people were. They quit, but they went back to Washington and got a special law passed through the Congress authorizing them to build the dam, on the theory that the river is navigable. But, anyway, Arizona got a good deal out of it.

This dam was built primarily as a diversion structure, for diverting a part of the Colorado River water into the Colorado River Aqueduct. In addition, it had a considerable storage capacity. One of the primary purposes at that time was to clarify the water, which at the time was muddy. It also afforded regulation and reduced the pumping head at the intake plant.

SCHIPPERS: You were saying Arizona got a good deal out of it.

HINDS: Oh, yes. The idea was that, since we were building it and it was going to have a fairly constant head, it would be a good place to put in a power plant. So one was installed, two units. The Metropolitan Water District installed one unit, and the federal government was authorized to install another unit for Arizona. So Arizona got half power that was produced without cost.

We didn't resent that. We considered that we were paying them for the privilege of using one of their natural assets, which was the fall in the river at that point. Just what deal was made between Arizona and the government, I don't know; but they built lines to Phoenix, so Arizona must be getting the power.

SCHIPPERS: Now would you like to pick up with about the year 1941 and your beginning as manager of the District.

HINDS: The year 1941, at least from my point of view, was rather an eventful year in the history of the Metropolitan Water District. As the year came into being, the first part of the Colorado River Aqueduct was nearing completion. As a matter of fact, it was ready to begin delivering water by the middle of that year. The first delivery of softened water was transmitted to Pasadena for central distribution in June, and the feeder to Santa Monica (the city in the District that was most urgently in need of water) was completed in July. Delivery was immediately started to that city. Everything was being made ready to change from a construction basis to an operating basis, although there still remained some clean-up work on the delivery systems to other cities. But, of course, the rather large force that we were employing during the construction period was gradually reduced to the status of an operating organization.

Among other things that happened was that Frank E. Weymouth, who had been the general manager and chief engineer from the inception of the aqueduct, decided that he wished to retire. His health was not too good, and he felt that he had finished the financing, promotion, engineering work, and construction, and everything necessary to bring this great job into being, and that it was time for him to step aside and take a well-earned rest. About the end of July he decided, on his own, that he would retire from the Metropolitan Water District. He had some very gorgeous plans--he and his wife were going to go on trips to South America and all over the United States, and things like that. But not more than a week before his retirement day, he had another one of the heart attacks that he had been having for some years. He didn't recover and he died on July 22. Immediately thereafter, I was appointed by the board to succeed him.

The aqueduct was formally declared completed in its first part on July 31. Immediately after that, on August 1, we changed over from a construction to an operation and maintenance status. Of course, it was a momentous time for me, and it was also a momentous time for the community. With the completion of the aqueduct and putting it into regular operation, all of the then members

of the Metropolitan Water District were assured of an adequate water supply for the near future and for a long time to come. This enabled them to go forward with their plans for growth, and to sustain the growth that comes every year with the influx of people from other parts of the world, without any danger or worry about water for the immediate future.

There was no one then that was foolish enough to think that this first stage of the aqueduct, which provided for delivery of 750 second-feet, continuous flow of water to the District, would be adequate for all time. Actually it was less than half of our entitlement under government contract to water from the Colorado River. None of us at that time thought that even our full entitlement of 1500 second-feet steady flow, or 1 million acre-feet per year (plus San Diego's contribution) would be enough for Southern California's ultimate needs.

This flow was estimated to be good for perhaps twenty-five years, which turned out to be a very good estimate. Beyond that, after we had used up all the water we could get from the Colorado River, we would need a new source. This problem we, of necessity, left to future generations. So we settled down to furnishing water to such areas as needed it and to offer it to selected surrounding areas that wished to participate in the project.

By 1942, we were beginning to gather up the stray towns all around us. For example, in June, there was the annexation of the Coastal Municipal Water District, over southeast of Los Angeles. As we went on down through the years, we kept adding more and more areas to the District, finally including the San Diego County Water Authority, the area around Hemet and essentially all of the areas immediately adjacent to Los Angeles and to the other thirteen original member cities, including the areas to the east of Long Beach and in the general direction of Orange County. Annexation was advancing rapidly.

SCHIPPERS: What did this annexation mean to you as a general manager? How did it affect your job?

HINDS: Well, it affected the job of the general manager because there were many decisions to be made. There were those in the District, in the early days, that were opposed to annexation. They thought that the water to which we had acquired a right would be adequate for the ultimate needs of the Metropolitan Water District, as of 1942, and they felt that we should not spread the water over too great an area, so that we would immediately have to start after more. They thought that we should let the other areas take care of themselves, holding our water for our own use. Every application that came in for an-

nexation to the District brought that question up anew. Some of the members of the board and many private people supported this idea. As a matter of fact, when I first went to the District, I subscribed to this idea. The philosophy was: "We've got enough water now for the ultimate needs of our present area. Let's build a fence around this area and keep the water for the future. Let's not give it away to others."

But as time went on, some of us began to realize that the economic development of the surrounding areas (our back country) was important to Los Angeles, and to Metropolitan. Without water they could not develop. There was no unappropriated water in the Colorado River and no other surplus source conveniently at hand. So, these fringe areas had no place to go. And if we wanted to be a part of a generally prosperous Southern California, we would have to take them in with our group.

SCHIPPERS: You say "as time went on." Would you specify what year you started to think that way?

HINDS: No, I couldn't name the year. But it was after I was general manager and chief engineer.

SCHIPPERS: Was it before the time that the San Diego County Water Authority annexed to the aqueduct?

HINDS: I believe it was after that time. It certainly was not a part of the consideration in the case of San

Diego for a definite reason. San Diego had a filing of its own on the Colorado River, which could be merged with Metropolitan's water right. Their water right was smaller, but just as good as ours. There was opposition both in San Diego and in the Metropolitan Water District to the annexation of San Diego, and it took quite a while to get that straightened out. I was always in favor of it myself.

SCHIPPERS: What about the Laguna situation?

HINDS: Now you take Laguna and many other areas in that vicinity. If they came in, we would just share our water with them. In effect, we would be saying: "We've got water. You haven't any. You come in, and we'll share it with you." There was lots of opposition to such a procedure. The opponents said: "We have built this aqueduct and this is our water. If we keep it and don't give it away, we'll have enough to take care of us indefinitely." The situation came to a head when Pomona wanted to come into the District. The City of Los Angeles opposed it, with considerable reason. There was quite a struggle about it. Finally, some of the people in Los Angeles, outside of the Board of Directors, came to the conclusion that Pomona was a part of us and should be brought in. So they were admitted, and others were admitted later.

I couldn't tell you just when it happened, but I gradually got over my original idea that we could build a fence around a limited area and hold the water rights for future needs. The Pomona case did as much as anything to change my mind. Pomona wasn't inside the City of Los Angeles, nor inside the Metropolitan Water District, but it was definitely a part of the community. You just couldn't let them dry up and blow away. The chief stumbling block was the City of Los Angeles. I'm not criticizing; they were doing what they thought was right. After I was converted--as Billy Graham would say--I wrote a report about it and I took it to the chairman of the board.

SCHIPPERS: Was it Jensen?

HINDS: Yes. This was some little time after Jensen became chairman. He had always believed in a fence around a limited area so that we wouldn't have to go for more water right away. I had also been in favor of the fence. But I got over it because of the things that I began to see just outside the fence.

I went to him one day with a long report, and said, "Joe, here's something that I've convinced myself is right. I could be wrong, but I believe in it so strongly that I've got to present it to the board. But before I do

that, I want you to see it." I also said to him, "I don't think you'll agree with it, but I have to present it anyway. Of course, if you don't agree, the board probably won't either, but I have to present it in order to live with myself." He took it and said he would read it.

Next morning he came to my office, put the report on the table and said, "Julian, I'll support you." I nearly fell through the floor. So the report was approved by the board, and there is where the change started. So Pomona was taken in.

Then the idea got through that, say, Hemet couldn't go anywhere. There was no place they could go and get any more water, and that's a vastly potential area. So if they couldn't get in with us, they couldn't go at all. It was the same with others.

SCHIPPERS: So you went in to see him at about the time of the Pomona annexation?

HINDS: No, it was after that. But I couldn't say just when. I wouldn't know.

SCHIPPERS: What do you think was basic to the agreement that changed his mind?

HINDS: Well, it was consideration of things mentioned above. The fringe areas are a part of our community. There's nothing they can do about water if they don't

come with Metropolitan. It had become evident that if Metropolitan adopted a rather freely receptive mood to outside areas, taking annexations as they probably would come, Colorado River water would last us about twenty-five years. But, by that time, the values created by the use of the water would enable us to "go to hell for water" (I said), if we needed to. I predicted and others agreed that by that time we'd have a $10 billion assessed valuation. Well, by the time the water was all being used, we had an awful lot more assessed valuation than that. This made it possible for us to take the next step.

SCHIPPERS: Very true. When San Diego County came in, the government had decided on that aqueduct, and there was some feeling that the hand of MWD had been forced. How did you feel about that?

HINDS: No, I didn't think so. I was for the annexation. I had always been for it, so I didn't think we had been forced. It was expedited by the war situation. This resulted in a few construction details that I didn't like.

There was the ever present question of how much of an initiation charge we were going to make. I didn't get into that personally, because I thought that whatever initiation charge they paid, it would be worth it to them.

But there was some question, quite a little discussion, about whether San Diego should come all the way to the San Jacinto Tunnel to get the water, or whether we'd meet them halfway. We were working then to get the government to help with the financing, because the urgency of the need for water in San Diego was to meet the needs of military establishments--and they don't pay taxes.

SCHIPPERS: That's right.

HINDS: So I thought it was perfectly reasonable for the government to come in and make a contribution in lieu of taxes. The government finally came in with immediate money, but with the idea that all costs would eventually be repaid by San Diego and Metropolitan. It finally was settled that Metropolitan would pay for part of the line, about as we had done for others. On all the other cities, we had an early ruling that we would deliver the water to them at a point at or near their boundaries. We didn't take it into the middle of the town. Well, we decided to go along with that for San Diego. Being a county, all we had to do was to approximate the county boundary line.

The aqueduct line, all of it, was really built under the auspices of the Navy, because it was the Navy that needed the water. Construction started and had gotten

well underway during World War II. The only way you could build it at the time was under government sponsorship. It was very difficult then for a private agency to get materials allocated to build water works or anything else. We got our allocations through the good offices of the Navy. Then the Navy made a deal with the Bureau of Reclamation to build the line, and they built it--our part and San Diego's part. We each paid for our share.

SCHIPPERS: What are some of the problems you encountered when you were general manager that stand out in your mind?

HINDS: Well, the problems that I had to handle almost exclusively had to do with this annexation and expansion business. We were discussing how we were going to charge for annexations, the price to charge for water, tax rates, etc. Of course, there was always the routine business of running the aqueduct. But, gosh, we had such a good set of operators that it just about ran itself. I didn't have to go out and turn the wheels on the gates, or anything like that. Diemer was in charge of all that and there was nobody better. So far as operating problems were concerned, you could almost say there weren't any.

The pumps operated without a hitch. We had spare runners in each of the plants. But, as far as I know, none of those spare runners has ever been used. They did have a little trouble once with a unit; they got some sand

in the oil. I don't know how it got in there, but it spoiled a bearing and they had to close the unit down while they replaced it. The tunnels, the canals and other conduits continue to operate without any difficulty.

We had some operation difficulty in the San Jacinto Tunnel, because the high water pressure in the mountain began to build back up to what it had been prior to construction. Once in a while, we'd have a pop-out in the lining and we'd have to fix it. That wasn't a major thing. It was just something you took in stride.

The softening plant at La Verne was a rather big institution of that kind for its time. There weren't many like it, or as big. It was a combination zeolite-lime plant, and there was very little trouble with it. For a while we had to experiment with the different kind of chemicals because the softened water might be more or less corrosive than some of the water that had been running through the pipe systems. You see, we had started with thirteen systems. It's up to forty or more now, and many of those systems had a slightly different kind of water. Encrustation that occurs with one kind of water may dissolve in a different kind, within the pipes. The water may begin running red. These chemical problems were problems for the chemists. They solved them.

An interesting thing from an engineering point of view was the flow testing of the San Diego Aqueduct. All my life I had been "hipped" on experiments. Here was a prime opportunity to learn about flow factors in pipe--seventy-five miles of conduits, of various kinds and sizes, with an unlimited supply at the intake, and a big reservoir at the outlet. It looked as if we could vary the flow at will, from lipping full to zero. An experimenter's dream! But the dream was to fade.

To be sure that we got all there was to be gotten out of it, we employed Fred Scobey, the most outstanding hydraulic tester of the world. He had worked for USGS, the Department of Agriculture, the Bureau of Reclamation, and as a teacher at Berkeley campus of the University of California. He was tops.

We decided to start with a full flow and gradually reduce to a very small flow, thus getting a full range of tests. The first results were astounding. The measured capacity exceeded the computed capacity by about 25 percent. Everyone exclaimed, "My, what a good job of surfacing we got!" And it was a good job. We took it as an indication of modern flow factors for new, well-made modern conduits.

So we were eagerly getting ready to cut the flow

down to the next notch. Then bam! An edict from San Diego: "We need every drop of water we can get through that line. Don't cut it down for testing or anything else." The facts were that their demand was high and their reservoirs were dry. Thus ended the dream for the time. We planned to come back later, but so far as I know the series of tests has never been completed.

But a short time later, "bam" again. The conduit was overflowing at every opening down the line. The immediate idea was that a log had floated in and lodged crossways in some control structure. But there was no log.

We inspected and inspected. Finally we found that a growth of algae had so roughened the interior surface as to destroy its original pristine smoothness. We called a biologist. He prescribed a big shot of chlorine. The algae died, sloughed off and floated away. The capacity rose above the design capacity, but never again up to the original 25 percent overcapacity.

SCHIPPERS: Besides this one time when you talked to Jensen about annexation, can you think of any other times when you may have influenced policy?

HINDS: Oh, I can't specify anything aside from matters already discussed. There were some small matters, but

I'll say that the rapport between the staff and the Board of Directors was, from the very beginning, outstanding. You know, however, that you can't get any twenty-five or thirty men together and have them all agree all the time. They wouldn't be men if they were doing that. It wouldn't be good for the organization. There have to be little differences of opinion. But we never had any that we couldn't settle amicably.

SCHIPPERS: Did the relationship between the Los Angeles Department of Water and Power and the Metropolitan Water District continue to be good?

HINDS: Yes. I'm speaking for up to 1951. They've had some little differences recently that I didn't think were sensible, but that has nothing to do with what we're talking about here. The thing that you might have seen in the papers is that Los Angeles has taken very little water from the District even yet. That isn't the District's fault. That's their fault, although it isn't a fault really. After we started on the Colorado River Aqueduct, they went up to the Owens River and extended their aqueduct into other water sources to firm up their own water supply. As a result, they didn't need water so badly when the aqueduct was finished as they did when it was started. And right now they are just bringing to completion another aqueduct from the Owens River country. So

it will be some time before they are awfully pushed for large quantities of Colorado River water. And, of course, since they have to pay money for Colorado River water, they will use their own as long as it lasts, which is right.

Well, of course, we all eventually had a hope that when the Colorado Aqueduct was running full, we could sell the water for enough to carry its load--capital cost, as well as operating cost. But there was a catch to this. When it got full, they envisioned the need for more.

So they had to go in on the state's Feather River Project. Its capital cost will be around $2 billion. Metropolitan is paying some 80 percent of this, which includes Los Angeles' share. Also, Metropolitan is spending $800,000, or more, capital cost for added distribution works. This also included Los Angeles' share. All of this can't be loaded on the satellite cities as a day-by-day water charge. If it could be, it wouldn't be fair. Until Los Angeles begins using water, they would be getting a free ride.

Well, some of Los Angeles directors, some of their water commission and some of their city council don't understand this. They want it all on water, which can't be.

If you should put the whole charge on water, Los Angeles, for years and years, wouldn't be paying anything towards the building of these works. And the other people can't afford to carry Los Angeles' part of the capital burden for them. I wrote quite a long letter to a mayor a while back, trying to explain the thing to him. I don't know if it did any good or not. I haven't heard too much about it since. But they don't want to pay for anything. That's the way Los Angeles wants to work it, and it's selfish.

But to go back to the time that I arrived in Los Angeles. When I first went to work for the Colorado River Aqueduct, I was employed by the City. And I was listed as a city employee and I was paid by the City. As I've explained before, the Metropolitan Water District didn't have any money at first. They had to wait until they could levy a tax and collect it. I did a little work for the City on other things during that time.

After the changeover, as far as I have any feeling about it, there was no difference of opinion between Metropolitan and the Los Angeles Water Department as operating organizations. There was no friction between them.

SCHIPPERS: Some of the outlying areas have resentment toward the MWD. How would you explain that?

HINDS: I presume you mean resentment from outlying areas, say, like San Bernardino and Riverside. There seems to be some resentment in a few places like that. Why? I don't know. Apparently they just want to manage their own water business. As long as they have water to manage, that's all right. If they are short of water, resentment won't help. It all seems a bit childish to me, but it is of little importance. They are not being urged to come into the District. If they want to come, they know the rules.

SCHIPPERS: You mentioned that Santa Paula doesn't want to go into the District. Why?

HINDS: Well, right now they think they can do better otherwise.

SCHIPPERS: How about areas like Riverside and San Bernardino. How do you explain that long history of opposition?

HINDS: Well, each one of them has always thought that it had enough water from its local sources, but in some cases it has been found out that two or more of them are counting on the same water, and there isn't enough. They just don't want to come into the District and assume their part of the cost of its expensive system if they can get cheaper water at home.

SCHIPPERS: Are you aware that feelings run pretty high against the MWD down there? One wouldn't think of them as really very rational.

HINDS: I don't think it's rational at all. You know San Bernardino started out being a bit irrational. People always are irrational about water when they haven't got it. In the very beginning, they were one of the original members of the Metropolitan Water District and they withdrew. The excuse they gave for withdrawing was that they thought the Colorado Aqueduct was going to follow a different route and that it would come out fairly high in the mountains above them with a return power plant right in their backyard. Just what good they thought that would have done them, I don't know. But that's the excuse that some of the people gave for it. But they just didn't want in. They withdrew and they have had an election or two since and continue to vote against annexation. In my opinion the District should say to them: "Go ahead and vote on it all you want to and when you get ready to join, we'll decide whether we'll take you in or not." The District, of course, should not hold a grudge against them, but as long as they think they can do better, more power to them.

Such bitterness is the kind of bitterness that per-

vades the water business, just like there is quite a little bitterness between Southern California and Arizona. They both want the same water. It means so much to each of them that they get bitter about it.

But I don't take the bitterness in Riverside and San Bernardino too seriously. Some people in Metropolitan and some in Riverside and San Bernardino do take it seriously. Some think that Riverside and San Bernardino ought to come in to unify the whole area and put it all under one management. There is some resentment against portions of these areas making contracts directly with the State for Feather River water. That's supposed to keep them out of Metropolitan forever. Some of the people in Metropolitan don't think they've accomplished an awful lot by doing that. I doubt it myself.

SCHIPPERS: In what way--economically?

HINDS: Well, I think that they'd be better off to unify the area. But it is essentially a matter of economics.

SCHIPPERS: Then you're not afraid that the Metropolitan is likely to become an overbearing organization?

HINDS: Oh, no, they can't. That's out of the question because there are too many people involved and too many individual cities. You see, it's made up of not one group of people, but a bunch of organizations. There are too

many of them. No one of them can be overbearing because there are too many to jump on them. I don't think there's any trouble about that. For example, take the Calleguas area over here in Ventura County. That is an area that I was trying to find some way to bring into Metropolitan long before I was general manager and chief engineer of Metropolitan.

SCHIPPERS: Really?

HINDS: Yes. But there was a serious difficulty about it. At that time Metropolitan wasn't prepared to deliver water anywhere near them, and any water available within shooting distance was softened water, the cost of which is high for agricultural use, and it isn't quite as good for agriculture as water right out of the river, because it has more sodium in it. And there was no feasible way to get natural water over there.

We tried to make a deal with the City of Los Angeles whereby we could give the City of Los Angeles extra Colorado River water and then they could make some of their water available for the Simi area at fairly high elevations. But Los Angeles never would do it. They claimed they couldn't, and I think they were right. I think the people up in the Owens Valley were raising the devil about Los Angeles taking their water away from them.

The City pled that it was for municipal use, which was a higher use. They justified it on that basis and settled their suits. Well, if they took it and brought it down here and gave it to another agricultural area, there would have been trouble. And I think they were right when they denied it.

Well, then, when Calleguas later began to grow, they started to look to Sespe Creek for additional water. Well, in the first place, there wasn't enough water in the Sespe Creek for their needs. Anyway, it was all needed over here in the Santa Clara basin. And ignoring both of those things, it would cost too much to take it over the mountains, more than they really could afford. From the very beginning, I felt that there was only one thing for them to do--that was to go to the Metropolitan Water District of Southern California.

TAPE NUMBER: III, SIDE TWO

MARCH 15, 1967

HINDS: Well, they finally lost out on Sespe water, and joined Metropolitan. They immediately began growing like a house afire; as soon as they had an ensured water supply, they exploded. And there's no limit really to where they can go. The Metropolitan is good for them. Joining was a good thing, and they would have made an awful mistake if they hadn't.

SCHIPPERS: That brings up the issue of the use of water and whether the industrial use is being encouraged to the disadvantage of the agricultural interests.

HINDS: By whom?

SCHIPPERS: By any agency, the MWD for example, and is this also figuring into the thinking of state development.

HINDS: I don't think so. I don't think the Metropolitan Water District takes too much interest in what its agencies use the water for, whether you're going to use it for agriculture or not. I don't believe they do that, except I remember when I was there that I really tried my best to discourage a special industry that wanted to locate near Laguna. That was a bleaching plant for cotton goods, sheets and things like that. The reason that I was against it was that its water consumption is all

out of proportion to its value to the community for other purposes. In other words, the water can be used either for agriculture or for some other reasonable kind of industry that will be much more profitable to the community than a bleaching plant. That is an industry that shouldn't be located in a water short area. It can go where the water is. And since I've been up here, there was some talk of establishing a paper mill somewhere in Ventura County. I discouraged that as much as I could, because a paper mill is a great consumer and polluter of water. Let them go to the Northwest where the water is running out their ears, not down here.

Of course, we have a paper plant here, now, but it's a fabricating plant that uses paper that's already made. That is all right. It doesn't use much water. But to start shipping pulpwood in here, and mixing it with water, would, in my opinion, be wrong because it would use water so badly needed for other more basic purposes. We don't need to process pulp here. We can have the paper made someplace else and ship it in much more profitably.

Those are the only two cases that I know of where any attempts have been made to influence what's done with the water.

SCHIPPERS: Do you think they would make an attempt though?

HINDS: If you mean would they make an attempt to stop a paper mill, I can say that if I were there, I would try. Whether I would get away with it I don't know. I don't think I'd have any legal standing.

SCHIPPERS: You've indicated from what you have said that there always seemed to be an awareness of community needs in the planning and thinking. Was this true in most of the considerations you made within Metropolitan?

HINDS: Well, our primary purpose for being in existence was to benefit the community, and we would always take an interest in things that were being proposed or coming up because of the effect they would have in the community. But we didn't take it upon ourselves to specify in detail what kind of business anyone should go into, what they should manufacture, or anything of that kind. For example, take the steel mill out at Fontana. We were somewhat doubtful about the water needs for it--at least I was. They went ahead and built it anyway, but they finally did do everything they could to minimize the amount of water they used and to reduce pollution. They used it until the last drop of it was evaporated. They use it for whatever purpose they need it, and finally they use it for quenching their steel after it was already too mineralized to be used for agriculture or other purposes, so they couldn't

turn it loose in the streams. They had to get rid of it someway, so they just squirt it on this hot steel and if there is an excess of this unacceptable water, they'll take it out and put it on a slag dump, or anything to evaporate it.

The thing about that plant that bothered us more than anything else was the air pollution. They said that they were going to completely clean the exhausts so that it wouldn't pollute the air. Well, I doubt that they are quite able to do that. It probably does contribute something to polluting the air.

SCHIPPERS: The MWD is a pretty remarkable organization in administrative structure and certainly in the way it's operated.

HINDS: Well, I think it's been outstanding. It has been fortunate in having a very competent, earnest, and intelligent group of men on the Board of Directors. They are all men who are thoroughly alive to the needs of their own particular community, the one they represent. And every one of them is sincerely trying to do his bit, with an understanding, of course, that his community's needs have to be coordinated with the needs of the rest of the District. And they have worked it out that way. I wouldn't want you to think that when forty or fifty men gather together, they're all going to sprout wings and become

angels, but they have been a wonderful bunch.

SCHIPPERS: When you were general manager did you have to do much public relations work?

HINDS: Well, not particularly. I had an awful good public relations man there--just like I had a good operator for the system. I had Bob Diemer to run the system and Don Kinsey for public relations. Both were exceptionally good. Kinsey was very competent; he and I always worked well together. I wouldn't say that during that period I had much public relations difficulty. Whatever I did have, had to do largely with annexation matters.

I'm sorry that I overlooked the fact that we had two interim chairmen of the board prior to Jensen's becoming chairman. I'm reminded by the note you have handed me that Mr. Whitsett retired as chairman of the board in January 1947 and Mr. Rossetti took his place. Mr. Rossetti was a close personal friend. I had many contacts with him during his service on the board, both prior to and after I became general manager. He contributed profoundly to the policies of the board for the full time of his membership.

Your note also reminds me that in February of 1948 Jack Ramboz was elected chairman of the board. I had much contact with Ramboz, particularly in land matters and the acquisition of rights-of-way, because he happened to be

the chairman of the real estate committee. I knew him not only as a director, but I knew him personally. I had a very high regard for him, but I can't tell you in detail just what contribution he made as chairman. I can tell you that whatever jobs came to him he did well, whether he was chairman or not. Throughout all his years on the board he was a very valued member. In January 1949 Joseph Jensen was elected chairman of the board and he is still there.

SCHIPPERS: And what is your considered opinion of Mr. Jensen?

HINDS: Well, Mr. Jensen is a very productive thinker, and not only a thinker, but a doer in the interests of the District, just as a plain member from Los Angeles, or as chairman. I only had three years with the District after he became chairman, but I remember those years very well indeed. I don't remember that he influenced the board very much more than he had before he became chairman. He always had a dominant influence and was deeply interested in all the problems of the Metropolitan Water District. After he became chairman, he continued in that same way, perhaps with a little more effectiveness in carrying out his ideas. He was very unstinting of his time. He spent a great deal of time on District business

for which, of course, he was not compensated. And there was nothing having to do with the District's business, particularly with the District's water supply, that he didn't pursue diligently. He's been a very good member of the Board of Directors, and a good chairman.

SCHIPPERS: He's been the center of some pretty sharp controversies, and one of them, of course, occurred after you had left the MWD. This was in regard to the development of the California Aqueduct.

HINDS: Well, he took an interest in that because it was something in which he had strong opinions. He took the same kind of an interest in it as chairman that he would have taken twenty years before as a plain member.

SCHIPPERS: Are you aware that it is said that he was really in strong opposition to bringing in the water from the north originally.

HINDS: I never knew him to be in opposition to bringing in water. He's been in very strong opposition to some of the procedures, but I never knew that he was in opposition to more water.

SCHIPPERS: I'm not fair to him and I have stated that badly. Actually, he was against the passage of the bond measure.

HINDS: You're talking about the state bond issue.

SCHIPPERS: Right.

HINDS: I didn't know that. He has supported all of the bond measures required by the District to handle the water after it gets in, I know that. And my opinion, now, is that he heartily approves of the idea of bringing the water to Southern California from the northerly part of the state and he supported the contracts between the District and the State of California. He probably has some misgivings about the details of the contract the District was asked to sign. I am not sure about that. If there was something he didn't like, he would fight it.

SCHIPPERS: He most certainly did. You were going to tell me how these rather remarkable set of annual reports of Metropolitan got started.

HINDS: Well, of course, every year, before the starting of this series, there was a report of some kind on what we had been doing for the year. They were not published, merely typewritten with a few mimeographed copies. And then, in 1938, it was decided to make a report on what we had accomplished, not just what we had done in 1938, but what we had accomplished through the conception, planning, and building of the aqueduct. And for that we had with us a man that was an excellent writer, Mr. Charles A. Bissel.

If I were to tell you that he and I were classmates

in the University of Texas, beginning in 1904, you'd think for sure that I had picked him up someplace as a pal, but I didn't. The former chief engineer, Frank Weymouth, knew him in the Bureau in Washington. One day, he came to me and said, "You know, there's a man back in Washington that we ought to have on our specifications." I asked who and he said, "A fellow named Charlie Bissel." Well, of course, I was delighted, and I said, "Sure, why not?" We offered him the job and he came.

He did a great deal of work for us on specifications and feature reports. When we finished an important tunnel, he wrote a feature report on it. He was good at it.

Well, in 1938, we decided it would be a good idea to write a history of the construction of the project. Bissel understood the job of preparing this report. It was entitled the History and First Annual Report. The format seemed to be pleasing to everyone and it has been followed to this day. After Bissel went away, a man named Ezra Rider took over the report job until he retired. I do not know the name of the individual who is handling it now, but whoever he is, he is doing a good job.

SCHIPPERS: Yes, they're really good. I don't think you've explained yet why you decided to leave the District.

HINDS: Well, it was not a matter of decision. As soon as I became chief engineer and general manager, I thought that the District should have some kind of retirement plan. We had never had any. I began working on it and finally brought it into being, about 1945.

We procured a contract with the state to have our people taken into the state retirement system. That was possible then. I think it still is. Any municipality, or quasi-municipality or governmental organization such as Metropolitan, can participate in the state's retirement plan by meeting certain requirements and rules. It looked like a pretty good plan. It required compulsory retirement at age seventy. It hit me a little hard because I was so close to age seventy that I had little time to build up a base. I thought for a time of exempting the general manager's and chief engineer's position from the plan, but in the end, I didn't. I thought, "Well, what the heck, maybe when I get to be seventy they won't want to keep me anyway." When I did reach seventy, I just waved goodbye and said, "Give the job to Diemer." And that's how I quit.

TAPE NUMBER: IV, SIDE ONE

MARCH 21, 1967

HINDS: [continuing discussion of his retirement] Thus I left the Metropolitan Water District by my own doings, but when the time came, I didn't exactly feel jubilant. However, under the rules that I had established myself, I had to go.

And with retirement approaching, my wife and I, although very happily located in a home we had built out in Westwood, thought that when I was no longer tied down to Los Angeles by a job, it would be well to get out of the "rat race" and move to a smaller community, free from smog. We looked at La Jolla, Claremont and a dozen other places where we might locate. We hadn't made up our minds but were just looking around to see if we could find a "nice little place."

Well, a few months before time for my retirement, I was visited in my office in Los Angeles by a delegation of directors from the United Water Conservation District of Santa Paula. I had never heard of this district before, but they sang me a song that was interesting. They wanted to know if it was true that I was retiring at the end of the year, and I said, "Yes, it's true." They asked, "Well, how would you like to come up to Santa Paula and build us

a couple of dams?" Well, I liked that idea, but said, "I couldn't answer right off. I would have to think about it a little and talk to my wife."

When I told my wife what had happened, she looked up and asked, "What are you waiting for?" She said, "Well, we have been looking around for a nice small place to go and there isn't a nicer place anywhere than Santa Paula. It looks to me like it's just made to order for us." I said, "OK, that's it." So I called them up and told them that I would be glad to report for duty on the first of January, 1952. They appeared to be delighted. We made a deal right off.

They asked me if I couldn't get a little time off, to come up and kind of case the project, and get it ready for a quick start at the beginning of 1952. I said, "Well, I think I can," and I did. I employed Jack Haine, a young man from the Bureau of Reclamation, to come up and start the job. He was to work full time. Then, Saturday and Sunday I would come up, go over what he had done the past week, and lay plans for the next week.

At the end of the year I rented myself a house out in the country and began living there. I was trying to find a place in town, but at that time you could hardly find a vacant house to buy or rent in Santa Paula. So

we bought a lot and built a home on it. Now there are houses of every kind and description to buy or rent. We bought a part of a big lot and built our home on it.

The young man that I had employed from the Bureau of Reclamation to help, Jack Haine, was a very good man, but unfortunately, soon after the beginning of the job, he had a heart attack and passed away. I missed him. There I was up here all alone, with two dams to build, with no data "nor nuthin," just the basic idea that they should be built. So I had to get out and find a staff. The job was really a two-year job, after the preliminaries were over. It would take about a year for investigation; so it was really about a three-year job. It was a sufficiently difficult assignment to require good men, and it's awfully hard to go out and find good men--at a time of fairly high employment--just floating around ready to be picked up. The fellows that you want are always working for somebody else. And because I only had at most three years of employment to offer them, I had some trouble.

But I did finally get an excellent group of comparatively young engineers to join us. They have delighted me ever since. Since completing Santa Felicia, I have traveled a great deal on engineering projects all over the western United States, and elsewhere. The thing that

delights me is that almost every place I go, I find some young fellow in a responsible position who had worked for me here--and doing well. It gives you a good feeling to see that the men that you selected have turned out so well.

One of them was Neville Long. He's a Cal Tech graduate, and I found him working for Guy F. Atkinson and Company. But through some friends I let him know that I had a job for him, and he came. He was one of my right-hand men through the job, although he was quite young. He was ambitious to build dams. His wife, the daughter of a partner in the Armstrong-Schroeder restaurant at Wilshire and Santa Monica Blvd. in Beverly Hills, shared this ambition. Her philosophy was: "Go ahead and do what you like best. We'll stay with you when we can, and when we can't, why we'll look forward to when we can."

After finishing Santa Felicia, he just went right on from one dam to another, and had important positions on a number of them. Now he's down in New Zealand in charge of a hydroelectric project that consists of taking water from a high-perched lake, straight down into the ground and then putting a power plant down there with a tailrace tunnel out to a fjord. They have had some very difficult ground to contend with, but he's doing just fine. Between the time he left and before he went to New Zealand,

he was employed on half a dozen other hydro projects and buildings, mostly for the Bechtel Corporation. He has done a fine job wherever he has gone. I could go on at great length and name the individuals whose tracks I find around, and who are always doing fine.

Getting back to Santa Paula: we went ahead and completed preliminary plans for two dams--one on the Piru Creek and one on Sespe Creek. We put them up to the voters for a bond issue, and the bond issue failed. The people didn't fully appreciate their potential needs. They didn't want a lot of taxes. They didn't care particularly if the community grew or not. They liked it the way it was. I couldn't blame them for that. It is a nice place to live. But they weren't looking forward to what was going to happen forty years from now. They just wanted a nice place to live. Why not leave it alone? I was in that category myself, except that I was the one that was trying to do the work. I wanted things moving.

We had a public relations survey made that indicated that the people would go for one dam at a time, but not for two at once. The board put that up to me: I said, "I don't see why it wouldn't be all right if they realized that eventually there will be need for another one." We had shown conclusively that in the fairly near future there

would be a need for all the water that could be gotten out of developing both Sespe Creek and Piru Creek. But I couldn't say that we might not build one now and after a few years build the other. If you build a water project of any kind, just big enough for today, then you have to start on another one tomorrow. But since we had two damsites available to us, which would not only last us today but maybe until the day after tomorrow, why, we could build one at a time. We had another bond election for one dam--in Piru Creek. The bonds passed.

Then things began to pop. The type of dam selected for the Santa Felicia site was an impervious earth core, supported by upstream and downstream compacted gravel shells. Such a dam could not be constructed in a single dry season, so we scheduled it for two seasons. Because of the depth of the underlying gravel, a large percentage of the work was below ground--excavating the foundation and building the dam back up to stream bed. If the next floods should come while the low level work were only partially completed, previous work would be destroyed. So, it was important that the work be started at the beginning of a dry season.

The bond issue passed in November 1953. To avoid losing a year, we wanted to have a contract set, equipment

moved in and work under way in April 1954. We had "estimating" drawings, but no detailed construction drawings, and no specifications. These documents had to be produced almost "overnight," you might say, if ground was to be broken around April 1, 1954.

We didn't have the force to do it, nor time to build up a force. So we called for help. This call was answered by the Bechtel Corporation. They had a force of designers down here working with our own engineers within a week or so. And we made it. All documents were prepared, bids were called, a contract let, and work started by our deadline date.

So, we went into the foundation in the spring of 1954, and were out before the rains came. By April 1955, we were ahead of schedule, and everything was "go" for the final push. From here on, everything was a must--no place to stop, short of the top. We made it, with time to spare.

SCHIPPERS: Did your outfit select the damsite?

HINDS: Yes. This stream had been prospected many times in the past, also Sespe Creek, for alternative damsites. The one site on Piru Creek that looked best was the Frenchman Flat (or Pyramid) site near Gorman. It had a trouble--Highway 99 goes right through the middle of it.

The highway department wouldn't move the road for us. To move it would have cost nearly as much as the dam. Also, it was fairly far up on the watershed, where it would intercept only a part of the flow. Then we tried a couple of others. One was the Blue Point site. It was a very good damsite, but the reservoir site was poor--in a narrow canyon. After looking at a few other apparent possibilities, we settled on the Santa Felicia site.

SCHIPPERS: What were some of the favorable points of the Santa Felicia site?

HINDS: The Santa Felicia site had several points in its favor: One was a good reservoir site above it. Here, a dam 200 feet high, above stream bed, would store the 100,000 acre-feet that we thought we needed. A wide shallow reservoir lowers dam cost and is good for recreation. A deep narrow one is better from an evaporation loss point of view and usually from a power production point of view.

There are other factors, all of which must be considered for individual case:

One at Santa Felicia was that the stream bed gravels had ample strength to support the outer shells, so the gravels had to be removed only under the impervious core.

Also, excellent construction materials were close at hand, and the bedrock was good.

And it was near the mouth of the stream, thus controlling most of the runoff.

For us it was a good site.

SCHIPPERS: Briefly what was your construction procedure?

HINDS: First, we excavated an 80-foot deep trench, sixty feet wide on the bottom, with one-to-one sloping sides, during the summer of 1954, filled it back to the stream bed with core material and compacted ground. Thus eighty feet of the dam was built that year. Then we continued to work on the west end during the winter, leaving a gap on the eastern end to pass flood flows. We blanketed the material in the gap with gravel, for protection against the next floods. The next spring we took gravel and a little topsoil off to get a fresh start. The second year we filled that gap, finished the dam and completed the spillway.

You haven't seen it, have you?

SCHIPPERS: No, I haven't.

HINDS: You ought to drive up there sometime. It has quite a little water in it now. It's about a third full. It turned out to be a happy choice.

SCHIPPERS: Yes. At that time the state was conducting an investigation in the area and apparently in their Bulletin No. 12, they recommended a damsite in another

location.

HINDS: I am not familiar with this reference, but the state approved the Santa Felicia site. It obviously suited our purposes. The state did suggest the preliminary investigation of two other sites on Piru Creek--one between Santa Felicia and Blue Point, and one just upriver from the town of the Piru. Neither of them panned out.

You might be thinking of Blue Boint at the upper end of the Santa Felicia reservoir. They thought at one time that if we would build a big enough dam up at Blue Point that they could use some of the storage for their Feather River job, making it a joint venture. But they had no construction money. They were not prepared to participate in it at that time. We talked this over very seriously with A.D. Edmonston, the state engineer, and we finally agreed that the thing for us to do was to go ahead with Santa Felicia. There was some thought that Santa Felicia should be built for larger storage capacity than it was. I favored this, but the state was still interested in Blue Point for themselves alone at some later date. A higher dam at Santa Felicia would have inundated the foundation at Blue Point. The state didn't like this, so we went for the 100,000 acre-feet. As it turned out, it looks like we just about hit it on the nose. It's been there twelve

years and it hasn't overtopped. It will overtop sometime, of course, but we're not really much worried about the overflowing.

The method of operation we are using is somewhat unusual. We don't hold the water in the reservoir until somebody can come and get it. We turn it loose and put it into the underground storage, and the people pump it out, so that the space that they pump dry during the summer months is filled up from released storage. That greatly stretches our storage capacity, you see. The farmers so far have not wanted direct pipeline delivery, because they already have their pumps, and they'd rather have the underground gravel strata as their pipelines. This is working out just fine. I still wouldn't mind if the reservoir had a little more capacity, but it is just about right.

SCHIPPERS: Do you think the Santa Clara Valley anticipates tying into the Feather River Project?

HINDS: Well, they have. Ventura County has contracted with the state for 20,000 acre-feet of water. That isn't near enough, but it'll serve them for quite a while, particularly if they ever go ahead with the Sespe project. By that time, conditions will have changed to where there will be some way for them to get more water. No one thinks the

20,000 acre-feet of state water will carry the county forever. The state has plans on the shelf for the time when this "first stage" of Feather River Aqueduct will need to be doubled. When that comes, then Ventura County will be in a position to get into it more seriously. There might be a time in the interim when they may be a bit tight. But they will work out a way. They are never going to let this valley dry up. If something happened and we ran out of water, we couldn't stop from drying up. But as long as there is water, even if it belongs to someone else, they'll get enough to get along on until the second stage of the California Aqueduct Project comes along. When they've used up the 20,000 acre-feet, everyone else will be short and the state will be building a second unit.

SCHIPPERS: So you feel that the Santa Felicia Dam is going to serve them basically until what year?

HINDS: I don't have a year in mind. I think they need more water right now. They're overdrawing, but if they will develop the Sespe and get some 20,000 acre-feet a year from that source, and take 20,000 acre-feet from the state and use all of that 40,000 acre-feet, they can get along after a fashion for quite a few years. They aren't going to have water running out of their ears, even so.

SCHIPPERS: Did the Bureau have anything to do with any

of this?

HINDS: Well, the Bureau of Reclamation, at the request of United Water, last year worked out a plan for developing the Sespe. The plan was put to a vote of the people, and it lost by a very narrow margin. Whether they will try again, I don't know. It depends on settling some of our local squabbles. We can't get all the people of the local area to agree on a plan. Read the papers up here and you'll find that out.

For example, when we were developing the initial plan, we depended on Oxnard--which really needed the water more than anyone else--to carry the bond issues. The people up the valley were understandably cautious. Some of them were a bit smug. Take the people that live in Santa Paula--an excellent group of people, many retired--they didn't want to pay taxes for water because they believed that they had plenty, with a firm right that nobody could take away from them. Santa Paula hadn't started to grow yet. But now these upper valley people are quite a little more interested. But Oxnard has joined Metropolitan and think that they can get all of the water they need from that source, so why go along with developing a local project. We're right in the middle of trying to straighten this all out.

They ought to build the Sespe project, now! Oxnard

and everyone else needs it. The Sespe water is the cheapest and the best water available for this area, now or ever. It will be a shame to let it go to waste and then go off someplace else and pay more for poorer quality water.

SCHIPPERS: There's a quality problem involved, isn't there?

HINDS: Yes. The Sespe offers the best water that we have available to us for quality improvement.

SCHIPPERS: Can the people down in the Oxnard plain use the MWD water for agriculture?

HINDS: Well, they are.

SCHIPPERS: They had to do something to it, didn't they?

HINDS: No. MWD water is usable for agriculture. It's not the best water in the world, but it is better than none. I remember our chief counsel who lived in Pasadena, some of his friends came around and began complaining that all their azaleas were dying because of "that darned old Colorado River water." The advice given by our chief counsel was: "Why don't you try letting them get along without any water for a while?" That was a pointed way of telling them that maybe Colorado River water isn't the best water in the world for azaleas, but it's better than no water. Colorado River water is rather high in dissolved

solids, which is unfortunate from an agricultural point of view.

The water that comes to Oxnard from the Colorado River is taken from a line that carries softened water. Metropolitan has a large softening plant over in La Verne, capable of softening about half of the water that comes into the area, because it is used primarily for domestic and industrial purposes. But for agriculture, it is more expensive and less desirable. There isn't any really easy way to get unsoftened water to Oxnard. I don't know when they'll ever get an unsoftened pipeline of any particular size ever close enough to serve Ventura County.

SCHIPPERS: [tape recorder turned off] In your opinion, do you feel that the Sespe should be developed?

HINDS: Yes, by all means. I think that it's the cheapest and the best supplement that they can get here. It isn't adequate for all time, but it will always be useful.

SCHIPPERS: When do you think this development may take place?

HINDS: Well, that's difficult to say, because there has grown up, as often occurs in the case of water problems, sharp differences of opinion and some emotional attitudes to some of the problems. It's difficult to get all of the communities together. The United Water District is

not a single community. It's small enough that you might think it would be, but these relatively small towns which are growing and prosperous, each gets its own idea about water. It's hard to get them all to think alike about it. Of course, I always think that my ideas are the best, but the people don't always agree with me. I don't say that dogmatically, of course. I don't expect everybody to agree with me. But I do think that these communities ought to find a way to get together.

The difficulty is that two or three years ago, Oxnard as a city, joined the Calleguas Municipal Water District, which lies further east in Ventura County, east of Camarillo, and is a member of Metropolitan. At a great expense they joined in the building of a pipeline from Glendale through Simi Valley, with a branch to Oxnard. That was an expensive pipeline to build. Its cost would have contributed materially toward building a sensible development of the Sespe. I don't say it would have built it, but it would have helped. Now that they have this pipeline they want to depend on it, although it costs money to use it. One thing is that they have to pay back taxes to the Metropolitan Water District, designed to pay their share of the investment on the Colorado River Project. This tax levy is presumed to be based on the taxes that

the annexing entity would have paid if it had joined in 1930. They are allowed to pay it in installments. They don't figure it quite that way.

Now, they have settled on some simpler procedure, but with the same basic purpose. It is to all intents and purposes an initiation fee. I have heard it said, but can't vouch for it, that the present fee is $200 per acre. For farmland that's pretty high. But if you take into consideration that some of the land being brought in has no water at all, and that when they annex, the price of the land increases far more than $200 per acre, the charge is not unreasonable or unjust. Somebody's got to pay for the cost of development. It wouldn't be fair to let newcomers in without buying into that facility. Whether the amount they are asking now is reasonable, I do not know.

The Metropolitan Water District also assesses a small annual ad valorem tax on its constituent areas to help constituent areas to help continue preparing for the future. This tax amounts to about 14 cents per $100 at the present time. In addition to these items, Oxnard has to pay annual interest and redemptions cost on the several million-dollar bond issue for its delivery line, also taxes to Calleguas Municipal Water District, plus a rather stiff

charge for the water from Metropolitan. When you add these things all together, it becomes a rather formidable sum.

To me it just doesn't make sense not to support the Sespe. But if I told them this, they'd come up with answers. They're running their town, not I. I supported the bond election that we had last year. I support the Board of Directors. I think they're good men, trying to do the best they can for their community. The board members were of the opinion that there's no way to get a project on the Sespe except to have the Bureau build it. They thought voters would approve a contract with the Bureau, whereas they wouldn't vote for a bond issue. You know, the world is full of people who think that anything you get out of Washington is free. They think that the money back there grows on trees. They couldn't be further wrong.

But the Bureau is my old alma mater. I have wonderful friends back there and I have worked for the Bureau on a variety of outstanding consulting jobs in recent years. I believe in them, and I believe in their engineering ability and their engineering integrity. But they sometimes get a little wild-eyed, I think. When I went to work for them recently as a consultant on Glen Canyon Dam,

I said to Leslie McClellan (their chief engineer at the time), "Mac, if you want me to help your engineers build a good dam in a place where they've already been told to build it, why, I'd be as happy as everything to help. But please don't try to get me into your politics." He says, "I know what you mean. We want you to help build dams--nothing with our politics." [laughter] And that's how it went.

But on the Sespe they came up with a $90 million project. Well, they were not just for water conservation; they put in a lot of recreation, made places to water ski, to swim, to fish, flood control and places for boating. It's all right to put those things in, but somebody has to pay for them. The Bureau offered to pay for all the extras, but it still cost the taxpayers' money. You can build a project on the Sespe that will conserve water for beneficial use for a lot less than the part that they wanted to charge to United. And when I say a sensible project for the Sespe, I mean an honest-to-goodness figure on how much you need to spend to develop the 30,000 acre-feet of water that's going to waste.

Then if somebody else wants to add something, make them put their money on the barrelhead. If we pass our bond issue to do that one simple thing and somebody comes

along and wants to add a fish pond, let them finance it. Any dam built would be available for recreational use, just as at Santa Felicia, but they want to go further than that. They want to put in a lot more dams, little dams, for the people to play in. Well, I'm not opposed to that, but I think what we need first is water. We need some recreation; it will cost so much; let's get somebody to pay for it. But whenever the county is willing to go along with a reasonable scheme of financing a sensible development of the Sespe, we'll get going. But Oxnard has to be willing to join us. It would save Oxnard money.

SCHIPPERS: Now this tendency of the Bureau to sort of get bigger and bigger, what would you attribute that to, just to the law of bureaucracy?

HINDS: Well, yes. It seems to be the order of the day in the federal government--build everything bigger and hopefully better. If you'd propose to build a project just the right size for the conservation of this water, they'd say, "Oh, that's too little. You must make it big, big, bigger."

I'll give you an example: On a job I'm on up in Washington, there's a reservoir that has, I would say, some two-hundred miles of shoreline. Some six or seven miles of it are bordered by a railroad ten or twelve feet above the water level and close to the shore. The rail-

road is built on friable, sandy rock. There's no place to move it cheaply. Well, the thing to do was to protect it with riprap. Well, do you know the government didn't want to let them riprap it. They said, "We don't want you to do anything like that. It takes shoreline away from the people. What you should do is to beach it with sand."

Well, that would fill that reach of the reservoir half full. To try to put a beach there would be perfectly senseless. They had been told from the top: "Put recreation and beautification above everything." There are at least eight reservoirs below this one on the Columbia River, so that they've got a double shoreline all the way from Portland up to the Canadian border. It's all shoreline with very few exceptions. To say that you can't take eight miles out of all that and riprap it to keep a railroad from sliding into the lake, just doesn't make sense. It's sort of the same thing with all of government things. I believe in being a liberal; I don't believe in being a reactionary. But I think you ought to be sensibly liberal.

SCHIPPERS: Certainly there's an issue here, too, that dates back to the Central Valley Project days, isn't there, in that the Bureau came in and developed an area and then

started imposing restrictions?

HINDS: I presume you are referring to the 160-acre limitation in Ventura County. They had worked out a scheme where by this restriction could be avoided.

Originally, the 160-acre limitation was not as unreasonable as it is sometimes thought to be. The purpose of the Bureau in the beginning was primarily to develop public lands that were lying unused because of lack of water. So the Bureau would go around and build irrigation projects to water those lands. Then, they'd dispose of them to settlers. In order to keep speculators from getting a big cut out of it by buying up the settlers' lands and then selling them at high prices, they limited the amount of acreage that one man could water from the project. These projects were financed with funds that came from the sale of public lands, not general funds. When a man took up land from the government, he was supposed to pay enough to cover the price of the land and the cost of the work within a period of ten years. The payment period was gradually extended to twenty, thirty and forty years. As the money was coming from the sale of public land, the government was paying no interest on it; so they charged the settlers none. This was sort of a subsidy, and they didn't want to subsidize one man

for more than 160 acres. This was the original concept of the 160-acre limitation (it was 320 acres for a man and wife). But when they come to private landowners, if they gave these owners a long time to pay back the costs with no interest, that wouldn't be fair. But what they need to do is put an interest component back into the deal for large acreages. If you want to help the little fellow, you can still forgive the interest up to 160 acres. That's the way I think they should do it.

SCHIPPERS: Were you in any way involved in the efforts of the state to buy back the Central Valley Project from the Bureau?

HINDS: No, I was not.

SCHIPPERS: Do you think it might have been a good idea?

HINDS: Well, I think if it had been possible, it would have been a good idea for the state to do the project in the first place. I don't know if they could have financed it.

One thing about it, I was an old reclamator at the time, and I got in on it a little--not very deeply--in an unofficial capacity. But I know that some of Metropolitan's board members were interested in it, not officially, but as citizens. I know that some of the directors of Metropolitan--the best doggone financial people you

ever saw--thought the state should insist that the Bureau should just furnish the money to the state and let the state build it. They seemed to think they could get away with that. I said, "Haw, haw. The guy that's putting up the money is going to call the tune. The Bureau is a builder, not a banker." So the Bureau built it. I don't know how good a job they did of it. I don't think it's too bad.

SCHIPPERS: No. I don't think it's a question of the engineer.

HINDS: No. I don't mean it that way. Looking at it from every point of view, I think it was a successful venture. We're better off than if it hadn't been built.

SCHIPPERS: Right. I think the resentment just grew out of what some people felt was a socialistic concept, as far as the land limitation was concerned.

HINDS: Yes. Well, the Bureau should not have done that. The scheme that I mentioned above would have been better. That was an idea that came to me after I was out of the Bureau. I wasn't in on anything where it was directly considered, but I might have sat down and talked to somebody--like I'm talking to you here, except it wasn't being recorded--and told them what I thought. But the first fellow that I know that came out boldly for it was a con-

gressman from up north.

SCHIPPERS: Sheridan Downey?

HINDS: No, Clair Engle from northern California. His idea was: if a project is to be built where all or most of the land is in private ownership, don't deprive the excess holders of water, just take the subsidy away from them and make them pay interest on their excess holdings. And I think Clair Engle's proposal for handling the problem was excellent.

In Ventura County they proposed to work it out a little differently. There are quite a number of large agricultural holdings, numerous cities and industrial areas, none of which rate an interest-free subsidy. Then, there's a great many small agricultural holdings which according to the rules should not pay interest on deferred payments. The apportionment was worked out somewhat along the Engle plan. I don't have all the details, but it was intended to give a fair deal. I don't think it was bad, but it would have been better to eliminate all of the subsidy, in my opinion. The government pays interest on its money now.

SCHIPPERS: You brought up one other theme here, and that's multipurpose development of damsites. How do you feel about that subject in general?

HINDS: Wherever multipurpose feasibilities exist they should be considered and examined. But I don't agree with government philosophy that if you go into a watershed to develop one badly needed purpose, you should be required simultaneously to develop all other potential purposes, whether the need for them is urgent or not.

For example, there is an urgent need in Ventura County for the conservation of Sespe water. It is reasonably urgent to provide some flood control. Power possibilities are limited and not economically feasible at the present time. Recreation is important, but not immediately pressing. I see no reason why in a situation of financial stringency, we should not be permitted to develop the water supply alone, as long as we agree to build our work in such a manner that will readily permit enlargement or expansion to other purposes. We developed Santa Felicia Dam on Piru Creek for water conservation only. That was all the money we had. We agreed to cooperate in future extra purposes. We have developed recreation, provided pipes to which a power plant can be attached (if and when feasible), and have built the dam so that it can be raised for flood control. In other words, we have developed our water supply without blocking other possibilities.

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HINDS: [continuing discussion of Santa Felicia Dam project] In fact, any reservoir on a stream contributes to the control of floods. For example, Santa Felicia Dam, under all circumstances, will have an effect on reducing moderate to smaller-sized floods. But flood control and conservation are not completely compatible; hence, the flood control effects, even for moderate floods, are somewhat dampened.

The mode of operating Santa Felicia adds something to the value of flood control. The water is not held in the reservoir for gradual release through the year but is released for underground storage. And it is released as fast as the gravels will absorb it without any spill into the ocean. Thus, at the beginning of the winter rainy season it's likely to be at a low level. Thus, it will absorb all the early winter floods, saving any damage they might have caused.

But, if just as we get the reservoir about full and think we've got a good water crop at least for the summer, a big flood should happen, most of it will go on down the river. It will be somewhat impeded, but not adequately so. The only way that you can really meet that situation

is to figure out how much you need for conservation and how much you need for flood control. Add the two together and build for both. We couldn't afford both, or thought we couldn't, so we built for water supply, leaving things so flood control could be added later. A flood control reservoir is emptied as fast as the downstream channel will safely take it away to get ready for the next flood. This generally results in waste to the ocean.

A good example of multipurpose dam is being constructed now up near Turlock, on the Tuolumne River. They are building what's called the New Don Pedro Dam. Well, it's a combination, or a multiservice job. The City of San Francisco, the Turlock-Modesto irrigation districts, and the Corps of Engineers are cooperating in it. The top part of it, down to a specified level, is being paid for and will be controlled by the Corps of Engineers as a flood control. Storage below that level is for irrigation and municipal use and power. It is being financed cooperatively, but is being constructed by a single agency.

This is multipurpose at its best. It has city water, irrigation water, a power plant, flood control, recreations, fish and wildlife, and perhaps other uses. They have coordinated these things to make the most out of each purpose. That's as good an example that I know of complete multipurpose development.

SCHIPPERS: Yes. Now how about the use of reservoirs for recreation? How do you feel about that? You mentioned that the Bureau sometimes goes overboard on that.

HINDS: I think that wherever it's permissible, reservoirs should be open to recreational use. But I do not approve going wild on it, and spending a lot of extra money unless someone other than the water user is willing to foot the bill. Also, the situation at New Don Pedro Dam is such that they can, without waste, let out a fairly substantial flow to go down the river to make it a live fishing stream. Of course, fishing will be excellent in the fairly large reservoir. They can also make it a bird refuge.

SCHIPPERS: You wouldn't advocate opening Lake Mathews to recreational purposes?

HINDS: That is not my problem. I always have opposed it. I don't know if I'm right or not, but if they're going to open it, I'd like to know a month or two ahead, so I can get me some land. [laughter] But the water from Mathews is used for domestic purposes. It goes through a softening and filtration plant, it's true, but some of it may eventually go directly into the homes of the area. For that reason, they thought that they wouldn't permit any swimming or boating.

SCHIPPERS: And you think that's reasonable, of course.

HINDS: I think that's reasonable, yes. The City of Los Angeles has always had that attitude towards its reservoirs. They don't even filter their water. The pipelines lead right out of the reservoir into your home. They do have chlorination plants. They've always gone on the theory that it was a bad idea to have the water used for recreation under such circumstances. I very strongly supported this theory twenty years ago. Whether I would now, I don't know. I'd have to study the details of it. I haven't been up against that problem since I left Metropolitan.

SCHIPPERS: You think though that the cost of adding a filtration system, or something, wouldn't make it worthwhile in terms of the land development and the revenue from perhaps concessions and the use of such facility?

HINDS: Well, I don't know. It's a little bit hard to make the recreation pay much profit. I know that Lake Henshaw, which was controlled by the same people that own Riverside Cement Company, permitted recreation, and they claimed to have made money out of it.

But take Santa Felicia, here they are just about breaking even. They just charge enough to make it pay for itself so that they don't have to tax the people for it. But I'm not opposed to what we are doing here, particularly

as long as we're putting the water underground, as we are doing at Santa Felicia. I think this is a service to the community. Where you can have more recreation without any detriment to your water service, I'm in favor of it, particularly if you can make it pay its way.

SCHIPPERS: Could you say something about the Bechtel Company?

HINDS: I began working for Bechtel before I left the Metropolitan; I had an agreement with Metropolitan's Board of Directors that I would be permitted to take time off, without pay, to begin building up a little consulting business so that I would have something to do after I was off their payroll. They were all quite agreeable, and I was quite careful to take leave without pay every time I went out for Bechtel. I didn't charge such time to Saturdays, Sundays or annual leave. Any time I worked, say, three days for Bechtel, I'd take three days off my paycheck for that month with Metropolitan. I wasn't making much money out of it, but I was building a little business.

I was very careful to see that this rule wasn't broken. The only time that I deviated was towards the end of my last year at Metropolitan. As I told you before, I started working in Santa Paula before my actual retirement date so as to get this project underway. I had Jack Haine up here

working full time, and on Saturdays and Sundays I would come up, go over what he had accomplished the week before, and plan for the week ahead. On advice of Metropolitan, I didn't charge off these days. They were not normal workdays. Once or twice I took a day of my annual leave to work up here. The only time that I ever did that was to come up here to work for another public organization.

After I moved up here I continued my work with Bechtel until now, right straight through, some twenty years (I don't know exactly without looking it up). This has been a very good arrangement for me. As a matter of fact, I shall be forever grateful to them for having picked me up when Metropolitan turned me out to pasture to eat grass.

I wasn't too lonesome until after I finished Santa Felicia. But after that, it was good to have a fair number of consulting jobs. They gave me something to think about, even when I was not working for pay. I charged it to education. I think it's had a lot to do with my being able to keep going as well as I have.

SCHIPPERS: Your work for them, did that get you into any of the studies that Bechtel did as consultants on the Feather River Project?

HINDS: Yes, it did. At that time I understood that I couldn't work directly for the state. I don't know if

I was still working for United then or not, but at any rate Harvey Banks called me up and asked if I would be willing to serve on a board of consultants for the Feather River Project. I said, "There was nothing that would please me more." But I asked, "How are you going to pay me?" He said, "What do you mean? We can pay you." I said, "I don't think you can." He asked, "Why not?" And I said, "Well, I'm retired under the state retirement system, and I understand that precludes my employment by the state." And he said, "Well, I think you're wrong, but I'll look it up, and call you back." He never called me back, so I think he came temporarily to the same conclusion. But I found out later that I was wrong.

I found it out when Walter Brown, who was the state engineer for safety of dams at that time, wanted me to serve as a consultant on the Malibu Dam. I told him I would. Arrangements were all made--where we were going to meet and all that--then he said, "I suppose you understand about our pay schedule?" I said, "Yes, I know, Walter, but it makes no difference. You can't pay me anyway." He says, "Why not?" And I told him. But I said, "Don't let that bother you." Walter worked it out, and they paid me.

Well, ever since then, they've been able to employ

me. I'm doing a lot of work for the state now on the Feather River Project. Also, for quite a few dams for the Dam Safety Section.

But for the state work that I did for Bechtel earlier, I still thought that the state couldn't pay me directly, and so we went through Bechtel. Actually this was not necessary. And that's how I got in on the preliminary investigation.

SCHIPPERS: Which addressed itself to what problems specifically?

HINDS: Well they were very general problems. One on which I did the most work was the Oroville Dam. We went over that site in great detail. We helped them figure out where to get the material and how to get it up to the site. We checked the spillway location and its general features. But I was not on the state's general Oroville Dam consulting board. It was too far along and in charge of another board before I found that I was eligible. So I'm not on that, but I'm on the Castaic, which is probably as important as they have, and numerous others. I was not on the San Luis Dam, a big one up at Los Banos, except for the general reconnaissance when I was with Bechtel. I also reconnoitered the general location of the aqueduct. I gave particular attention to the possibility of taking

it over to the coast, up in the Los Altos area and around Paso Robles, in an attempt to avoid the Tehachapi Mountains and the San Andreas Fault. This coastal route coming around through Santa Barbara and Ventura would have been very good for us in Ventura County, but it turned out to be expensive and very complicated.

SCHIPPERS: In effect, that report really endorsed the plan that the department had worked out for the aqueduct route, didn't it?

HINDS: Yes. We just confirmed that they had done about as good as they could do. We were very sincere. We wanted the alternative scheme, but it didn't have enough advantages to offer to justify the change.

Metropolitan, which is to pay 80 percent (more or less) of the cost, was strong for the coastal route. They were also flirting with the idea of going to the northwest corner of the state, getting their own water and bringing it down independently of the state. They employed Bechtel to make a reconnaissance of that, and I went with them. We inspected the Eel River, and all of the other sources up in the vicinity of Eureka, and made estimates on ways of getting the water down here. It finally was dropped, although to my surprise, the people of the northwest were in favor of Metropolitan's project. It offered them some

badly needed flood control. They didn't need to worry about the water, but they were worried about the floods. But the state still has that source of water to supplement what they've got in Feather River.

SCHIPPERS: In establishing the Central Valley route for the aqueduct, you as much as said it was economically the best thing to do. How about the lift over the Tehachapis?

HINDS: Well, I was a loner on that. The City of Los Angeles has a tunnel near by the state's crossing that goes through the Tehachapis and crosses the San Andreas Fault way down deep in the ground. It's sixty years old and never has caused trouble. It would have been much simpler and much cheaper to build a low-level tunnel through the Tehachapis and save a lot of pumping. But no one would agree that that would be safe. I believed in the scheme, but I probably was wrong. I knew that there was enough doubt about my position that I didn't argue it too strongly. We certainly would have saved a lot of operation costs by eliminating the 2,000-foot lift over the hill. I had been thinking about that crossing and scheming about it for years before there was any Feather River Project. I was rather disappointed when I found out that they had their hearts set on going over the top. But anyway that's how it is, and I refuse to be sad about it. So I never

made a point of it. I don't think I would have gotten anywhere if I had.

SCHIPPERS: How about the storage site? On this side of the mountains, do you think it's in a good spot?

HINDS: At Castaic?

SCHIPPERS: Yes.

HINDS: Yes. I do. I wasn't too enthusiastic about it at first, but we've been going over it thoroughly for the last three or four years. The state has made a most thorough examination. For one thing, the site was deeply overlaid with alluvium between the surface and the bedrock. The bedrock is not anything to write home about from a gravity dam standpoint, but it's stronger than any earth that's going to be put on it. It isn't too hard, but it's good rock to support an earth dam. There was at one time a feeling that there might be a fault up and down the creek, maybe a fairly serious one. To investigate this, they drilled holes all over the place, dug many big pits, tunnels and auger holes big enough for you to go down in and see what it was like. Finally, they excavated a deep trench, maybe thirty or forty feet wide at the bottom, all the way across the creek bed, which was very wide at that point, just as an investigational endeavor. It couldn't be saved as a part of the final excavation, because the first flood that came along would wash it full of gravel, and it did.

But we found no serious fault. They have done all the other investigations with great thoroughness, and they are doing their best to make a good job of it.

SCHIPPERS: This, too, is something that you didn't have anything directly to do with, but I still want to ask you about it. What do you think about the development of the East Branch and Metropolitan's efforts to delay it?

HINDS: Well, the East Branch is a reality. I personally think that it was not entirely necessary. I think the works that Metropolitan is building on the West Branch would have gotten the water to where it's needed without difficulty. There are lots of politics involved--state, Metropolitan and local.

There are some areas over in the vicinity of San Bernardino that always have resisted joining Metropolitan. They are still resisting. Now they have contracts with the state for water, and they may never need to join Metropolitan. They didn't want to have to deal with Metropolitan. It was political and Metropolitan was not entirely free from politics. Some of the engineers that were over there had different ideas about it. Some of them thought it ought to be built, and some of them thought it shouldn't. I'll be darned if I can tell you which ones. Bob Diemer thought it might be better one way and Jensen liked the other way. But as far as I'm concerned, it's a matter of

economy. They've got to get the water over there some way, and Metropolitan is going along with it now. The East Branch will take water around for eastern areas, and on down to San Diego. It will be regulated in a big storage reservoir near Hemet.

SCHIPPERS: Perris?

HINDS: Perris Reservoir, yes.

SCHIPPERS: Doesn't it make you want to think sometimes that somebody should be able to come along and club a lot of these warring factions over the head and pull them all together?

HINDS: Oh, I wouldn't say so. Let them fight a little.

SCHIPPERS: OK.

HINDS: Remember what Robert Burns said: "Oh wad some power the giftie gie us, to see oursels as others see us!" Sometimes I wish we could make people see the facts underlying these things. I probably mean facts as I understand them. I think it's good to get together on the facts, or alleged facts, and let each express his opinion whether they all ever agree or not. I think it's good to weigh all the opinions. If I were starting a big project, I would think it rather unfortunate if all my helpers were yes-men.

SCHIPPERS: Well, in a real long run, won't all these facilities provide a great versatility in distribution with future development?

HINDS: There won't be duplication. Metropolitan can take advantage of the fact that that water is going directly to the east, and they won't have to build their lines quite so long or so big. You see, without the East Branch they would have had to transport all the water to the entire areas south of the San Bernardino Mountains, Hemet, Orange County and San Diego, around or through Los Angeles. With the East Branch a lot of the water will go around Metropolitan's system. They probably will have about the same number of main distribution lines, but they will be shorter and smaller, whether it's good or bad I don't know, but it is making a lot of people happier. So I should worry!

SCHIPPERS: How about the pushing of the delivery date back for the bond issue? You know, moving it back from 2020 to 1970 and bringing the capacity down to suit. Do you think that was wise?

HINDS: Where did you get this question, and what was the "it" that was moved back?

SCHIPPERS: Well, in Bulletin No. 78, the original one, I understand that they had planned for an initial capacity sufficient to meet the needs of the year 2020. Governor Brown said, "We had better move that back a bit," because the public weren't going to approve a bond issue for $2 billion to build capacity, much of which wouldn't

be needed for half a century. Do you think that was wise?

HINDS: Politically, it was certainly wise. Practically it was wise to restudy the situation to find an optimum initial capacity. I wasn't in the problem in any way, but am of the opinion that it was concluded that 1995 would be a good "upset date." It seems to me that this would have been reasonable.

SCHIPPERS: What do you mean by an "upset date?"

HINDS: I mean the date at which a chosen initial capacity will just meet the growing need for water, leaving any growth beyond that date to be provided for in the future.

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SCHIPPERS: Tell us something about your consulting work with Bechtel.

HINDS: The first construction job that I was on with Bechtel was Southern California Edison Company's Vermilion Dam that forms the Thomas A. Edison Lake in the Big Creek area. That dam was an important structure as are all dams of any notable size. It's important that they be planned right and built right so that they will perform the functions that they are designed for without any danger of failure. They must be so built that they are no hazard to life. You have to watch very closely.

The Vermilion Dam had one unusual characteristic, and that was that it was founded on a deep bed of glacial till. It was a gravel-fill dam with an earth core. There was no possibility of taking the core down to bedrock. That would have required a fantastic depth of cutoff, completely unfeasible financially. So we had to find a means of building it on top of the glacial till. Glacial till is reasonably watertight, and for steady loads like the load of an earth dam, it is of adequate strength. It isn't a clay material. It won't squeeze or slide out from under a dam, so you can build on it, but it does

permit some seepage that needs to be controlled. This control was supplied naturally over a part of the foundation by a thick, completely impervious layer of silt, with adequate strength to carry the dam load. But over a substantial part of the foundation this silt had been eroded away. There we resorted to the expedient of simulating the silt layer by building a watertight blanket made out of fine sedimentary materials, strong enough to support the dam, tight enough to hold water. We spread this blanket some 600 feet upstream from the dam. This probably didn't prevent some minor seepage passing underneath the dam, but because of long distance of travel the underflow was reduced to a negligible amount.

The amount of seepage had to be negligible from two points of view. It had to be small enough so that the value of the resulting loss of power would not be great enough to be commercially important. Actually this was not a possibility. And the water must not escape at the downstream toe with sufficient velocity to pull away particles of earth and cause piping. We accomplished both of those things very handily with the blanket. Vermilion was a good-sized structure and moderately expensive. It has been a successful venture.

Perhaps I should proceed with the things that I have

done for Bechtel without trying to put them in chronological order.

SCHIPPERS: Yes. Well, why don't you just stick to them by areas then.

HINDS: Well, I would rather just abandon any attempt at a formal order. But there was another requirement for a dam in that same general area (also for the Southern Edison Company). This was quite a large dam at the Mammoth Pool site, on the San Joaquin River, across the ridge and downhill from Mammoth Lakes, where there was a very excellent hard-rock site. It had the appearance of an excellent arch-dam site, and it looked in the beginning as if it would be much more economical to build an arch dam there than any other kind. Although the foundation was excellent granite rock, it had a kind of an onion peel structure. Big pieces of it would sometimes flake off. We were afraid that if we cut notches for arch abutments, the spalling would increase. That perhaps could have been overcome, but that and other features made it appear to the estimators that an arch dam would cost one or two million dollars more than an earth-and-rock-fill dam. There were some problems with the fill, but they could be overcome. So we finally decided to build a rock-fill dam with an earth core. The dam is what is called a "zoned" dam, consisting of several

selected zones, or curtains.

The constituent features of the dam section were about as follows: The section was roughly similar to that described for Santa Felicia. In the general vicinity of the center was an impervious core, flanked on each side by a filter zone to prevent loss of the fine core particles. Upstream was semipervious fill with riprap protection against waves on its outer face.

Downstream of the downstream filter was a pervious crushed rock zone. A horizontal extension of this zone was laid along the bottom of channel, outcropping at the downstream toe of the dam. These drains were to intercept any small seepage that might get through the core and transmit it to free water below the dam.

The downstream face of the drain zone was followed by filter to maintain its separation from the coarse rock of shell below it. The downstream shell was of random quarry rock. Fairly soon after the dam was completed, it filled and overflowed around the spillway, cut through the rock at the west end. It showed no distress. I'm sure it's a wonderful dam.

I would like to skip a little out of order to another important dam that I worked on for Bechtel, up in the state of Washington. It was the Swift Dam, Lewis River.

It was a somewhat earlier example of the rock chimney idea. Rock and gravel to build the up-and-downstream shells was lacking, but by screening and washing a very limited supply they got enough for a "drainage chimney," as described for Mammoth Pool. This made it possible to construct the dam from materials available at the site, subject to careful selection, of course. Here again, as at Vermilion, the depth to rock was very great. But it was a different material. It was fairly gravelly. It was strong enough to support the dam without question. So it was not necessary to take it out for structural reasons. But it was quite pervious. Obviously it had to be sealed off to avoid excessive loss by seepage, with possible danger of sloughing at the downstream toe.

The obvious thing was to take an impervious core all the way to bedrock. This was, more or less, out of the question, so we proceeded thus: We dug a core trench, as at Santa Felicia and Mammoth Pool, as deep as we thought feasible. Then, in the bottom of this trench, we drove two rows of interlocking sheet piles a few feet apart, with cross walls at short intervals, thus forming a cellular steel cutoff, driven all the way to bedrock. Then, with a Portuguese pump, we evacuated the gravel from the cells and refilled them with concrete. An expensive opera-

tion, but the results were good. (I was working with Bechtel for Pacific Power and Light, on Swift Dam.)

Going on with Bechtel, I was consultant on quite a number of dams on the upper American River, maybe twenty-five or thirty. Some of them fairly important, some of them small. They ran from concrete arches to concrete gravity dams. The Union Valley Dam was a fairly high earth-fill dam structure with a considerable volume of storage. It had all the problems that these other dams had. We used the same devices. The small concrete dams generally were simple diversion dam structures, but there were some large ones, mostly arches. And then, of course, there were lots of tunnels and penstocks and powerhouses and all the things that go with the dams to make a hydro-electric project. Overall it was a very important project, engineered and supervised by Bechtel for the Sacramento Municipal Utility District. They are producing and distributing power in the Sacramento area.

I also worked with Bechtel on two similar and very important dams near Paso Robles: one was the Nacimiento Dam on the Nacimiento River; the other was the San Antonio Dam on the San Antonio River. They were both central-core dams, with pervious shells, more or less like the Santa Felicia. They drain areas from the coastal range. The

Nacimiento Dam filled and spilled almost as soon as it was completed. The San Antonio Dam, with a similar drainage area, didn't fill quite so fast. Whether it's full now, I don't know, but it has stored quite a bit of water. They both serve an irrigation district down in the Salinas Valley.

Another job that I helped Bechtel with was J. H. Turner Dam, formerly called the San Antonio Dam, for the City of San Francisco, up in the general vicinity of Livermore. It is in operation and has quite a little water in it, but it has not spilled when I visited it last week [1967]. It was the same kind of a dam as the others that I have just described.

There were also ten or twelve dams up on the Oroville-Wyandotte Project, designed and supervised by Bechtel. I visited and inspected all of them. They were important structures, but had no outstanding characteristics differentiating them from others previously described. I've had other dams for Bechtel, but not outstanding enough to justify detailed descriptions here.

We might now go from the work with Bechtel to some of the work that I have done on the Columbia River for various agencies. The Columbia River has a fall of some 1300 feet between the Canadian border and tidewater.

This fall is practically all developed for power. As they say, it's cascaded--one dam right below the other. The Columbia doesn't lend itself to any big, high dams, aside from the Grand Coulee. I had nothing to do with Grand Coulee, which was the daddy of them all.

At the other end of the string is Bonneville, not far upstream from Portland. There isn't much to develop below Bonneville, because it would be drowned out by tides. In all there are a total of eleven dams. I have participated in the construction of six of them. I shall review them in geographical order proceeding upstream from Bonneville. The next, in this order (but not in time) was The Dalles Dam at the headwater of Bonneville near the Celilo Falls in the Columbia Gorge, very famous as a salmon fishing place for the Indians. This dam is a very interesting structure. It is a combination of a rock-fill dam across the main stream of the Columbia, and then followed by a long line of powerhouses which of course act as a part of the dam, and then by some just plain gravity-type spillways and a navigation lock. The whole thing is arranged in the form of a "Z." It is an interesting structure.

It has one particularly interesting feature that hadn't been done before. Just down below the Celilo Falls,

the Columbia River is very deep. Removing the water from it was almost impossible. We tried just dumping the rock into the flowing stream. There was practically no gravel on the stream bed, just smooth rock. We opened up a quarry in a nearby basalt bluff and arranged our blasting to yield very large stones, with a few smaller ones mixed in, of course. We hauled this mixture over to the river bank and just dumped it in, starting on the land bank and going right across the river until the gap was closed, and the water was forced to run through some of the power units that hadn't been quite finished (they had been left open for this purpose). We made the rock fill watertight by dumping on its upstream face first some fine quarry muck that wouldn't all be washed into the rock and then some sand that wouldn't all be washed into the quarry muck. Finally we dumped some real fine material that would settle in water to form a watertight zone that wouldn't be washed into the sand. When we got above the water surface, we finished by conventional methods. It was one of the most interesting jobs I've worked on.

SCHIPPERS: Is that the Wells Dam?

HINDS: No. As I said it was The Dalles Dam. There was one sad feature that might be mentioned. The Indians had been fishing at the falls from prehistoric times. The salmon runs in the river at that point were heavy, many

big fish. The Indians had a treaty with the U.S. government to fish as they pleased. To drown them out, you see, was kind of a blow to them. So the government paid them $23 million for the fishing rights.

The next dam up the river that I worked on briefly was the John Day. The next dam upstream from John Day is the McNary, on which I did considerable work. It is similar in all basic concepts to The Dalles Dam except it is arranged in straight line across the river instead of a "Z," and the river bed was unwatered for the fill. It also has ship lock.

Proceeding upstream, there are the Priest Rapids and the Wanapum dams, both of the general type of McNary, but different in details. I had no connection with these two dams. A little further upstream is the oldest dam on the river. It's called Rock Island. It's a smaller dam with smaller power units. They are figuring on redoing it now. But at any rate, it's there, and I had nothing to do with it.

Then above that is Rocky Reach Dam, which was an extremely interesting job. It has certain features that sets it out from the others that I have described. One of these features was the high elevation of the bedrock. That would seem like an advantage, but it introduced some difficulty.

One was that it increased the cost of excavation in the powerhouse area to get the penstocks low enough for efficient operation. For economy, the spillway was more or less built on top of the rock surface. This caused some trouble, as there wasn't enough backwater to effectively still the discharge. The water ran over the spillway with a little too much velocity, which caused erosion of the concrete. We put in means for controlling this, but it was expensive. This dam is again arranged, roughly in a "Z" shape, somewhat like The Dalles, except that the spillway is in the main stream, and there is no navigation lock. The gated spillway runs straight across the river; the powerhouse section is parallel to the river to a finishing up cross-stream concrete gravity section. It was a very interesting structure.

One unusually troublesome feature was the left abutment, flanked by a deep and very wide deposit of porous gravel. Openwork gravel, they called it. This gravel had to be shut off some way. But one thing that was an advantage was that about halfway down there was a thick layer, some twenty to thirty feet thick, of real dense, solidified silt, almost a siltstone. It is similar to the condition I mentioned at Vermilion, except that the underlying material at Vermilion was watertight, while

at Rocky Reach it was very porous. We excavated a trench down to this silt, eventually to be filled with impervious material, which would take care of that part of it. But the part below the silt was another matter. It would have been extremely costly to dig out both the silt and the openwork gravel to bedrock. But we had to do something about it. So we grouted it.

First, we grouted it with regular cement which closed, or partially closed, the larger openings in the openwork gravel, but there were occasional zones of coarse sand--and cement just won't penetrate sand. The sand filters the cement out of the water. But the sand was amenable to grouting with chemicals. We used a Dow Chemical material called AM-9. We did lots of experimental work, but we finally got a good job. We first grouted several lines of holes with the cement, and then we'd go down between the rows of cement grout holes with chemical grout. This procedure minimized the loss of chemicals. We tested our work by drilling holes upstream and downstream of the curtain and observing groundwater levels in them. If the upstream water was practically headwater level and the downstream water was practically tailwater level, you knew you had accomplished your purpose.

So we continued to drill, grout and test until we got

a good job. There is still some leakage, but it's presumed to come three-quarters of a mile or a mile around the end of the grout curtain, which did not go all the way to bedrock outcrop. We left a little gap there. The water that flows around this end is perfectly clear. It's just like a spring and isn't causing any trouble. It costs more to shut it off than the power it would produce is worth. Someday someone may decide that power is more valuable than it is now, and they might extend the curtain.

The next dam upstream in geographical order is the Wells Dam, which is under construction at the present time. I should have showed you some pictures, just so you'd have an idea how they look. You see this one over here?

SCHIPPERS: Yes.

HINDS: This Z-shaped one is The Dalles. I have a good picture of Rocky Reach, but the frame is broken. Here is an unframed copy. And here is a preliminary picture of Wells, which I was about to discuss. A distinguishing characteristic of Wells Dam is the telescoping of the spillway and the power plant made possible by the configuration of the rock. It was an ingenious device developed by Bechtel to make the best use of the site, to get the best dam for the least money.

There is also provided a very extensive spawning area

for salmon--a lot of canals With gravel linings which are supposed by the fish people to be ideal for tempting the salmon to spawn here and have it over with, without a long trip into the high mountain valleys. The theory is that after they have spawned here once, their offspring will always stop here instead of going to the headwaters of the Columbia, the Snake or other tributary. But in addition to putting a spawning ground in, they are also providing the conventional fish ladder for any salmon that are afflicted with wanderlust. It will be interesting to watch to see if they can get them to spawn here, which should reduce the mortality of the fish going up and then the fingerlings coming down.

The next dam upstream is Chief Joseph, built by the United States Corps of Engineers. This dam is sixty or seventy miles downstream from the Grand Coulee and backs the water up to Grand Coulee. It is the second step in the cascading of the river. Chronologically, it was my first dam on the river. Its chief problem was similar to the one at Rocky Reach. One back of the river was against rock. The other had miles of buried openwork gravel. Going through an inspection tunnel, you could stick a pencil back into the gravel. It would take water like nobody's business, and we had to do something to tighten it.

Quite a few plans were discussed. One was to construct a concrete curtain wall from bedrock to the top of the dam, using the stopping method described for Tieton Dam. For this you would have to excavate a vertical shaft to the deepest place of the foundation. Then you dig a tunnel, cross river. When the tunnel meets the rising side rock, it is partly filled with concrete, then heighten the tunnel, and again partly fill it with concrete. Repeat over and over until the concrete curtain is as high as needed. It was one way of doing it, but expensive.

An alternative plan was adopted. The river took a turn a short distance upstream from the dam so that the gravels were exposed on river bank. Thus the water could get into these exposed gravels freely. If they went through too freely, there would be trouble. The final solution, which was reasonably successful, was to clear off the bank, smooth it up a little, and then cover it with a thick blanket of impervious material. In other words, instead of digging up a hole in the center of the abutment and putting in a cutoff, we built an impervious earthen cutoff on the outside, on the slope, and called it a blanket.

Just as at Rocky Reach, a measurable amount of water is still going around the dam, but it is nowhere near enough

to cause any trouble. There are plenty of opportunities for any seepage to escape without building high internal pressures. The dam has been in operation some twenty years, and it shows no deterioration. The water lost they would like to have for power, but it would cost more to cut it completely off than the power is worth; and since it's no hazard to the safety of the structure, they just don't worry about it. Remember--the water itself is not lost.

There's one other item that I would like to mention: Only one of the six dams on the Columbia River that I worked on was designed and supervised by Bechtel. That was Wells. Even there I was not working for Bechtel, but for the Douglas County Public Utility District, a local public agency. On four of the remaining five I was working for the U.S. Corps of Engineers. On Rocky Reach, the remaining one, I was working for the owner--Chelan County Public Utilities District.

I was connected with a Bechtel-supervised dam on the Deschutes River in Oregon. It is called the Round Butte Project, because of a characteristic nearby butte. It was built for the Portland General Electric Corporation. It is a rock-fill dam with a central earth core and a drain chimney following the pattern of other dams of that type.

The canyon in which it is situated is quite deep and is all in basalt--and you know basalt can be notoriously porous. There was considerable worry at first whether we could build a dam there that would hold enough water to make it worthwhile. There was certainly no trouble building a safe dam. You could have built a concrete dam of any kind, and it would have been safe. The rock-and-earth-fill dam selected was cheaper and also structurally safe.

The problem came not with the dam, but with seepage around it. The question was whether it would hold water. It was being built purely for power. It was at the head-water of another dam owned by the same company, and the sole object was to hold the water and back it up to get head to produce power. If it wouldn't hold water, there was no use building it. So we did an extensive job of investigation, drilling core holes and going with drifts far back into the bluffs. After considerable study and much testing, we decided that a reservoir there would certainly lose water, but that the loss would not threaten the safety of the dam, nor would it seriously affect its economic value. We built it. We made an estimate of about how much water we'd lose. It was quite a little, but bearable. Now that the dam's been operating a few

years, measurements confirmed the estimates. It made us feel like we did a real good job. Quite a lot of water is getting by, but it is very close to what we said it would be. The dam is built of crushed basalt with an impervious core.

Now let's see, I think I could end with a recitation of some of the dams I have recently been connected with on the Bureau of Reclamation. Of course, as I have stated before, I worked for the Bureau of Reclamation for many years. In that time I assisted in the building of many dams, far too numerous and too heterogeneous to try to cover. A few years ago, I was asked by them to come back and serve as a member of a consulting board on a number of important concrete arch-dam structures they were building.

The first one was the Glen Canyon Dam. It's a massive arch dam built on a different principle than the Hoover Dam, a little closer to a pure arch than Hoover. Hoover was a combination arch and gravity. Glen Canyon is 700 feet high. It isn't very wide across stream. It's quite a distinct canyon. It's upriver from the Grand Canyon a hundred miles or so.

One characteristic of it, aside from its height and its mass, was the nature of the rock from the point of

view of an arch dam. The rock was not outstandingly strong, but it was stronger than the concrete to be placed upon it, which is good enough. It had one characteristic--it is unusually massive. That is, it is free from fissures, cracks, faults, and other imperfections of that kind, quite outstandingly so. There's no trouble about water going around the dam, although there were many adverse statements made by people that were opposed to a dam being built in that location for ecological reasons. (I have always had a considerable respect for people of that kind. I'm against the needless despoiling of nature.) I had nothing to do with that part of the job, but I don't think there was any trouble in that respect. But, some of them said that if they ever got any water in the dam, that the porous rock would absorb it all. That was foolish, of course. It didn't turn out to be true. It's finished now and it's working.

I was on the job practically from the beginning of construction work. Not from the time that it became a gleam in a designer's eye, nor during project planning, just on the technical engineering part of the designing and construction work. It was an extremely interesting job. One feature that's been quite beneficial to the Eastman Kodak Company is a very spectacular bridge across

the canyon, just downstream from the dam. I bet there have been more films shot on that bridge than on any other bridge in the world. But at any rate the dam is built now. It's working OK.

And then the next one was a dam similar in form, but smaller, built up at the Flaming Gorge site on the Green River, in the northeast corner of Utah. Then another one of the same general type, quite large in its own right but not nearly as big as Glen Canyon or Hoover, was the Yellowtail Dam that was built on the Little Big Horn River--if you can imagine such a name for a river. It's up in Montana near Hardin, not too far from Billings. It has just recently been completed. It has the same general configuration as the two just described. As dams go in Europe and other places, these arches are quite thick. They are outstandingly safe. They conform to the Bureau of Reclamation's prevailing standards for building arch dams.

A fourth one, the Morrow Point Dam in Colorado, was thinner. The Bureau of Reclamation got quite a little publicity for going to a so-called, double curvature dam, which is thinner, much more curved and a much more modern type of an arch dam. I believe that it has been finished. It involved more exciting engineering and computer work.

We went over every detail very carefully--the design computations, its location, the general arrangement, and so on--and got them well started on the construction of it.

At that time, we had a five-man board composed of myself; Ed Burwell, retired from the Corps of Engineers; Professor R.E. Davis, retired from the University of California at Berkeley and a concrete expert; a geologist by the name of [John W.] Vanderwilt from the Colorado School of Mines; and John Hammond, who had worked many years for the Bureau of Reclamation before his retirement and had been associated with very important consulting work around the world.

But about the time that we got Morrow Point set up and on its way, where they didn't need a board of consultants very badly, Ed Burwell passed away, and Hammond--as we say out in west Texas--"hung up his spurs" and decided to quit. That kind of decimated the board. They needed to resupply it or drop it. So they just decided to drop it. All of these four arch dams are finished now and are storing water.

It seems to me that about wraps it up, covering in a descriptive way the work I've done as a consultant since leaving the Metropolitan Water District.

SCHIPPERS: Why did the Bureau go from the thick dam to

the thin dam at Morrow Point? What was the reason for this change of concept?

HINDS: I don't know. I just don't know. There were a lot of engineers that were rather critical of them for not using the most modern method of designing arched dams, thereby wasting concrete and money. They had their eyes on what to them was considered conservative safety. They perhaps were going a little bit beyond the call of duty to be safe. It is hard to criticize safety. But, in my opinion, a dam such as Morrow Point can be made just as safe as one, say, like Yellowtail.

SCHIPPERS: How is the trial-load analysis of arched dams performed?

HINDS: The hard way. First you select from a trial lay-out of the structure a number of typical thin horizontal slices--that is, arch slices. Usually there will be ten or more of the trial slices. Then you similarly select thin vertical slices, called cantilevers, distributed around the arch. Then it is assumed that part of the total water load will be carried by the arch slices and the remainder by the vertical cantilevers. You estimate, or guess, the ratio of these two part loads at each point where an arch slice and vertical slice intersect. With these "trial loads," each arch ring and each cantilever is analyzed and you figure their computed defuction. Ob-

viously, if the estimated load divisions are computed correctly, the arch and cantilever deflection at each intersecting point will be equal. If at any one or more points they are unequal, your estimate of load division is wrong; hence, you make a new estimate using the first results as a guide, and start over. This process is repeated until satisfactory conformity at all points is achieved.

This can be an extremely laborous procedure, depending on the experience and skill of the computer (human computer, that is). Obviously, it can be enormously expedited by correct use of an electronic computer. The use of such computers has substantially advanced in recent years. Simultaneously, the solution has been complicated by the introduction of more and more actions and reactions taking place within the body of the concrete. These include, but are not limited to: tangential and radial shears between arch slices, vertical and radial shears between cantilevers, sideways deflection and twisting of cantilevers, etc. Consideration is also given to foundation deflection. There is no end to the refinements that can be introduced. Each addition adds work.

SCHIPPERS: Was Calles a double-curvature dam?

HINDS: Yes, quite by accident. Our original layout, although relatively thin, followed the conventional Bureau type--no overhang on the downstream face. But after the foundation was excavated, the lower arches built, and the top arch nailed down as to position, we ran into a soft spot in the right abutment rock. The easiest way to fix it was simply to push the affected arches upstream a couple of meters, leaving the top and bottom arches as laid out. The change was made gradually to keep smooth surfaces. The result was an accidental double-curvature dam. A quick review of stresses showed that they actually were reduced.

This was quite a lesson to me. I preached it to the Bureau of Reclamation. For a long time my preaching had little effect. Finally, after double-curvature arched dams had become common practice, they tried one at Morrow Point and they seemed proud of the results. It got quite a little notoriety in the technical press.

SCHIPPERS: Speaking of the opposition of the conservationists to dam building, could you expand on your comments?

HINDS: Well, let's start right at home in Ventura County. We need and eventually must have a dam on Sespe Creek, maybe at the Topatopa site. It happens that the last known habitat of the North American condor centers in that area.

SCHIPPERS: That's right.

HINDS: The Audubon people and so-called nature lovers all over the world--many of them knowing little about the situation or about condors--are opposed to building such a dam. Well, we built one nearby on Piru Creek and the condors came down and helped us build it. They were all around the job. They didn't worry about us. There have been quite a lot of experiments carried out to see if operations simulating construction would discourage them, run them away or reduce their number. Nothing seems to bother them. And I don't believe the condors care. I think it's just a matter of hysteria among people who don't want to see anything disturbed. As far as I am concerned, I wouldn't want to be the cause of the extinction of any important type of life from the earth. The condors certainly were useful in early times, as they subsisted strictly on carrion. They never kill anything so far as I know. It just gets to be a kind of hysteria. The people against it really don't understand why they're against it.

Another example is Lake Powell, the reservoir upstream from Glen Canyon Dam. There are many who bemoan the fact that this reservoir inundated a few square miles of desolate desert and filled a few dry gulches, while all around there are millions of square miles of equally desolate

desert and a lot more dry gulches.

Upstream of the dam is a rather famous natural bridge--Rainbow Bridge. It's not on a river. It's on a tributary where the rock arches across a dry gulch. If there ever is any drainage it flows through the opening underneath the bridge. Well, a lot of people don't want the bridge "spoiled." There was a time when it appeared that we were going to have to spend $20 or $30 million for a dam further down the gulch to keep reservoir water from backing up under the bridge, then put in pumps to pump any rare drainage over into the river. Well, I have talked to people who have been up there since the reservoir rose, and they say it doesn't hurt the scenery at all. Full backwater will put a few feet of water under the bridge. To me, that would make the bridge look more purposeful, more useful. It wouldn't hurt it at all.

It would also make it so that one doesn't have to be a roughneck and ride a donkey in a packtrain to get a look at it. You can get into a boat and ride right up to it and climb the hill if you wish. And that does not, in my opinion, detract from the beauty of the place at all. They wanted to leave it "wild," like the Good Lord made it, you know. That doesn't appeal too much to me.

You might as well have left New York City or any other place wild. I think that we should preserve some of our wilderness areas, but not at the expense of everything else.

For another example, a few years ago, there was quite a furor about a dam they wanted to build on the upper reaches of the Colorado River (I don't recall its name) that would have inundated what are supposed to be some prehistoric dinosaur tracks. Well, they avoided it, and I think it's all right to have avoided it. I was a bit sympathetic to the archeologists and people who want to preserve those tracks for people to see in the future. They really would have been destroying something of historical value. This would have been destroying evidence of the past not available elsewhere--not just something widely spread over the entire desert, but isolated objects of historic value. But at Rainbow Natural Bridge, nothing is destroyed except a little desert, of which there is plenty. And it is being replaced by water, which is scarce in that region. You're hurting nothing. In the case of the dinosaur tracks, a dam would obliterate them. Future archeologists would not be able to inspect them. I think it's at least of some importance to preserve them. Just like in Egypt, it

would be rather bad, if in building Aswan Dam they don't preserve some of their ancient shrines. I doubt that we should go all out to preserve the relics of somebody that lived 10,000 years ago if it means the starvation of the people who are living now. If you have to choose, let's take care of the live people.

SCHIPPERS: Right. Very often dovetailed in with the nature lover's argument against dams is the growing idea that high-rise dams are not always as effective as they were once thought to be.

HINDS: I'm not familiar with that argument.

SCHIPPERS: Well, how about the feeling that there is too much evaporation loss in the large storage units.

HINDS: Well, that is not imagination. That's true. You have to recognize that. It's a computable factor. For example, I have not been particularly favorable to the building of those two new dams they're talking about in the Colorado River, one in Marble Canyon and the other one at Bridge Canyon. Bridge Canyon has a new name now, some Indian name. From a purely water conservation point of view, even Glen Canyon is not needed to anything like its constructed capacity. Hoover Dam has been in existence now for at least thirty years; in that time it has spilled a little once. That was an artificial spill in a way. It didn't have to spill. The water was up at the

top and it might not have spilled, but they wanted to see how the spillways worked, so they opened the gates. They found some difficulties in the tunnels. They got them fixed, which was a good thing. In all these years no other water has ever gone over the dam.

Now, we've built Glen Canyon with an equal amount of storage. We've more than doubled the evaporating area, more than doubled the loss by evaporation. And you don't need the storage for water control anyway; all you need it for is the production of power. It doesn't serve any other useful purpose.

Whether we can afford to give up the increased evaporated water in order to produce the power that we'll get from Glen Canyon is a problem, but it's a mathematical problem, and you can figure it out if you can set up the right criteria. Being a kind of a nut on water conservation, I hate to see needless evaporation. But I may be wrong. That problem is up to the statistician. I would be inclined to oppose the building of two more high dams in the canyon--but I hope not emotionally. I doubt the necessity of two more dams up there. They would quadruple the amount of water being lost at Hoover through evaporation, and without conserving any more water, because Hoover alone is doing that job. Sometime during a very

wet year there might be enough water to make an appreciable spill at Hoover, but year in and year out, there will be little water going over Hoover that doesn't go through the powerhouse.

As to putting in the other two dams, the first thing I would do would be to investigate the possibility of developing the same power by tunnels. The water is already controlled. Power tunnels are used all over the world. Take the Southern California Edison Company at Big Creek. Most of their power plants are not right at the dam. They may be ten or fifteen miles away and the water is being taken by tunnel so as to get increased fall. If there are rapids in a stream below a storage dam, the flow is taken around the rapids by tunnel to a power plant downstream. And that's the standard way of doing it. There are numerous examples of this procedure in the SMUD [Sacramento Municipal Utility District] project on the upper American River.

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HINDS: [continuing the discussion of the use of power tunnels] They could do that same thing at the Bridge Canyon and Marble Canyon sites. I don't know whether it would figure out economically. As far as I know nobody has made any studies of it. But if the project were mine, I would investigate the tunnel alternative as opposed to more dams.

SCHIPPERS: Some of the severe critics of the Bureau say that they have gone a little building mad, that they like to build for building's sake.

HINDS: Having been an old-time reclamator and having done a lot of work for them in recent years, it will probably be ill-becoming of me to say this, but so far as I know, all bureaucrats are that way. They like to get more jobs to build so they can have more help; and, therefore, they will be more important people. It's a natural human characteristic. The Bureau is no worse than other public (or even private) agencies.

SCHIPPERS: And yet you brought up this other factor--that there has to be justifiable reason for a structure. This, of course, was part of Udall's original plan--wasn't it?--to get more power so that it could finance more develop-

ment.

HINDS: Yes, that's right, and others before him were worse. They like to get power plants because that gives them some money that Congress doesn't have to appropriate. I think that's wrong. I think whatever they collect should go back into the Treasury, and when they need to spend for something else, they should seek a new appropriation. In fact, in many cases they do.

SCHIPPERS: While we are on that subject, what do you think of large regional development plans like the Southwest water plan?

HINDS: You mean like the Feather River Project?

SCHIPPERS: I was thinking more of the larger one, the Central Arizona Valley Project, perhaps going ahead and bringing in water from faraway sources, let's say, from outside the state of California, maybe from the Columbia River.

HINDS: An awful lot of people will tell you that that is an ultimate necessity. That isn't necessarily true, because people don't have to come here, and if they get here and don't find water, they don't have to stay. But it is something that's essential if California is going to continue to grow and to develop to its maximum potential--that is, grow all it would grow if it had unlimited water.

If it's going to do that, you have to get more water, because California with plenty of water would certainly develop far beyond the limits that can be supported on the water supply that it has locally. So, if it's going to develop its ultimate capability it has to have more water.

That is quite different from saying: it has to have water. It doesn't have to grow! But I think that it should grow. I think that it's a good place for people to live and it can be an important area where people can live pleasantly and profitably. It has some advantages in that respect over other places. For example, if the farmers have plenty of water they can expand to the full extent of their lands. If they don't get new water their expansion will be limited. I think it's very worthwhile for Southern California to be provided with water sufficient to take care of its ultimate needs. Of course we could get too many people here for comfort. That wouldn't be good.

In the case of the Columbia River Project it would be a lot more important to bring some of their water here than to leave great volumes of it waste into the ocean. But you can't argue with people in the Northwest that it's permissible to take the water from farmers up there and

to bring it down here to farmers and manufacturers and home dwellers in California. They wouldn't like that, and you can't blame them. But, if there is a surplus that is not about to be used, that's different. I think that it's entirely permissible, from a nation-wide point of view, for California to be permitted to go north of its border, to pick up and transport here any water it can afford to transport if it is not really going to be used where it is. But I don't think that we've got any right to go up and burglarize those people of water that they need now, or potentially. That region is not a bad place to live either.

SCHIPPERS: Do you see this coming soon, or do you think that getting northern California water down here is going to be enough to hold?

HINDS: I think that we can get enough water in northern California to last us way beyond my lifetime. I don't think that limiting use to the water available in California will permit California to grow to its ultimate destiny. So, if the water is to be taken out as the limiting factor, we've got to go further than California to get it.

Let me say, there's always a chance for a breakthrough in the desalinization of seawater. I have never believed

that cheap, reclaimed seawater is just around the corner, but I don't mean to say that it never will be. Many more miraculous things have happened. Taking sodium salts out of water is a laborious job, labor that is not performed by human hands. It is performed by electrical energy, heat or something of that kind, and it's expensive. I don't see anything that would lead me to think that sometime somebody is going to find some way of straining the salt out. Some chemical might be found, as has been for other non-sodium salts.

Electrical osmosis, or reverse osmosis, is also possible. The electrical current required for osmosis is roughly proportional to the mineral to be removed. In seawater it runs into a lot of kilowatt-hours. In certain kinds of brackish waters or sewage, there might be a breakthrough, but with repeated reuse the residue from brackish water would eventually approach the density of seawater. Then you might as well use seawater. But I don't see any promise of anything like that right away. A breakthrough might come with the expanded use of atomic energy.

Suppose that there were an island over here in the vicinity of Anacapa, maybe part of Anacapa itself. It's very small and it doesn't have room enough for a lot of

rain to fall on it. For some reason or other, a lot of movie stars want to go out there and build homes, just like they do at Malibu. A lot of other people also like to live there or have summer homes, but there is just not enough rain falling on the island to supply them with water. Well, I think in that situation, if they really wanted to stay there, they could well afford to put in a desalinization plant now. They could get the water at a price that a person of that type could afford to pay, rather than to abandon a place he likes or bring water from the mainland. But when you begin to put it on orange groves, cotton patches, or something requiring irrigation, it's quite a different matter. It probably would be hard to get it to really pay. If you want to raise cotton, you better go somewhere else.

SCHIPPERS: Would you apply that same logic to importing water if there has to be a choice made whether Arizona gets the water or whether the Central Valley gets it or whether more comes to Southern California?

HINDS: If you restrict your choice to just these three areas--the Central Valley, Arizona, or Southern California--and if you had just a limited amount of water and had to decide where you wish to put it, it would be purely a political or economic decision, because the water could be

beneficially used in any of these places; a lot more water than is presently available could be absorbed. You'd still have to make a choice, and it would have to be largely political.

SCHIPPERS: But does the ability to pay become a factor in this argument?

HINDS: Of course, if an area can't afford it, if it won't yield a profit or pay its way, they wouldn't be likely to get it.

SCHIPPERS: Earlier you said that the thinking behind your stand about expanding the limits of the Metropolitan Water District was that if this area grew economically strong enough they could "go to hell for water," if it wanted to.

HINDS: I don't think there is much water down there, but they could go down and look for it.

SCHIPPERS: You said they could bring it in if they had enough money to go get it. So, do you feel that this same thing applies to going beyond the limits of California to get it?

HINDS: Yes. I have made no figures on it. I've read a little about figures that have been made, and I am of the opinion that if we had the political permission to take water from the Columbia River we could afford it. I think that we could bring it down and put it into the Colorado River basin, where it would be handled by existing facili-

ties to a great extent, at a price we could afford to pay.

SCHIPPERS: One leading water man in the area, or someone who is connected with water, likes to throw into these arguments about the financing of long-range or expensive developments, that if we ever had a depression or recession, this kind of commitment could really bankrupt a whole area.

HINDS: What did he mean?

SCHIPPERS: Well, let's say that we would spend all this money on the Feather River Project or that we're putting out big money for desalinization, if there was a recession or a depression and these bonds couldn't go, the whole area could panic. In other words, isn't the financial reality of it--how far you can project into the future--always a concern for the engineer?

HINDS: I think you ought to plan for the ultimate future, but I don't think you should build too far in advance. Actually, we're going easy now. Take desalinization: that isn't going to break this community, but one thing that will sure break it is not to have enough water. If we don't have enough water, we will certainly go sour. Short of some temporary thing like the Depression in the thirties, which was artificial in many respects, if you

have the facilities here, if you have the advantages and all those things prepared, people will sooner or later use them.

SCHIPPERS: In other words, if there is any gamble involved, you would gamble on the side of development?

HINDS: Yes, I think so, but don't go hog-wild about it. For example, maybe fifty years from now we are going to need twenty of these desalinization plants down here, but we'd be mighty foolish to go out and build twenty of them now.

But if you were going to build an aqueduct to Los Angeles, let's say, from Portland--it would be a poor place to build an aqueduct, but it could be done--you could build it to bring all the water in the Columbia River down here ultimately if we could get it. We couldn't finance it. Or you could build a smaller, carefully planned proper-sized project for twenty-five to fifty years. This would be more reasonable. Now if you're going to build it, a lot of its features would be tunnels.

Let us suppose that the city of San Bernardino had a water right of its own to the Colorado River water and started to build a line to supply the city of San Bernardino alone right alongside of the present Colorado River Aqueduct. And suppose the engineer wants to build every-

thing just as small as it can be. If all those tunnels and pipes were made as small as they could be to bring in the water that San Bernardino alone needs now, you'd get them so darn small that they would cost more than big ones, because as they get smaller, they get more expensive per unit of material involved. If you get down to where you could just barely crawl through a tunnel with a wheelbarrow, it would cost you a fortune to build a two-foot diameter tunnel or three-foot diameter tunnel from San Bernardino to the Colorado River.

The point I want to make here is that there is an optimum size. If you make it too big, you get into a lot of trouble and unbearable expense. If you make it too small, you can't afford it at all. There's some optimum size. If you knew that eventually you could use a 100-foot diameter tunnel and all the water that it would bring, and that you could get the water--whether it's there, in the first place, and whether you need it, in the second place--you might say the best thing to do is to build a 100-foot tunnel in the first place and get it over with. Well, that isn't necessarily true. If you only needed a five-foot tunnel to start with, you couldn't build it because it would be far too small; it would cost too much. There's some optimum size.

Even if you knew that you would need all the water

that would flow through a 100-foot tunnel, and if you knew it was there, don't try to build it all in one tunnel; build it in several barrels of reasonable size. Even if you decided that you were going to build for full capacity now, you should still build it in several barrels so as to avoid some of the difficulties that go with such a big one. If you are only going to build one barrel now, maybe at the end of twenty-five years things will change and you won't want any more. On the other hand, at the end of twenty-five years, you may be damn sorry you didn't build half-a-dozen barrels because prices have gone up and it will cost you more. You don't know. But the thing is: don't gamble any more than you have to. Try to put in something that will take care of you for the foreseeable future, say, for twenty-five years or a generation.

SCHIPPERS: I have a few questions or just observations, really. I notice that a lot of the dam work you've done is earth fill and gravel, although you've done a lot of concrete structures, too. Is there a kind of shift toward the earth-fill gravel dam in recent years?

HINDS: Well, I think so. There is a good reason for it. I want to say, to start with, if I cast up the dams I have built, I think more of them would be concrete than the earth or gravel or fills. The reason that I've accen-

tuated the others here is because most of the dams I've been talking about as a consulting engineer have been in relatively recent times. And in recent times, there's been a tendency to switch to the rock-fill, earth-fill, or gravel-fill dams. There are at least two reasons for this. The primary reason is that all of the better dam-sites have been pretty well used up. Most places where you want to put a dam now are not suitable for masonry dams. There are few--if any--sites like Hoover Dam left. Most of the sites, because of the nature of the foundation material or because of their extensive length and the extensive amount of materials they require, are more suited to fill dams. As time passed, we have naturally used all the easiest sites. We've got to build in some of the more difficult ones now, and they are usually more suited to fills than to concrete, although, if you'll notice, all of these dams on the Columbia are combinations of concrete and fills. There are no exceptions to this. We are not abandoning concrete; we are just using earth where it is more appropriate or more economical .

Another reason for the recent predominance of fill dams is that in recent years there has been great improvement of fill-handling machinery for earth dam construction. Also, earth dam construction has changed from an art to a science. We know more about how to build them, and we can

figure more effectively and with greater certainty whether they will be safe or not than we could fifty years ago. We know more about earth properties. Of course, we have always known (ever since I have been able to know anything about them) that a properly constructed earth-fill dam on a good foundation is probably one of the most enduring works of man, because dirt has already deteriorated about as much as it can. Well packed and protected from erosion, it will stay there. In a suitable site it's a perfectly satisfactory material for a dam.

The sites where a concrete dam would be more economical are relatively scarce now. If you notice, I did mention four concrete arch dams on which I recently worked for the Bureau of Reclamation. Every one of those sites was in a good arch damsite, but they would also have been good for a rock-fill earth core dam.

SCHIPPERS: Do you think that the Columbia River has been developed about as far as it can be for its power-drop potential?

HINDS: Well, that is generally speaking true, for conditions as they exist today. There is one damsite remaining in that chain between the Grand Coulee and Bonneville, presently called the Benjamin Franklin site, that has been skipped because building it would inundate the Hanford Works, and they haven't gotten up the courage to tackle

that yet. But if the need for power should get sufficiently acute, somebody would move Hanford and build the dam. It doesn't look like it's going to happen in the immediate future.

Power potentialities in that region are getting a great big assist from the cooperative work that's being done between the United States and Canada. I don't know how far the cooperation goes, but certainly they have much greater storage facilities in Canada. Our storage, even including Grand Coulee and the numerous works on the Snake River and other tributary streams, nowhere near handles the maximum spring flood. There's a lot of water that goes over the dams unused. Because it lasts for such a short time, they couldn't afford to install units to use it as it passes, but when this storage contemplated in Canada is completed, the river will be largely controlled. The sustained year-round flow can be made quite a lot greater than the sustained low period flow now. They could practically eliminate the wintertime low flow.

The low flow is in the winter when the precipitation in the far north is snow falling and not melting. The peak comes in the spring when the snow begins to melt. With the storage in Canada, they can store the snow melt, and let it out during the dry river period of the next winter

when everything is frozen up. That will make it possible to install additional units at the plants that are already in existence. This has been anticipated to a certain extent--you might say that holes have been bored for extra units. They are already going ahead with the installation of the extra units. I have heard no intimation that anyone wishes to delay the installation of the additional units. They will find it profitable at some of the dams not only to fill in the blank spaces that are provided, but to provide some additional spaces by an extension of the power plants--and in the relatively near future, in the next fifteen or twenty years.

SCHIPPERS: Since I'm asking you to play prophet--you know the West Coast and you certainly know California resources pretty well--what do you think the trend is going to be in development? Do you think that our resources have been effectively taken advantage of now?

HINDS: Well, to a considerable extent yes. But, there still remain some hydroelectric power plant potentialities, for example, up in the northwest part of the state on the Eel and Mad Rivers, and on other streams up there. Also in some of our other areas, such as in the Edison Company's Big Creek territory, there are some potentialities. They're not the most glamorous potentialities, because the most

glamorous ones were picked out and built first. But as power gets scarcer and scarcer, and more and more people come in, they will develop these sites. And there are other sites scattered around, here and there, throughout California's mountainous areas where some power can be produced. I think all of the large scale potentials outside of far northwest California have been developed. I think, when the next stage of the water producing era comes in, the northwest part of the state will be involved in some power production. One trouble is that they are going to pump the water back over the hill, which will reduce the power potential. But, there will always be some power potential that can be developed.

Another thing that's going to be developed is pump storage. That doesn't really give you any new power. It just makes the power that you have more usable by changing it from the time of day when the demand is small to the time of day when we need a lot of it. Steam plants and atomic plants work better on a fairly constant load. You can, of course, run these plants at variable loads to meet fluctuating demands. But shutting them down and turning them back on isn't quite as simple as it sounds.

The ideal thing for adjusting the supply to a fluctuating load is a hydroelectric plant. Where there is

not a large enough supply to meet peaks from a direct hydroelectric source or from a steam source, they can take water from a reservoir down at a low level and pump it up to a high-level reservoir in the wee small hours of the night when there's plenty of power around. Then the next day, when everybody wants power, they'll turn this water around and run it through the same wheels backwards and produce power to meet peaks.

This reproduced power costs a little more. Some of the primary power is used in lost efficiency going up and coming down. So, if you put a certain number of kilowatt-hours into the pumping operation, you get a few less kilowatt-hours back. But on-peak power is worth more than off peak; so what you get back is worth a little more. In other words, they decrease the amount of power, but they increase its value. You might say that they could accomplish the same thing by just putting in another steam plant. That is of course true, but power from fluctuating steam is expensive. This is a factor that should be analyzed in each case. Mostly, but not always, the pumped storage will prove better. There are many places where they are being built, and where they are economical. Well, it would cost a lot of money to build another plant, and you would no doubt find it cheaper to buy yourself a storage battery which you can

draw on for your peaks.

Suppose you live far out in the country where ordinarily electricity is not available, with no power line nearby. And suppose you built a long, but very small transmission line, which you thought would supply your needs. Then suppose your wife bought a lot of gadgets, dishwasher, washing machine, drier, etc. and you find your line is too small for your peak demand. You could enlarge your line or put in a duplicate one. Either way is expensive. With a storage battery you keep your line operating at full efficiency day and night and meet the variations by means of the battery (or a pump storage project).

SCHIPPERS: This is a question that is sort of hard to phrase, but in all your years as consultant, what of your savvy or your experience do you think was called on the most?

HINDS: Well, I have been called on more to advise in technical capacities than anything else. I have a technical tendency, and I have been called on to advise whether a proposed design is safe and economical for construction. I had relatively little experience in advising on construction problems. However, I've been on all kinds of problems--tunnels, waterways, bridges, highways, railroads and hundreds of other things. But, primarily, my

consulting field has been reviewing the proposals made by others who originated the designs. Advising whether I think they are right or wrong, or advising--where appropriate--what I think they can do from a technical point of view to get a better and a cheaper structure and still have it perfectly safe. That's been the main kind of a contribution I've tried to make, and that I think I have made.

SCHIPPERS: To wind this up, I notice you have several honors here. Among them you had an LLD from the University of California, which you received in 1957. What was the occasion for your selection for that honor?

HINDS: I haven't the remotest idea. I received a letter telling me that my name had been suggested as a recipient of an LLD. And, of course, I didn't say no. The citation ran along the line that I had, more or less, made the desert bloom as a rose. My contribution had been to help supply water to the thirsty West, from one end of it to the other. President Sproul made quite a nice little speech. I don't think I have a copy of it; in fact, I don't believe I ever had one. But that was the tenor of it.

SCHIPPERS: I notice you also got an achievement award from the Consulting Engineers Association of California

1963. Why did they pick on you for that?

HINDS: Well, perhaps they had to pick out somebody. It would be hard for me to say why they picked me. I was glad to get the citation and I appreciated it. There again they made quite a nice little talk about the things that I had done, and they evidently thought that I had done my share. They didn't have any notion, I'm sure, that I had a corner on all good deeds. There is nothing that I had done that somebody else couldn't have done, but maybe I had met more problems to solve, and they thought I had solved them in a satisfactory way.

SCHIPPERS: Have you had other citations?

HINDS: Well, I don't have a room full of trophies. I have already mentioned the Norman Medal, from ASCE, awarded in 1926, in connection with the design of the Tieton Dam spillway.

I also received the Rickey Medal from the ASCE in 1954, for a paper on the history of dams, delivered at the Centennial Convention in Chicago, in 1952.

I was also made an Honorary Member of ASCE in 1959, a highly prized honor.

In 1960 I was cited by my alma mater as a Distinguished Alumnus.

I was about to overlook the "Julian Hinds Pumping

Plant," at Hayfield, on the Colorado Aqueduct. I got a bigger lift out of that than out of any of the others. A 441-foot lift in fact.

SCHIPPERS: How about technical societies?

HINDS: Well, there are a few: Honorary Member of ASCE; Life Member of AWWA; past Member of American Concrete Institute; Member of the Inter-American Sanitary Association, and the International Commission on Large Dams--and the following honorary technical fraternities: Member, Tau Beta Pi; Honorary Member, Chi Epsilon; Member, Sigma Xi.

SCHIPPERS: How about books and published papers?

HINDS: I have been fortunate enough to have published quite a few technical papers in the Engineering News-Record and in the journals of ASCE and AWWA. Also a few scattered articles.

For the past twenty or so years I have had the honor of being the continued author of the section on Dams in the Encyclopedia Britanica.

SCHIPPERS: And have you published any books?

HINDS: A few contributions of chapters and parts of technical books. Also full partnership in one of which I was very proud. Its subject is fully revealed in its title, which is Engineering for Dams. It was published by John Wiley and Sons, in three volumes, in 1945. The authors

were: W.P. Creager, Joel Justin, and Julian Hinds. It was widely received and used. It is now woefully out of date, but otherwise still a good book. If you would like to read it, I can furnish you copies in English, Hindu, or Japanese.

SCHIPPERS: As you talk about the West, and obviously a lot of men have been involved in it, what do you think about the water engineering of the West as an achievement as opposed to the East Coast or some other section of the country?

HINDS: That is not a good question to ask me, because I don't know enough about the East Coast. I can talk about the West Coast; but I do think, for example, that we have been more foresighted in the West in water matters than they have in the East. Some people in the East get into trouble about water, and they run out of water for no natural reason. It's a man-made reason--they haven't built enough facilities. It hasn't been the difference in the men. It hasn't been because the engineers of the West are more farseeing than the engineers in the East. Some of those who had quite a part in water development here came from the East. But we <u>had</u> to look out for our water supply; and we had to look out for it in advance. And if we hadn't, we would never have gotten anywhere. It was a necessity.

Back East, they have enough water for ordinary times. There's plenty of it falling from the skies, and nobody is water conscious because they aren't in the habit of running out of water. In the West, people are in the habit of running out of water or going broke because the well went dry. That doesn't often happen back East.

But they can get into trouble back there because their wells are too shallow; their reservoirs are too small. Not because there is too little water, but inadequate facilities. They are just as smart as we are, maybe smarter, but they don't worry about water till the well goes dry.

We in the West do the same sort of thing. You can't pass a bond issue for water works in a wet year. If we appear smarter it's only because we get into trouble more often. The very necessity of jumping in and helping nature out is stimulating. Just as in the East, we get our water from natural sources, but we have to jump in and help nature out to have our water, where we want it, when we want it. Because we in the West have always had to do that, it naturally makes us realize that ten years from now there will be many more people, and we haven't got a big enough facility for them. So we'll get in and build it.

While back East, they just take water for granted,

just like they do air. They're getting over that. Here in California, we don't do anything much about purifying our air; we should and we'll have to. But if we had to do that from the beginning, if every time we had built a little factory it spoiled a little area around it, we would have done something about it. When the big factories came, we would have known what to do about them. As long as it was one or two or a few small factories, the pollutants from them would dissolve in the air and blow away. Now we have many large factories, many automobiles, many planes, an ocean of street lights and hundreds of other things, all pouring pollutants into the air. It no longer can blow away--nowhere to blow. And we don't know what to do about it. But we gotta learn!

And it's the same way about water and other environmental pollution.

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