



US Army Corps
of Engineers

Water Resources: Hydraulics and Hydrology

*Interview with
Franklin F. Snyder*

Franklin F. Snyder

Water Resources:

Hydraulics and Hydrology

This manuscript is an edited version of an oral history interview conducted by **John T. Greenwood** at McLean, Virginia, on June 6, 14, and 20, 1995, and on August 22, 1995. The original tapes and unedited transcript are in the Research Collections, Office of History, Headquarters, U.S. Army Corps of Engineers, Alexandria, Virginia.

Preface

The United States Army Corps of Engineers significantly contributed to hydraulic and hydrologic engineering over the last two hundred years. Exploiting theory, innovation, and mechanical ingenuity, Corps civilian and military engineers studied the behavior of rivers and the motion of water. They investigated hundreds of streams in the United States, many more than once, collecting data on the physical, chemical, and biological characteristics of rivers; regional precipitation; and local runoff. Their work vastly improved the nation's ability to predict floods and to take preventive actions

This interview is one of several being produced in a special series covering engineers who shaped the Corps' hydrology and hydraulics program. Understanding the experiences, contributions, and thoughts of these individuals illuminates the past and provides guidance for the future. We commend this interview to all those interested in the development of twentieth century research in river hydraulics and hydrology.



Earl E. Eiker, P.E.
Chief, Hydraulics and Hydrology



Paul K. Walker, Ph.D.
Chief, Office of History



Contents

Early Years	·
University of Toledo	3
Ohio State University	4
Camp Hocking	6
Geological Survey	7
Weather Bureau	10
Marriage, October 1, 1938	10
Civil Servant, Weather Bureau, Pittsburgh	14
Weather Bureau, Washington, DC	16
Headquarters, United States Army Corps of Engineers, September 1942	19
Technical Representative, European Theater of Operations, 1944-1945	25
Review of High School	39
Tennessee Valley Authority	42
Publications	44
Civil Works	52
The Saint Lawrence Seaway	52
Computers	54
Mississippi Basin Model	55
Headquarters, United States Army Corps of Engineers	59
Corps Consultant	62
The International Hydrological Decade	63
Civil Works Division	67
Old Timers in Civil Works	81
Water Resources Council	90
Hydraulics and Hydrology	99
Regulating Reservoirs	105
Directors of Civil Works and Assistant Chiefs	110
Major Projects	121
Major Changes in the Corps of Engineers	123
BG William Whipple Jr.	128
Consulting Engineer	130
Lake Barcroft Dam	135
The Most Complicated Job: Bangladesh, Pakistan, and India	138
Major Contributions to Hydrology	154
Appendix A: Retirement	A-1

Franklin F. Snyder

Franklin Farison Snyder was born in Holgate, Ohio on 11 November 1910, the son of Samuel L. and Nettie M. (nee Farison) Snyder. He graduated from Libby High School in Toledo in 1928 and attended the University of Toledo for two years. In 1930, he transferred to Ohio State University, where he received a B.C.E. degree in 1932.

During the Great Depression, when promising engineers often encountered difficulties finding employment, Snyder obtained work in state and federal agencies. His first position was as a surveying foreman for the Ohio Division of Forestry. Afterwards, he joined the U.S. Geological Survey as a junior hydraulic engineer and assisted in the studies of rainfall and runoff. Results of his work were included in U.S.G.S. water supply paper #772, Studies of Relations of Rainfall and Runoff in the United States (1936).

Although still young, Snyder rapidly gained a reputation for expertise in the relationship between rainfall and runoff. He continued his work with the Tennessee Valley Authority in 1935-37. In Knoxville; he developed new flood routing procedures that were applied to existing and planned reservoirs in the Tennessee River basin. These procedures enabled hydrologists to calculate the course and character of floods as they progress through a river reach or a reservoir system. Snyder then joined the Pennsylvania Department of Forests and Waters, where he supervised studies of rainfall and runoff, part of a state effort to construct a statewide flood forecasting and warning system.

Meanwhile, beginning with the Flood Control Act of 1936, the United States government had initiated an ambitious flood control program to protect urban and rural areas. As the program developed and expanded, the necessity to develop reliable hydrologic data became apparent. The data was necessary to establish necessary reservoir and spillway capacity and to improve flood forecasting. Given these circumstances, Snyder's work obtained a larger audience, and his skills became more in demand.

In 1938, Snyder published the first of several papers in which he explained an important new approach to the study of runoff. He called his idea the synthetic unit hydrograph. Hydrographs show for a given point on a stream or channel the discharge, water surface elevation, stage, velocity or some other property of water in relation to time. Their dependability rests on available historical data from river and rain gauges, as well as on considerations of topography, channel slopes, and storage capacity. Unit hydrographs, as used by Snyder, were discharge graphs for one inch of surface runoff from a given area for a typical or specified type of storm over some unit of time. By analyzing runoff conditions in a large number of basins, Snyder was able to develop values for the duration of the runoff and flood peaks for different types of basins under varying conditions. His procedure allowed hydrologists to study and analyze drainage basins in

areas of from 10 to 10,000 square miles for which records were not available or were unreliable--this included a great number of basins in the United States.

In 1940, Snyder moved to Washington, D.C. to become an associate hydrologic engineer for the U.S. Weather Bureau. He was responsible for flood forecasting in 75 river districts. Gail Hathaway, chief of the reservoir and hydrology section in the Office of the Chief of Engineers, persuaded Snyder to come to the Corps in 1942, and Snyder remained with the Corps of Engineers for the next 24 years. In 1944-45, Snyder worked in Europe supervising flood forecasting procedures for the Rhine River. He received the War Department's "Exceptional Civilian Service" award for his overseas contributions. When he returned to the United States, he rejoined the Office of the Chief of Engineers and eventually rose to become the assistant chief of the hydraulics and hydrology branch. Snyder worked closely with Hathaway and others on questions dealing with spillway capacity. He also served as a special engineering consultant on the St. Lawrence Seaway project.

After retirement in 1966, Snyder became an international consultant, working on projects in Mexico, Columbia, Greece, Jamaica, Canada, Pakistan, India, Sudan, and the United States, among others. In 1989, Snyder received the Outstanding Civil Engineering Alumni Award from the Ohio State University Civil Engineering Alumni Association. Snyder married the former Elizabeth Bruton of Delaware County, Pennsylvania, in 1938. They have three children.

Personal Data

Franklin F. Snyder

Born: 11 November 1910
Hogate, Ohio

Education: University of Toledo, 1928 to 1930
Ohio State University, BCE Degree, December 1932
Ohio State University, CE Degree, 1942

Marriage: Mary Elizabeth (Bruton) Snyder
1 October 1938

Children: Mrs. Marilyn K. Stack
Carol Lamb Snyder
Gregory Lewis Snyder



FRANKLIN F. SNYDER

Interview with
Franklin F. Snyder

Early Years

Q: I want to begin by asking you to tell me a little bit about your family and your childhood.

A: Well, it's been a long time ago. I was born in Hogate, Ohio, which is a small town in northwestern Ohio. It's claim to fame, I guess, is because the famous comedian, Jerry Lewis, the man with the big mouth, you probably don't even know who he was, was born in Hogate. I went to school there through the grades. My father was the mayor of the town for most of the time, and he died when I was in the 8th grade. I had an older brother, five years older than I, who finished high school the following year.

As a result of my father's death, my mother decided to take me to Toledo to give me a chance at a better high school. So my mother and I moved to Toledo after 8th grade and before I began high school. I went to Libbey High School in Toledo. She put me through school by doing housework and other types of work. Part of the time when she was engaged, I would be able to live there, and other times I lived by myself.

The early years in Hogate were pleasant to remember. I mean we had normal circumstances and my father had a grain and flour mill. Before that, he'd been in the lumber business.

Q: Were you, did you have an interest in engineering or science before high school?

A: I was a prolific reader even in those early years. I would scrounge the neighborhood for books to read, and I was always struck by the adventurist life of the civil engineer. So, even while I was still a child, I had decided I was going to be a civil engineer. So there was never any doubt in my mind as to what I wanted to do. I don't know whether you are interested in anything more about the early years or

...

Q: Oh, very much so, yes.

A: I don't have a lot of memories. We just lived a few blocks from the school that I went to. It was just a normal childhood. I trapped muskrats several winters and things like that. We had a pond where we could swim and ice skate. I remember one time we had a snowstorm that was drifting so much that you had to duck your head to get under the telephone wires. It was pretty deep. I always remember that.

One time I collected horseradish for the roots; I think we were in the kitchen. My mother was helping process it when the house caught on fire and burned down. We moved next door until the house was rebuilt. We were Protestants, but there was a Catholic Church next door. It burnt down one time, and they brought all of their sacred things over and stored them in our house for awhile. Those-are-just sort of things that I remember.

My mother's name was Farison, and my father's, Snyder, and there was a section of Henry County, which was the county that Hogate was in, and there was an area where practically every other farm was either a Farison or Snyder. They must have gone courting together because three Farison's married three Snyders, so I have a lot of double cousins.

Q: Now, had both of your parents' families been there for a long time?

A: Both families came to Ohio around 1850 when the canal lands became available. There was a canal built from Toledo, it was along the Maumee River and then it went through Indiana to the Wabash River, which then connected with the Ohio River. During that process, the states got lands on each side of the canal, just like they did when they built the railroads out West. Then Ohio sold these lands. That section of Ohio, northwest Ohio, was heavily forested, but, of course, they gradually cleared it off. The soil was and still is a very good, but it took a lot of drainage so they built a lot of tile drains and ditches.

Q: What were the courses in high school like?

A: I took the academic course, preparation for college. I was the valedictorian of my class and graduated in, I guess it must have been 1918.

Q: '28'

A: '28, yes. That reminds me. I do remember World War I, they had a false armistice three days before the real armistice on November 11, 1918. That was one thing I always remember. My birthday is on November 11.

Q: Significant day.

A: Armistice Day, yes, yes.

Q: Were there any teachers in Libbey High School that particularly influenced your later career?

A: They didn't influence me as far as career-wise, but they did influence me in studying, and that sort of thing. It's hard for me to understand now why they have such a hard time educating children. I just can't understand what the problem is anymore. Everybody in those days, what they went to school for was to get an education. There weren't any side issues that kept them from doing that.

Q: So they made you work and do a lot of homework?

A: I don't really remember about whether I had much homework or not in Grade School, but I'm sure I did, although I don't think it was, it wasn't like it was in high school, that's for sure.

University of Toledo

Q: Now, you went from there to the University of Toledo?

A: Yes.

Q: Did you have any other options available to you? I mean was there a reason you went to Toledo?

A: We went there for the high school part. Then I intended to go to Ohio State, but financially, it was just better for me **to take the** first two years at the University of

Water Resources: Hydraulics and Hydrology

Toledo and then transfer. It was pre-engineering courses that I took, and they were all accepted at Ohio State. So the transition was perfectly normal. There was no difficulty in transferring.

Q: So they mainly were the basic engineering courses, and you specialized only when you went to Ohio State then?

A: Well, yes, but I took the pre-engineering at the University of Toledo, in other words, the mathematics, and the physics, and that sort of courses that you needed.

Q: You intended to study civil engineering from the very beginning?

A: Right.

Q: So when you went to Ohio State, you had done all of your prerequisites so you could go directly into civil engineering courses?

A: Right.

Ohio State University

Q: Now, what was your field of concentration in civil engineering?

A: I specialized in structural engineering, but I never worked a day at it. We had a Clyde T. Morris as the civil engineering professor in structures. At that time, he was well-known. He was consultant on the--every once in a while he'd go to New York. He was the consultant on what's the famous big building?

Q: The Empire State Building?

A: Yes, if it was being built at that time, that was the building. It was one of the well-known buildings that he was the consultant on.

The civil engineering students took their hydraulics in the Mechanical Engineering Department. So I had some hydraulics courses there. When it came time to pick

a thesis, why, one of the instructors in hydraulics, a professor by the name of Ralph Powell, suggested that I do a thesis on rainfall and runoff. I had a partner, William Collins. The two of us did it together. He worked for the Muskingum Conservancy District, which the Corps of Engineers was involved in, and he eventually worked in our office here in Washington. He died at a relatively early age while he was still employed in our Civil Works' office.

We did this thesis on rainfall and runoff. We worked out all of the correlations using Least Squares, which at that time wasn't new or anything, but our professor in concrete was an expert on that sort of thing. So we ground out hours' and hours of Least Square solutions correlating the rainfall and runoff data. In that day, we worked with monthly data rather than daily, or shorter term data. That got me, that's what partly led to my getting away from structural engineering because I graduated in 1932 near the bottom of the Depression.

In 1930, when I had only been at Ohio State for a short time, I went to the Ohio State-Michigan football game. When I came back to my room, I started having a severe pain in my stomach. I had just been pledged to a fraternity so I went to the fraternity to eat. By the time I got there, the pain was terrible. The brother of one of the current members of the fraternity was a surgeon, but they couldn't get him right away. They got another doctor. By that time my stomach was just like a brick.

The doctor came in and said that if I wasn't so young, that he would say it was a ruptured ulcer in the stomach. But since I was so young, it must be appendix. But it was a ruptured ulcer. They took me to the hospital and the surgeon that they had been trying to get was available. My mother was still in Toledo doing her usual work, and they couldn't get hold of her. They brought me to long enough to get permission to operate. By that time I told them I didn't care. They could operate or hit me in the head with an ax, it didn't matter.

I was very fortunate because at that time, there was no medicine for peritonitis, and that's what you get when you have a rupture in your abdomen. It kills you rather quickly. Doctor McCready said he had all of my insides laid out on the table, washing them off.

I was very fortunate, but I missed a quarter of school as a result of that. But there was a black woman, who was the cook at the fraternity house, who took care of me. So I stayed at the fraternity house during my recovery. With a ruptured ulcer, you have to eat soft foods, so she saw that I got the right things to eat and everything.

But as a result of missing that quarter of school, I made up almost everything except two courses. I didn't graduate in June. I had to go another quarter--they're on the quarter system there--and I graduated in December. There, again, I had the highest grades in my class, but since I didn't graduate at the regular time I guess the professors got together and decided that I couldn't have the prize, so they gave the prize to Collins for having the highest grade record.

That was in December of '32. It was sort of at the depth of the Depression. I think by about that time, the fraternity had gotten into poor straights and I was not living at the fraternity anymore. I was living in a rooming house.

The head of the Civil Engineering Department was C.E. Sherman. He was also the state representative with the U.S. Geological Survey. I don't know whether you know how the U.S. Geological Survey operates, but they have cooperations with all of the states, and he represented the state in the state's relationship with the Geological Survey. He also was the head of the States mapping: He was just finishing up a map of the State of Ohio. There'd always been an argument about the boundary between Ohio and Michigan, the part of it in Lake Erie. He was in the process of getting that settled. He gave me enough work so I could pay my board and room. So I worked for him for awhile on mapping and other things.

I was there when they had the Bank Holiday. I was in his office and he went over to his bookshelf, took a book out, he opened the book up, took a \$20 bill out and gave it to me. He said he didn't know whether I needed it or not, but I could have the \$20 in case I needed something while the banks were closed.

Q: Those were very difficult times, weren't they then?

A: Beg pardon?

Camp Hocking

Q: Those were very difficult times when you graduated?

A: Yes, it was. So I don't remember just when, but that was the time when they started opening up the CCC [Civilian Conservation Corps] Camps. One of the professors or instructors, Professor Wyatt, in the Civil Engineering Department had resigned, and he took the job as Superintendent in charge of Camp Hocking, which was set up by the Ohio Forestry Department to map the boundaries of some of the state

forest lands. So he hired three of the civils, two other fellows and myself, out of civil engineering graduates to do the survey.

I got the job of being in charge of it and having the office work. The other two, Henry Demboski '32 and Erwin Eckhardt '33, did the field work. They would take the CCC enrollees and train them in the fundamentals of surveying, and then start marking the boundaries of the state forest land. It was a lot of fun. I figured out where some cornerstones used to be, should be, and then I'd go hunting for them, and found a number of them, like that. But it was interesting. We were hired by the State Forestry Department. Since it was paid by the federal government, I got credit for that time.

Q: Time in service?

A: Time in Federal service, yes.

Geological Survey

Q: Now, according to your biography here, you worked at that for about a year, from July of '33 to April of '34.

A: Yes. Then because of my work on that water thesis and Professor Sherman's relationship with the Geological Survey, I got an offer to be a junior engineer with the Geological Survey on a special study that they set up to study floods, rainfall, and runoff. That was under the direction of a W.G. Hoyt. It was funded by PWA (Public Works Administration).

Q: There was also a Civil Works Administration for just a little while.

A: Well, anyhow, they had to have a political endorsement. Even then I was a Republican, but the camp carpenter foreman introduced me to the county Democratic Chairman and I went and talked to him. He didn't mind whether I was a Democrat or not. He gave me the endorsement, which was just a sort of a paper thing that they had to have in Washington. So then I was accepted as a junior engineer for the Geological Survey. It was a temporary appointment and not regular civil service, although again, I got credit for that time.

Well, it was a special project funded by PWA. The studies were authorized and directed by the Mississippi Valley Committee of the Emergency Administration of Public Works, subsequently the Water Planning Committee of the National Resources Board and assigned to the USGS. The best-known hydrologists in the country were consultants for the studies, so it gave me a chance to meet all of those people during that time.

Q: Who were they? Do you remember them?

A: One was Robert E. Horton, who still is widely quoted. There was W.W. Horner from St. Louis. Adolph Meyer of Minneapolis and L.K. Sherman, the father of the unit hydrograph, from Chicago. Merrill Bernard from Louisiana, who was a live-wire and who later on became my boss in the Weather Bureau, was a part-time employee. I don't know if we really want to skip to that now or not.

Q: We'll try to go along chronologically, I think.

A: That was really the beginning of my real interest in hydrology and in doing research. I always liked to do research work, so I worked on that in Washington. One of the staff, who was a clerk on the project, was Duane Paul. He and I roomed together. We had an apartment on G Street just about a block from the Treasury Building. We lived there for some time. Did our own cooking and everything. The USGS was in the old Interior building then and about two blocks from our apartment:

That project came to an end after, I guess probably a year and a half. Then I started writing letters looking for other work. Up to that time and even later, I had firmly decided I was not going to work for the Government all my life.

One of the men I met while on this project was chief engineer for the Pennsylvania Water and Power Company. His name was C.F. Merriam. He gave me letters to some of the chief engineers of some of the big hydropower companies, but none of them had a vacancy for me at the moment. W.G. Hoyt, the man in charge of this project, through his acquaintanceship with a man at the TVA [Tennessee Valley Authority], got me a job as a hydraulic engineer with TVA, which was a nice engagement. I had a chance to spend most of my time there on research.

We developed some flood routing procedures, which is one of the papers that was published in ASCE [American Society of Civil Engineers] with two other writers from TVA. I, being by myself, spent a lot of my weekends and a lot of hours doing

other research on streams in that area. I collected a lot of data and made a lot of studies. I used that data later on in some other papers, but I never did publish a paper just on that work in Knoxville.

Q: Now this was still relatively early in the development of hydrology in the United States.

A: *Yes.*

Q: I mean, it hadn't progressed to the state it is today, certainly, and there was still a lot of work going on.

A: One of the interesting things, while I was back in Washington on the rainfall studies, there was a standard Geological Survey publication on groundwater. Meinzer was the author's name. At that time, he was the authority on groundwater. The groundwater they considered at that time was a base flow that went on forever.

It didn't make any sense to me that, in studying the hydrographs that we were analyzing there, that after a rainstorm, why, no matter how slow you figured the water moved true surface runoff would all have to be out of the basin within a fairly short time, and yet the hydrographs were way above what Meinzer called "ground water." So it just became obvious that there was "sub-surface storm flow," which was water that actually entered the ground, but came out of the ground rather quickly and was not part of the real base flow.

There were others who were developing the same ideas at the same time, but, anyhow, within my circle, I was the originator of the idea of this second type of direct runoff along with the true surface run-off. I looked through' the project report, *Water Supply Paper 772*, the other day and that idea was not even mentioned in our report. But, within a year or two, I published papers in which I expounded that theory.

Things were going on okay with the TVA, but there didn't seem to be any great room for advancement, although one of the men-we had bowling teams and softball teams. One of the men that was in the same bullpen I was in, who worked for the power section, later on became chairman of the TVA. I tried to think of what his name was, but I don't remember. That was some years ago, but that was quite an advancement for him.

But about that time, the Weather Bureau, the Geological Survey, and the State of Pennsylvania worked up a cooperative program where they were going to install rain gauges and study flood forecasting. Pennsylvania had just suffered the 1936 floods which devastated the state. This was an unusual federal-state program, where the state furnished the money. Generally, the Federal government furnishes the money. But in this case, the state furnished the money.

By that time, Merrill Bernard that I mentioned as a part-time employee on the Geological Survey Study had become Chief of the River Service in the Weather Bureau Washington office. He was the Weather Bureau officer that was working on this cooperative program along with a man from the Geological Survey and the State of Pennsylvania. They formalized the agreement and then started hiring people. So Merrill Bernard, the man in the Weather Bureau, contacted me.

Weather Bureau

The program was divided into two parts: one in the research, which I was to be in charge of; and another on the field work of putting out the recording rain gauges and everything, was under the charge of another man by the name of George Weber. So I accepted. I had a telegram, official Weather Bureau telegram from Bernard, after I had accepted telling me to report.

I mention that because this George Weber had been a regular Civil Service employee. So when he shifted over to state employment, the Geological Survey still paid his retirement pay which kept him in the federal service. At that time I still wasn't fully convinced I was going to be a government employee, so I didn't give much thought to it. But I should have arranged a similar deal with the Weather Bureau. So later on when I retired, which we'll get to eventually, from the Corps, I was scrounging together to get all of the service time I could. I tried to get credit for these two or three years in Pennsylvania. I had a Congressman write, and I had this telegram from the Weather Bureau and everything, but they never would accept that.

Marriage, October 1, 1938

I went to Pennsylvania then and that's where I met my wife. We were married in, I went there in '37, and we were married in '38, October 1, 1938.

Q: You went to Harrisburg, according to your vita.

A: Yes.

Q: Okay. So you went to the State Capital. That's where they set up the office to do that work?

A: Yes. We had the state divided into three sections: the Delaware section, the Susquehanna, and the Ohio. So I immediately started collecting data with the staff, getting information together and developing flood forecasting procedures for all three river basins. They were published by the, well, I don't know whether you'd call it published or not, but the state printed them. They weren't in a real book form. They were in a soft book. We had developed flood procedures for the three major basins.

Pennsylvania has always been a pretty strong political state. Whichever party was in charge, almost without fail, the employees paid their contributions or they didn't work. Well, I was assured that I would not be subject to that. We were sort of winding up the forecasting studies and most of the rain gauges had been installed. My wife was a secretary in the office of the head of the Forestry Service. But somehow, they got the word through her to me that they were going to start, that the Democrats were going to start working on me. I think it was suggested that I resign rather than get fired.

The Weather Bureau hired me then to go to Pittsburgh and be in charge of hydrologic services in the Pittsburgh **Office** of the Weather Bureau as a focal point for floodcasting the Upper Ohio River. They had also suffered severely in that 1936 flood, and so my wife and I moved to Pittsburgh.

Q: Okay. So you were in Harrisburg for about two years?

A: Yes.

Q: Let me ask you about this flood forecasting. Now, that had to be in its very early years of flood forecasting. What did you use as a basis for developing your procedures?

A: What we called gauge relations. In other words, from floods of record you would plot the reading at one point against the readings at the next point and on down the river system. Where tributaries come in, you could plot a family of curves. In other words, you'd have a family of curves instead of a single curve. You'd have a relation between three gauges then. That was the normal procedure, but while I was in Harrisburg I had started developing the relations between rainfall and runoff which had not been done very much up to that time.

As part of the project field work, they began to add to the reporting system where they'd have readers at these various gauges and they would report the reading into, for the Susquehanna Basin, to Harrisburg, for instance. The Weather Bureau, now the National Weather Service did then and now still does the river forecasting for the whole country. That's why they were around in this joint study.

So in the days before this, most of the Weather Bureau officials would, it would be a judgment call. They wouldn't have any fixed procedure, just based on their experience, and lot of them were real experienced, but just from their past knowledge. By having an idea how much rainfall there was, they would estimate what these river readings were going to be. So I developed a number of procedures, the relationships for a number of the river basins, as part of this study, whereas if you had so much runoff with certain, I think maybe that time I was using the base flow, the groundwater flow, as an index of how much runoff you'd get from a given amount of rainfall. Based on past studies of past storms, again, I plotted relationships between the index conditions, the amount of rainfall, and how much runoff you would get. Then we used unit hydrographs to convert that rainfall into runoff. I don't know whether you want to, I guess it doesn't matter whether I jump around, does it?

Q: No, whatever you want to do to explain is fine.

A: In 1932, L. K. Sherman, who became a consultant on the Geological Survey study, developed what he called a "unit graph," which theory was that if one inch of runoff gave you a certain hydrograph, two inches of runoff would give you twice that hydrograph, but that the time scale would stay pretty much the same, but the ordinates, the intensity of the runoff, would fluctuate with the amount of runoff. You'd develop these "unit graphs" for one inch of runoff so then you could just multiply the ordinates by however much runoff you expected. But, of course, involved in it is the duration of the storm.

But he developed this idea, and it was published, in the *Engineering News Record*. Of course, it caught on rather rapidly, and I was using it then in converting these predictions of the runoff from a given amount of rainfall, converting it into a hydrograph of stream flow and using it in these flood forecasting procedures. I don't suppose you're interested in them. I've got a copy of them if you. ..

Q: Yes, I think we would be, yes, because this apparently was some very early work in this area that you were doing, L.K. Sherman in Chicago was doing, that you then took, and modified, or tweaked a little bit.

A: Beg pardon?

Q: That you took his work and you modified it, perfected it?

A: Well, I published a paper about this time based a lot on the work I had done on the side in Knoxville on those streams there. I published a paper on synthetic unit graphs, where you would develop a unit graph for a stream where you didn't have any records to study. That's where the name "synthetic" came in, and that's what got me the job with the Corps of Engineers, eventually. But, well, I diverted to get the unit hydrograph into the story here. (Note: Sherman called them unit graphs but we eventually called them unit hydrographs.)

Q: No, that's very important because one of the guys in the office asked me this, specifically to discuss the unit hydrograph with you, so you got me before I got you.

A: That paper got me world-wide acclaim. Years later on, when I did a lot of traveling for the Corps on a lot of international projects, it didn't matter where I went. It was translated into Russian and other languages. People knew who F. F. Snyder was. They were always surprised. They expected me to be an old man with whiskers.

Q: I was just looking at your vita here trying to get that paper that you mentioned. Okay. That's the. ..

A: With the American Geophysical Union.

Q: '38, '39, '40, *Transactions of the American Geophysical Union*, Section of Hydrology, on synthetic unit graphs. So that's what made your name?

A: Yes.

Q: That was all based on your own little work down in Knoxville?

A: Mostly that, but then, of course, I was in Harrisburg when I prepared the paper. I had all my information from Knoxville, but that would have been just a regional thing, so I incorporated and collected data on other areas. I had the Pennsylvania data also.

I collected other data so that it was, well, so that I felt that it would work most anywhere. I put certain factors into it that you could change when you got into an area where the characteristics of stream flow were considerably different than they were in these rugged areas that I had data for. Most of the areas I had at Knoxville were rugged territories--and even in Pennsylvania, most of them were certainly rugged. The procedure did work with the adjustment.

In other words, the Corps' offices started using it and you would study your stations where you had the records and you would develop these factors that you could then use to develop a unit hydrograph for an ungauged area, using the factors that they had developed in their own area. My wife and I moved to Pittsburgh then, and I became a civil servant then.

Civil Servant, Weather Bureau, Pittsburgh

Q: With the Weather Bureau?

A: With the Weather Bureau, although I think that took a little doing, too. But Merrill Bernard arranged it. He had the energy, always on the go. He'd been a private engineer in Louisiana developing cotton and rice lands. But he got mixed up with the Federal government during his PWA days, and he ended up being Chief of the River and Flood Service of the Weather Bureau.

That was the same time that Reichelderfer came in as Chief of the Weather Bureau. He was an ex-Navy officer. He organized the place like a ship. I think everything was vertical instead of horizontal. I think Bernard was there maybe a little before Reichelderfer, but when I came to Washington later on, Reichelderfer was there and

all of the forecasting was put in one division--the river forecasting, weather forecasting, and everything like that was put in one division. But that's aside.

In Pittsburgh, my responsibilities were entirely on the river work, and I suppose I developed some more procedures there, although we had already developed a lot of them. We had several significant floods while I was there for which I did the forecasting. I remember spending nights at the office and what not during these floods. I think the procedures worked out fairly well.

Q: How extensive were the rainfall and river gauging stations at that time?

A: The rainfall was perhaps a little deficient. But the river gauges, they were pretty adequate. Reports were available from navigation dams on the Allegheny and the Monongahela Rivers, which the Corps operated. There were gauges on all of the tributaries and that was the area that the field man had put recording rain gauges and lined up reporters to report the rainfall in to the central office. It wasn't too bad.

Q: Was the development of the rain gauge system more in the 1930's with modern communications, telephone and things like that, where you would have people being able to call in the readings?

A: Even before this, for years the Weather Bureau basic data for forecasting was almost entirely river and rainfall gauges which they operated. The Weather Bureau used to publish the river gauge readings for those stations, separate from the Geological Survey. The observers would phone or telegraph readings in to the forecasting office, wherever it happened to be for that particular river basin. We began to get into using radio reports, too, although not very much. That came a little later. The Corps was active in the initiation of radio reporting.

Q: But the development of these rainfall gauges was critical to getting the information early, wasn't it?

A: That's another story where Mr. Hathaway is the hero. I don't know whether you want to jump to that now.

Q: Well, we can do that, sure.

A: Well, why don't we wait a little while.

Q: Okay. Let me make a note on that.

A: When I get into Washington.

Weather Bureau, Washington, DC

Q: I don't want to take you ahead of the story.

A: That was a good engagement in Pittsburgh. I enjoyed it, particularly when we had a flood on. That always added a little spice to life. But eventually, there was a vacancy, or else he made a vacancy, Mr. Bernard moved me into Washington in his division, although, as I said at that time, they had reorganized so that actually, he was no longer the head of River Forecasting because it had been moved in with all other types of forecasting. But he had a special assignment as Supervising Hydrologist. He was still primarily in the river work. But actually, my boss was a man in charge of all forecasting. His name was Tannehill.

We moved to Washington then, and we stayed temporarily at an apartment near the Geological Survey. But then, through Duane Paul, that I had roomed with earlier, we got into Arlington Village. I don't know whether you're familiar with that or not, but it was a new development. The first development was Colonial Village, the one off Wilson Boulevard, right near Rosslyn. Well, anyhow, this same builder, Ring, built Arlington Village. They were row apartments, but they weaved in and out, and they all had a back court as well as a front yard, and they had very strict requirements. I think the rent was \$48 a month.

Q: That's off Glebe Road, right? South Glebe Road?

A: No, off of Columbia Pike.

Q: Columbia Pike, okay.

A: They'd been converted into condominiums three or four years ago. It's right close in. It's right close to town.

Q: There are a lot of those developments and multiple housing units that. ..

A: Well, Buckingham is a little bit like it. Buckingham was built a little bit later. But Ring first built Colonial Village, right out of Rosslyn there, which was converted to condominiums. They made them preserve a piece of it. Of course, the original builder had sold it. The owner was required to maintain a piece of it as what do you call it when you preserve?

Q: Historic preservation?

A: Yes, yes. But anyhow, we were real fortunate to get in there. It was very nice living there. Of course, then part of my job in the Washington Office of the Weather Bureau was to do the river forecasting on the Potomac River, which was a function of that office. The man I think that had been doing it, I don't suppose he was too happy to have me arrive, but I think maybe one of the senior men had passed on or something, so the chap that was my assistant had never really been in charge. We had no trouble about that.

So I started developing the same type of river forecasting charts for the Potomac River. About that time, this Professor Powell from Ohio State contacted me to see if I was interested in getting a professional CE Degree from Ohio State. Of course, I was. So I used the development of the river and flood procedures for the Potomac River Basin as my thesis. One of the requirements for the professional degree was a thesis, an approved thesis. I went through the red tape of getting it approved.

But also, my job was to travel around to the various river districts that had a forecasting office located at one of the Weather Bureau offices. Generally, the forecaster was the official in charge. In other words, they didn't have a separate organization. The official in charge also did the river forecasting. My job was to try to get these people to put their knowledge on paper. As I said, most of them, they had it in their heads and a lot of them did a real good job, but when they left there was nothing left there for the next man.

So while doing that, I also for a lot of these river basins started developing the forecasting procedures. I don't know how many. I suspect I developed the forecasting procedures for more river basins than anybody ever has. But that traveling around didn't make my wife happy. I guess I told you she passed away in January, did I?

Q: Oh, I didn't ask. Sorry to hear that.

A: But she managed all right, and I did do a fair amount of traveling. An interesting corhmentary, about that time they began to authorize travel by air. So when I was with the Weather Bureau, I had a mixture of train and air. But when I moved to the Corps of Engineers, you couldn't fly. You had to go by train.

Q: Is that right?

A: For awhile, not very long.

Q: That must have made your traveling very hard.

A: But about that time Gail Hathaway arrived on the scene. Well, he was already in Washington before I was. But I mean in my picture, he arrived on the scene. He convinced the powers-that-be in the Corps that the spillway capacity for the dams were not being adequately studied. I think the first one he sold was for Dennison Dam in Texas. He convinced them--and I don't remember the name of the general that backed him up--that they should have a meteorological study made as to what the potential rainfall might be for the emergency situations. With that as a start then, I don't know where he was before he came, well, I know in private practice he was out in Oregon, but whether he was in a field office of the Corps before he came to Washington or not, I don't remember.

Q: I thought he was in Omaha.

A: He might well have been.

Q: So many of those people came out of Omaha, right.

A: Started in Omaha, yes. He was in Washington. So he started the idea of having a Maximum Probable Flood (later changed to Probable Maximum Flood) for the design of dams. As part of that, he sold the Corps on putting into their appropriation money for a nationwide recording rain gauge program, which was sort of, well, I guess it sort of followed the effort that Pennsylvania had done by itself. But that idea took hold and so the Corps got the appropriations and transferred the

money to the Weather Bureau and they began to install recording rain gauges all over the country into a national network.

About the same time he initiated the other program of having the Weather Bureau set up a Hydro-meteorological Section, who would make these studies of the maximum probable precipitation for the Corps' projects. That, again, was funded by the Corps through direct appropriations showing what it was for. It was not buried in the regular appropriations. It was an appropriation that was to go to the Weather Bureau. His principal assistant was Al Cochran.

Q: Okay.

A: A little later, a number of the people began to take commissions in the Army and go into the service. That would have been--well, I transferred from the Weather Bureau in '42, Hathaway maneuvered that. It was primarily because of the unit hydrograph studies that Hathaway wanted me to come over and work in the Chief's Office. About that time, the Weather Bureau, they had some sort of a program where you could get an increase of \$100 a year, and they wouldn't give me one.

Hathaway proposed that I come to the Corps, and I guess it was a promotion involved, too. I think I went from an assistant to associate, but anyhow, I transferred then to the Chief's office.

Headquarters, United States Army Corps of Engineers, September 1942

Q: Okay. That was in September of '42?

A: Well, September of '42, we had the second highest flood-of-record on the Potomac River. I had just transferred, but I went back to the Weather Bureau and did the forecasting. I did a pretty good job of it, too. I think I hit the Washington forecast within a few tenths of a foot. I was a little high upstream. But, you see, they had built a bunch of bridges, temporary bridges, across the Potomac. They kind of screwed things up a little bit, but we tried to estimate for that.

I remember before the crest had arrived, I'd been down at the Weather Bureau office, I guess, to around midnight or so, and when I was driving home, I stopped there at the Washington Monument on 17th Street and they were laying sandbags across the street there to keep the water from--the Reflecting Pool was going to be

flooded, but they were blocking off 17th Street so that water wouldn't get up, and around the Navy. The Navy had a lot of buildings along there.

Q: Temporary buildings in there, yes.

A: They were building sandbags along the back there. I stopped there on the way home. A man couldn't understand why there was water on both sides of his sandbags. They eventually found out someone had forgot to shut some valves on the Reflecting Pool, and the water was backing up through the Reflecting Pool and getting up on the wrong side of the sandbags there on 17th Street. I enjoyed that experience.

With the Corps, my principal work was with the operations of the reservoirs for flood control. I was in charge of that work. A lot of other routine stuff that flows through an office.

Q: Well, the Corps didn't have. . .

A: It didn't have too many reservoirs yet then. Is that what you were going to say?

Q: No. I was going to say it didn't have too many hydrologists at that time.

A: Well, I don't know what they were, I suppose my rating was hydraulic.

Q: Yes, I imagine you probably were a hydraulic engineer.

A: I'm sure they were all hydraulic engineers then. I'm sure that's what it was--that's what it was with the TVA and the Weather Bureau.

But Mr. Hathaway was an outgoing man that made friends easily. Even I think in those early days, he had his eye on being president of the ASCE because he did a lot of traveling, and he met a lot of people, and made a lot of friends all over the country. Rightfully so because he was quite a man. He had, of course, the backing of the powers that be. He got things done that most people wouldn't have been able to get done like setting up those programs.

Q: Well, he had very good relations with the Chief of Engineers, Reybold, at that time. Eugene Reybold?

A: I'm not sure who was Chief when I transferred.

Q: That's who it was. He was the Chief throughout the war.

A: He was Chief for a long time, right.

Q: Yes.

A: He was Chief when I went overseas.

Q: He was from '41 - '45, for four years.

A: Yes.

Q: And Thomas Robbins was the deputy chief.

A: Yes. I got to know Robbins quite well later on. He was on the board of the St. Lawrence Seaway Project. He was involved in the design, I guess, some board that they had set up. I got involved in the St. Lawrence Seaway later on. Well, I hadn't been over there long before Cochran went into the service. Hathaway was chief of the branch or whatever it was. I guess it was a branch or a section.

Q: Was that Hydraulic Engineering Branch?

A: I'm not sure what they called it then. Later it was Hydrology and Hydraulics. I probably have an organization chart someplace. It was either a section or a branch, however they were organized in the Engineering Division, and Hathaway was the head of it. Cochran had been his chief assistant. Mark Gurnee was another friend that went into the service at the same time. I forget where he was at that time; I think he was in a different branch. When he came back, he worked in our branch for awhile until they found another opening for him.

- Q: There wasn't much work going on in Civil Works in the Corps at that time, but there were flood problems.
- A: Yes, I was trying to think what, I don't really remember what I spent most of my time on in the beginning because there weren't too many reservoirs to operate either. So it must have been just the routine review of hydraulic features of the reports that the field submitted. A lot of work was done on the manual for design of airfields. Of course, we, our branch, Hathaway's branch, was the liaison with the Weather Bureau on this rain gauge and Hydro-meteorological Section and probable maximum precipitation. We had to report, you know, make the reports to Congress for the funding for those programs. Ralph Wilson in our office handled the details on these programs.
- Q: About that whole idea of doing the probable maximum flood and all of that kind of thing, that was relatively new for the Corps in its planning process, Civil Works process?
- A: It was new to the whole world, and the whole world has copied it.
- Q: Hathaway is the one that came up with that?
- A: Hathaway was the father of that business, right. There was just no competition. Quite often when somebody develops something? somebody else claims to do it at the same time, but Hathaway was way out ahead of everybody on those things.
- Q: He didn't seem to have any problem getting the structural people to go along with that then, or did he have problems?
- A: No, I don't think so. Not that I know of. He had the backing of the head office. It wasn't an instantaneous thing, but the change in procedures was adopted when we started working on a number of new projects. There'd probably been a lot of projects approved, but the details had never been developed. There was a grand program approved on the Mississippi Basin study years before, but they weren't building them until this period of time. Our branch sent out the instructions and the requirements for what had to be done in the design of the spillways to take care of the large floods. Certainly, there must have been some people that thought it was crazy, but there was never any official problem with getting it accepted. It had to be accepted and the credit goes to Hathaway for all of that.

Q: There were a lot of procedures you had to install and policies that had to be implemented.

A: Right, yes. I don't know when the engineering manual started, whether we had them right away. Eventually, that's the way we sent out the guidance on how to do things. Eventually, all of this stuff was in the engineering manuals. There were engineering manuals on the spillway design and most other features of project design.

Q: A lot of that was entered into the whole planning and design process, so I guess it had not been in it before, the requirements for the hydrologic studies.

A: It was what?

Q: They had to put that all into the design process.

A: Yes.

Q: A lot of it had not been considered before.

A: I don't know how they did it before they used this rainfall data and computed flood design. Design was probably based on study of past floods. But that's where the unit hydrographs got used, the synthetic unit hydrographs, because the Weather Bureau gave them the rainfall, but the field offices had to convert this rainfall into stream flows, and most of the offices used unit hydrographs. They weren't necessarily synthetic ones. If you had a stream flow record, you could develop a unit hydrograph from the records of past storms. But then to transfer it from where your gauge was to where you wanted to use it, the synthetic procedure had these factors in it which allowed you to make a transfer. In other words, you would determine the factors at a place where you had records, and then apply it at the dam site or wherever you subdivided the basin.

Q: Well, one of the problems, too, was that there weren't a lot of really good records for all of the river basins in the country.

A: No, there weren't.

Q: You didn't have more than what, even by that time 75-80 years of good records, good statistical records?

A: No. The records that they had, the quality may have been all right, but they were short and there just weren't too many of them. Very few records were as long as 50 years. I didn't mention that, but at the same time that Hathaway started a similar program of putting out rain gauges, he also started a similar program with the Geological Survey where they put in a bunch of stream gauges that we wanted for our studies, and which the Corps paid for. The same sort of program as they did for the rain gauges. Of course, Hathaway is the one that started that, too.

Q: I believe the Corps is still paying for that, for the gauges for the Geological Survey and the Weather Bureau, both.

A: Yes, I think they still do. I saw something where Congress is talking about eliminating the Geological Survey completely. I just can't imagine how an idea like that would survive. You would think that all of the engineers in the country would raise hell about that. I haven't seen anything about it lately.

Q: They may have decided there were better things to do than that. But at that time, you didn't have any problems, but I found, talking to people like Verne Hagen that they ran into problems with the relationships with the Geological Survey, and between the Geological Survey, Corps, and the Weather Bureau, on defining various common terms of reference, like national probable flood.

A: Well, the Bureau of Reclamation was the one that probably had more initial reluctance. They finally became believers, too, and they sort of joined in with our support of the Weather Bureau. They finally started hiring the Weather Bureau to develop storms for them, too. But for a long time they took a dim view. I guess a lot of private engineers to this day think it's out of this world. But there have been enough extreme floods that have happened that it should have made believers out of most of them, because even now they're going back and rebuilding some of the original spillways that were built by the new procedures. They came up with bigger possibilities, I guess. I am not familiar with the more recent developments, particularly if there is a national probable flood. Sounds like someone trying to save face.

Q: Well, I think two years ago they came up with a bunch of bigger probabilities, didn't they, in the Mid-West there, that they had never thought of?

A: Yes.

Q: But mainly what you were doing was making models, weren't you? You were developing models of rainfall and floods that they could use? So if you were to do that today, it's all on computers, what you were doing.

A: I'm not sure that I can. . .

Q: What I'm saying is you basically developed the models?

A: Well, yes, we didn't call it that.

Q: You didn't call it that, but that's what it is.

A: That's the popular term now, I guess. But we have another story when we get to computers.

Q: All this was done by hand calculation and by what, adding machines, what do they call them, calculating machines?

A: Yes, I'm trying to think. We did not have the hand-held calculators. That I know. It was done with slide rules.

Q: Slide rules mainly?

A: Yes. That is the normal calculations. I'm sure everybody used slide rules, but whether they used machines to back it up or not, I don't know. I don't think so, because the slide rules accuracy, generally, was good enough for most computations.

Technical Representative, European Theater of Operations, 1944-1945

Q: You weren't going to multiple decimal points, I don't think on those calculations.

A: Damn that decimal point, huh? I don't know whether there's anything more before we get into the Rhine River business.

Q: No, we can do that if you want.

A: Incidentally, did you take that article by Dzuiban?

Q: I do have that. Do you want that?

A: No, you can make me a copy.

Q: I have it right here.

A: Yes. I don't know who started it or why, somebody over there realized that they had a problem with the Rhine River and so the Chief Engineer asked Washington for someone to come over and survey the situation. Hathaway got that assignment. Well, Al Cochran was over there in the Paris, in the Chief Engineers' office in Paris. When I was there, they were building hospitals. They knew he was a hydraulic engineer. I'm sure he got together some hydraulic data on the river and whatnot, and I'm sure he recommended that they get Hathaway.

Hathaway went over. He was a good choice for that because he knew a lot of the engineers of the various armies. He's the kind that could go around and make friends with them all. He wasn't over there too long when he sent back a request for a meteorologist, an engineer, and a hydrologist. I don't know whether he asked for me by name or not. He probably did on the meteorologist. The chief of this Hydro-meteorological Section that the Weather Bureau had set up under the Corps' sponsorship was a Don Cameron. He probably asked for him by name; but whether he asked for me by name or not, I have forgotten.

But when the word got around the office, I told them if I didn't go, I would quit. I meant it, too, because there wasn't anybody that had the background I had in developing flood forecasting procedures. Probably by that time I'd developed flood forecasting procedures for 20-25 different river basins for the Weather Bureau. There just wasn't anybody that would have been better for the job than me. And, of course, I was selected. Whether it was a selection or a request, I don't know.

Then I immediately started collecting data and things. I don't know how much lead time I had, but the request went to Vicksburg for hydrologic data. In some of these articles, or I don't know whether it's in here or not, but I saw an article in my file, it was just about all of the work that Vicksburg did for the Rhine River flood forecasting work. But they did have a lot of records, actual gauge records, and other things, for different stations on the Rhine.

Q: All of its tributaries, too, I imagine.

A: Yes, yes. That data all came and I started tabulating, and began plotting gauge relations right away. I'm a little hazy on how much of it I had done before I left, but I must have had gotten about all I could out of that data before I left. Cameron and I went together, went to New York, and then I forget the field there that military aircraft left from, and we flew into Paris.

When we left, we didn't know whether we were going to London or to Paris because they said depending on the military situation, we might have to go to London and not go to Paris. But we ended up by going direct to Paris. The last leg overland, they flew right close to ground and boy, was it rough. I remember that. That was really a rough ride after we got across the ocean going into Paris. But everything went fine. They had quarters for us. Cochran was taking care of that. His commanding officer was Colonel W. G. Lyles. He became a friend and later on, Al Cochran when he retired, went to work for him down in Columbia, South Carolina. He was a head of an engineering company in South Carolina.

We had quarters there. The one thing that's outstanding about Paris was the champagne. These fellows traveled around all over the country on these hospital projects and as long as they had the empty bottles, they could get all of the champagne they wanted. It was the bottles that were scarce. So they brought champagne back by the cases.

They had hired a French ex-patriot, who had moved to South America and married the daughter of a prominent owner of a large construction company in South America. He had come back for the war as an expert. In fact, they brought him back the same way, I guess, as they did us because he was knowledgeable about the bridges. He apparently had worked on a number of the French bridges before he went to South America. After they got him, they could not figure out what they got him for so they assigned him to us, to our hydrology project, because he was French, and he did help us some in collecting more information. Later on, he got assigned to the correct area.

Q: Back to Paris and your French colleague.

A: His name was Pierre. I forget what his last name was. But anyhow, that's just sort of a side issue. I thought maybe I ought to try to learn a little French and I figured he, being available, might make it easy. But when he started pronouncing those French words for me, I decided right away that it was a hopeless case, so I quit trying to learn French. My ear, I have trouble understanding English-speaking people that have a little accent, so how in the world was I ever going to understand French? My hearing back then was poor. Now my hearing is shot. But even back then, my hearing for music or anything was no good at all so I decided right away not to try to learn French. You could get along very well, particularly during the war, with English.

We stayed in Paris for several weeks. We did get a little information there from the French organizations, but really not very much. Everything was still basically what we got from Vicksburg. Then the forecasting unit was being organized. George Mittendorf, he was a major, and, again, a Corps civilian, who had taken a commission, was in charge of the flood forecasting unit. We were assigned to the Chantilly, which was a race course town, about 30 kilometers out of Paris. It was where the 21st Weather Squadron was located. I think it was the 9th, and I think they were at the 9th.

Q: 9th Air Force?

A: 9th Air Force rear headquarters. I'm not sure it was the 9th. It was one of the Air Force headquarters.

Q: It probably would have been. The 9th Air Force was a tactical air force.

A: They had taken over a Rothschild chateau. They were in the main building. There were some temporary buildings. I believe they were converted stables that we were assigned to. I guess, at least I tell about it, it was the policy that the U.S. Forces took any property that the Germans had taken when the U.S. took it over. They didn't take new property away from the French, but they kept what the Germans had taken if they needed it.

We were billeted in a real nice, I don't know whether they called it a chateau or not, but it was a real nice mansion that the Germans had been using. It was in the town about a mile or so from the office. The headquarters were out at the edge of town, and it was walking distance back and forth from the residence to where our offices were.

So we had, I think in my paper there I describe how many people we had, but it was Mittendorf who was in charge. I think he has died. Al Cochran and Bill Lyles are also dead. Mittendorf was the head civilian in the Atlanta Division office after the war. I don't know whether this has anything to do with the story, but when, a few years back, the commanding general died and I think Mittendorf later on married his wife there in Atlanta.

He was in charge of the unit. We had several G.I.s and, Don Cameron was there. He had the contact with the Weather Service. In other words, he got all of the weather information that they could collect for us. All this is told in the articles about how we operated. Hathaway had gone around. He had visited all of the engineers of the various armies and arranged for collecting gauge readings and for putting in some additional gauges or replacing ones that had been destroyed.

At that time we had one bank of the Rhine and, I think, once or twice some of the G.I.s were killed reading the gauges. But the reason we were at Chantilly was the communication system. In other words, the data that we could get would come in, and then the forecast would get back out to the armies in an efficient manner. I never went into that. I'm not sure just how it all operated, but it apparently operated pretty good because of the planning and communications facilities there.

The upper river gauges were in Switzerland on one side, and Germany on the other. The Swiss couldn't give us that information, but somebody, the intelligence people arranged with somebody to get us the Swiss gauge readings.

Q: So you did have the-Swiss readings?

A: Yes. Then quite a bit of the time, the Germans were broadcasting river data in the clear. They apparently felt it was of more value to them for navigation and maybe they didn't know we were interested in it. Every so often someone picked up for us the river readings broadcast by the Germans for some of the gauges on the tributaries in the German held area. They were very helpful.

So we finally got organized there and developed a system for the forecasting which is described in my ASCE paper, I mean the routine of how often and where we made a forecast were pretty much dictated by when we were able to get information. We ended up in making two forecasts a day at noon and midnight. So things started shaking down, and we put out our first forecast 27 January '45.

We went over in late November. In December and January was the Battle of the Bulge. They issued orders that everybody was to carry a side arm. Of course, I didn't know whether that applied to me or not, but I love guns so one of the G.I.s picked up a Belgian pistol for me, so I got to carry a side arm. We had an awful lot of snow in January. It was stormy up at the Bulge, too, but we had a lot of snow in Paris, too, that January.

Q: When the Battle of the Bulge first started, how did the headquarters react to that?
There apparently was a lot of panic and uncertainty.

A: We could go into Paris every Saturday--there must have been some other activities in these buildings with us, and so every Saturday there would be a couple of trucks going into Paris, the guys would go in and then come back Sunday night. But we really didn't have any, I didn't have any military contacts at all except just immediately in our own unit there. But, the notice about side arms, and everything came out in paper. I don't even know who issued it.

But I suppose there was concern. There couldn't help but be. Who knows what would have happened if the Germans had succeeded there. It would have been a mess for awhile, that's for sure. There have been several different programs about the Battle of the Bulge. That's where, I forget his name now, sent back the nuts to the Germans.

Q: Oh, Anthony McAuliffe?

A: Yes, to the Germans.

Q: Well, that's not what he said.

A: They couldn't figure out, according to the movie at least, they couldn't figure out what that meant.

Q: Well, that is subject to a lot of interpretation.

A: Yes.

Q: They're not certain for certain what he said. He may have said something else to them that couldn't be printed.

A: Yes, that's right. After going through that battle, he probably did say something else.

Q: Now, how long were you in Paris for this work?

A: Only a couple of weeks before we moved to Chantilly.

Q: Then you were there how long?

A: I came back in May, so I was there from December--the original assignment was three months. They had to get it extended then for another three months. In looking through my file, I found a paper where I had to get the permission of the Draft Board.

Q: Draft Board?

A: Draft Board, yes. I had a deferment because I was working for a military organization, but I had to get their permission to leave the country.

Q: You would have an exemption. Not an exemption, a deferment or something?

A: Yes.

Q: Yes, I know. It wasn't a 4-F. You were a 3A-something or a 2. There was a number that you had. You had a specific number that exempted you.

A: Yes. I have the paper downstairs where I got their permission. I didn't have to get too many shots because I'd already been doing a lot of traveling, so I was pretty well up on my shots and everything before we went overseas.

Q: So this continued up through the seizure of the Bridge at Remagen and the crossings in March?

A: Yes. One side light in Paris. It was the same thing with perfume as it was for champagne. There were a number of the well-known perfume stores there right near where the Army people were. They would only open up once a week, and all of the G.I.s would line up to and get it. If you had an empty bottle to turn in, why it was real easy to get perfume.

I went to a night club one night so I must have been in Paris for a couple of weeks at least before we moved to Chantilly. I also was there on V-E Day. I went into Paris on V-E Day. I've got some pictures. Don't know whether I could find them or not of all of the people and buildings on the Champs Elysses.

Q: That must have been quite a day, huh?

A: We had quite a time, although I just stayed there during the day. I went back to Chantilly late in the afternoon. By that time, I had trained one of the G.I. s, which has been described in the paper, to do the forecasting so I could go home. I went back so that he could take his turn at celebrating that night. Getting back to forecasting, in the article of the ASCE I have some sidelights on the place where we lived. I don't know whether you want to hear about those. ..

Q: Sure, sure.

A: The janitor was a jockey. He was doing janitor work because there weren't any races going on. He would come in the morning and would build up the furnace, heat everything up while we were all at work, then when we'd come home, he'd bank the fires and there wouldn't be any hot water or anything when the men came back. So I caught onto that and they changed his way of living. During the day the maids had all of the windows open and everything. He had the furnace roaring. When we needed the heat at night, he was gone and the furnace was banked.

Q: Kept him warm though, right?

A: I don't remember Cameron being there, but he must have been in the same building with me. The other people were all fairly high-ranking Air Force officers. They were a nice bunch of people there, and they had a deal. The military was not supposed to take anything out of the French economy, so they had a deal where they supplied the baker with American flour and we got our French bread every day. Boy, that was good. I love French bread. Once in awhile, they'd be flying into London or somewhere. They'd bring some eggs back from London. But that was an experience there.

The heating system, no one could understand why we couldn't get any heat at night. It was a complicated system. The hot water storage was up in the attic and the heated water would go up there, I guess, and then get distributed and a lot of times people couldn't get a hot bath. Cochran sent a mechanical engineer out from Paris and on Christmas Eve, Cochran and I explored the heating system. We finally figured out something so that we could at least get some hot water for a bath. But that was a side light.

One event that happened, there are seven dams on the Upper Rhine where half of each one was controlled by the Swiss and half by Germany. There was always talk about the Germans blowing up some of those dams. One day, just before we issued our forecast, we got a message that the Germans had blown up one or two of the dams, so we quick figured out some new forecasts. Another message came in saying that the Germans had planned on doing it, but the Swiss had talked them out of it or something. They had not blown the dams up.

Q: Well, that was the real fear, wasn't it? It wasn't so much of the rain as the Germans would blow the dams on the upper Rhine and that would flood the downstream area.

A: Yes. Actually, it would not have extended far because they're relatively small dams. It would have been disastrous for some distance, but it would never have been carried too far. If they had synchronized and blown-up two or three of them, timed them all and everything, they could have sent a pretty good wave downstream. I don't remember how we estimated what would happen downstream. Anyhow, it didn't happen.

Water Resources: Hydraulics and Hydrology

Q: Well, there was great concern that it would happen in the midst of the crossing operations that would either strand forces on the east bank or else seriously disrupt the crossing.

A: There was some concern, I think more concern might have been with some of the bigger reservoirs on some of the tributaries because these dams on the Swiss and German border were mostly power and navigation dams and they didn't have too much storage in them, whereas some of these tributary reservoirs were fairly large. You know there was a big story about the British blowing up one.

Q: Well, yes, there were the two big reservoirs on the west side of the Rhine there, the Urft and Schwamrnenauel. They did blow the outlet valves during the Roer River crossing in early February. It caused a lot of trouble until they emptied completely out.

A: It seems to me there was one on the French side that failed, too. I'm not sure about that. I don't remember what that was. Seems to me one of the American armies had some flooding problems.

Q: It was the First Army.

A: Beg pardon?

Q: The First Army's the Roer River offensive in February of '45, the Germans did indeed blow some of the dams, the outlet valves, blew them open and it caused a lot of flooding. But it wasn't as disastrous as...

A: It wasn't like the whole dam going out, yes.

Q: No.

A: I guess maybe that's what I was thinking of rather than the French.

Q: Two of them had it. It was up on the, up toward Holland, east of Holland, in that Rhineland area, to the west of the river, west of Cologne. We had problems up

there. Did you ever get up to the Rhine? Did you ever get out of Paris while you were there?

A: Well, the substitute that was being trained, his name was E.A. Withers. He had been in the Los Angeles District office. I don't know whether he was a sergeant or not, but anyhow, he got experienced enough so that we would take turns doing the forecasting. Then it got to the point where I felt that in April, it was time to go home.-So Mittendorf left about that time, too. But we prepared a paper and explained the situation that Withers was prepared to do the forecasting and that the unit could continue to operate. So we got approval to come home. Of course, the Army was getting all of the readings they wanted. As time went on, the responsibility for forecasting began to change hands. Some of the French and Germans began to do it.

Then after that happened, I got orders. I spent three or four days in London on official duty. Then I got to go up to Mainz. The general there was most accommodating. It's shameful I don't remember his name. He had a nice speedboat, and he took me for a ride on the Rhine. Then we went up the Main River up to the point where there was a dam. You couldn't go any farther. So then we got in a small boat, and we could go through the gates of the dam, got in a small boat and went up a little farther up the river. But he was really nice to me so I had a nice visit, as you say, on the Rhine after the serious forecasting was over.

Q: That wouldn't have been Patton's engineer?

A: Beg pardon?

Q: Johnny Conklin?

A: I'm not very good at remembering names.

Q: There's another one who was engineer for Bradley, Pat Timothy.

A: The name Timothy rings a bell, but it may be because of some other connection.

Q: That's all right. You may recall it and jot it down.

Water Resources: Hydraulics and Hydrology

A: I don't think I'll ever be sure of his name because I've tried. All of the generals back those days, they're all gone now, too. But I've got copies of the letter from General Moore thanking the Chief of Engineers for our services.

I'd been pretty well tied down. We made forecasts seven days a week. After Ernie, that was Wither's first name, got so that he could spell me off, and, after the crossings were over, it wasn't quite so critical that I be there all of the time, but I did enjoy it.

My wife had a cousin that was stationed near London. He was in the Signal Corps. He was a pigeon fancier. He had trained pigeons and everything and as surprising as it may be, he got into the same work when he was in the Army. They always say you never get your work. But anyhow, he was located somewhere near London, and I don't know how I got in touch with him, but he came into London and we spent some time together in London.

Q: I know the Army still had a pigeon service.

A: Yes.

Q: Amazing they did have that. So you came back in May then or June?

A: May.

Q: May of '45?

A: '45, yes.

Q: Did you ever get to meet the Chief Engineer, General Moore?

A: I don't think so, not when I was in Paris. I'm not so sure that I might have met him later. Do you know what he did after, where he was assigned?

Q: He retired in '46 and then went to work for Baltimore. He was involved in building Friendship Airport [now Baltimore-Washington International Airport, BWI] .

A: I don't think I did. He was the one that signed the thank you letter though.

Q: Probably. I know I spent a lot of time with him before he passed away.

A: Is that right?

Q: He was very appreciative of your work, I can guarantee you

A: Is that right?

Q: He was very concerned about that problem and was involved with getting you people over to help him because he was really very afraid that the Germans were indeed going to do that. It would catch a lot of his assault forces right in the middle of the river.

A: Yes.

Q: One of the things he very much appreciated. Is there anything else about that time in Europe you want to mention? Were there any new techniques that you worked out, or any ideas you may have come up with while you were doing that?

A: No, Cameron, was limited in the amount of available weather data. The 21st Weather Squadron there prepared maps which he got everyday. He did his best in forecasting rainfall which, as I say, he did the best he could. I never let on, but I just couldn't rely on it too much because I just depended more on what gauge data we had. If there were indications of heavy rainfall in some area, I could take advantage of that in the forecast.

But the procedures were just the same that I used on the Potomac, the Susquehanna, and the Ohio and the other basins. There wasn't any opportunity to, in fact, they were probably a little cruder because of the lack of information. So there was nothing really, there wasn't any research I did while I was over there.

Q: Your data for the western tributaries, then, was fairly good. But it was just the eastern tributaries that were German property had very little data.

Water Resources: Hydraulics and Hydrology

- A: There were several, and the Main was one of the major ones, and I've forgotten the names, several of others that we estimated everyday to work into our mainstream forecasts. On two of those tributaries, we were getting these German readings, not everyday, but whoever was picking them up picked them up whenever they could. They were a big help. There just wasn't any chance for any research or anything.
- Q: Okay. This is a good convenient point to stop for tonight because I've gotten to the end of your Rhine Flood Prediction Service work and the end of World War II in Europe. We can tape your going back to your career in Washington next time, if that's all right with you.
- A: Okay.
- Q: All right.
- A: When I was with the Weather Bureau in charge of the River and Flood Service, at that time, the Weather Bureau put out a daily Washington Weather map. After I got there, probably after Pearl Harbor, they slapped security on, so I was one of about five people that got copies of that weather map. The President got one, and Congress got one, and I got one. There were only five of them distributed because of security. I don't know why, but that always amazed me. I don't know whether I saved one of them or not.
- Q: Hard to believe, isn't it? That they would consider the weather map to be a security issue.
- A: I don't know how long they did it. Also, my wife and I took weekly turns manning a station, reporting airplanes all night long. They did a lot of stuff like that.
- Q: You were in the Air Warning Service or whatever they called them?
- A: She was a nurses aide, too, while I was in France. She took a tour of duty up in the Newton D. Baker Hospital. Is that in West Virginia or Pennsylvania? Do you know?
- Q: I think it's in West Virginia.

A: Yes. She spent some time up there. They had a lot of German prisoners there while she was there. Then we did that air raid warden bit.

Q: As if they were going to attack. A lot of that now we know was just for morale.

A: Morale, yes. But it was awfully chilly up there some nights in that they built a tower and it was cold up there.

Q: Do your part? Is there anything else?

A: No, I think that will be it.

Q: Okay.

Review of High School

Q: Today you wanted to give some more details on your time in high school and your career?

A: Right. One summer I worked for a department store in Toledo. The principal of the school got me the job. It was the Tiedkes Brothers Store. It was really an unusual store for those days. It was a place where you could buy anything from an automobile to practically anything. Toledo is a lake port, of course. That's where they load much of the coal from southern Ohio. They haul it up there by train and then put it on the lake freighters. The Tiedke Brothers started their business by taking supplies out to the ships, and they ended up with this big department store. But that's sort of unimportant.

Q: Do you remember how they spell the name?

A: It was, I think, T-i-e-d-k-e-s, I believe it was. I am not sure. I haven't been back to Toledo very often.

Q: That's just for the transcriptionist, so she have an idea of how it was spelled.

Water Resources: Hydraulics and Hydrology

A: Yes, okay.

Q: All right.

A: One summer I hired out as a farm hand all summer on an Ohio farm. My brother, who I mentioned before, had studied agriculture in high school, and he planned to raise grapes and farm on the farm that my father owned on the Maumee River. But during the procedures after my father died, that farm got sold. He bought a Dodge touring car, cut down the sides of the front seat so it would lay down and make a bed, and he started roaming all over the country. So one summer, I hitchhiked to Philadelphia and was with him there where he was working with the Fireworks Company at the Sesquicentennial Exposition. That would have been in 1925, I guess.

One summer, I hitchhiked out to the middle west where he was following the grain harvest. They start down in Texas and go all of the way up to Canada. I joined him in South Dakota, and went up to North Dakota, and then I had to come back to go to school. But the thing I remember about that, one of the men that was cutting wheat, he carried a rifle with him. He'd shoot jackrabbits on the move as he was cutting grain. He could hit them.

But anyhow, the one I really was working up to, my mother had left Toledo around 1930 and joined my brother, who by that time had settled in Las Vegas, Nevada, where he spent the rest of his life, and she spent the rest of her life. So, in 1932, that summer was the one before I graduated because I had to go the fall quarter to finish, I hitchhiked out to Las Vegas and then went on to Los Angeles and saw some Olympic games. Then, when I came back to Las Vegas, the construction on Boulder Dam they called it then, was just beginning. I figured the best way to see it would be to get a job, so I heckled the local Bureau of Reclamation man until he finally gave me a job as a rodman on a survey crew.

They were drilling the tunnels then, and we were checking tight rock in the tunnels. We had, I guess they called it, the swing shift. We'd drive out from Las Vegas in the middle of the afternoon when it was pretty hot. It got to 120 [degrees] or so in those tunnels. Then when we'd go back to Las Vegas at night, we'd almost freeze to death in the desert. It's amazing that when I retired, they found and I got credit for, I think it was one or two months, working for the Bureau of Reclamation in Las Vegas.

Q: Did that experience at Boulder Dam have any influence on your career at all? Did it push you in any direction at all?

A: No, I didn't look up the gentleman's name that hired me, but he later on was, well, even then he was high-up in the Bureau, but I think later on he became the chief engineer. He made me promise that I'd go back to school, and I couldn't keep my job. I could work there in the summer, but then I had to go back to school in the fall. But he didn't have to get me to promise that because I would have done that anyhow.

Just as a side line, Ohio State at that time, the Civil Engineering Department, put a pretty high value on surveying. So to graduate, you either had to work one summer with an engineering firm or you had to go to summer camp. The way they ran their summer camps, they actually contracted to do work. For a year or two before I was there, they were out in Yellowstone Park surveying for the government. But the year I went to summer camp, we were surveying, of course, it was a contract, too, but we were surveying state lands there. But as I say, they always thought that knowing how to survey was important to civil engineers. I don't know whether they still feel that way, but that was probably primarily due to C.E. Sherman, who was the chairman, the one that I worked for after I graduated.

Oh, did I mention one of the summers while I was in Toledo I had a job with an engineering company that was surveying for an airport adjacent to Lake Erie? We spent all of our time in water, anywhere from six inches to two feet or more deep, doing this survey. That was kind of a wet job. That pretty well ends the summer experience.

Q: A little water-logged that way.

A: Yes. I don't know whether they ever built the airport or not.

Q: I want to ask you a question about the curriculum at Ohio State. Were there any formal courses in hydrology in the curriculum for the civil engineering?

A: No, no. I think as I mentioned, we did take a course in hydraulics, which was the closest to hydrology. In fact, I don't even know whether hydrology was a term then. As I say, the course was taught in the Mechanical Engineering Department because they had a laboratory. We rated weirs and things like that. They had a channel there that we could flow water through and rate different shape weirs. I

don't know whether it was a Mechanical Engineering course or a Civil Engineering course. We also took courses in mechanics in that same department.

Q: It was some time before formal courses in hydrology as a specialty were coming into the curriculum, wasn't it?

A: Oh, yes, I think it must have been--see, that was '32. The University of Iowa had quite an extensive hydraulic laboratory. I don't know when they got into hydrology. It must have been in the '40s before anybody had courses under the name of hydrology.

Tennessee Valley Authority

Q: Okay. I also wanted to ask you about your time at the TVA. Basically, I wanted to ask you if you ever met Jim Goddard when you were there?

A: Oh, yes, sure. I can't put my finger on what his job was. He was in another division. He was in the division that handled the river forecasting for their projects, and, of course, there was one of the men in their field office that did field work for the forecasting. He was a classmate of mine from Ohio State. I knew Jim fairly well. In fact, he and one of the chief executive assistants, and another man, D. J. Brumley, out of our engineering department, had rented a house and I used to play golf with Brumley. I never played with Jim, but I got to-know him fairly well.

Q: How would you evaluate his work, his ideas?

A: I don't have any idea. I'm thinking back. I wonder if I placed him in the right place. He was not in charge. The man that was in charge of the forecasting work was not Jim. Jim was in charge of the field work. I have flashes of memory of what happened to him later on. He wrote, seems to me, reports on a new subject that was, I don't know whether it was environment or....

Q: Flood plain management?

A: Flood plain management, that's right. I'm sorry, it may be that if I'm right about it, I got to know him more from where he was rooming rather than his work in the office. I've always kept diaries, but I can't find all of my early ones. We moved

here from Arlington in 1967, whether they got misplaced then or not, I don't know, but I sure would like to find them.

Q: Did you deal with him at all later on when you were with the Corps of Engineers?

A: I may have seen him once or twice at ASCE meetings, but I had no business dealings.

Q: Okay. You mention a little bit about what you did in high school and college in the summers. Is there anything else that you would like to amplify from last weeks discussion on that period up to 1945? I have some questions I'll ask you, but I thought I would ask you first.

A: There was one thing that, now I can't think of his name, but we had a real famous classmate that graduated from Civil Engineering in 1932. He was the commanding general of the Air Force during World War II.

Q: You mean Curtis LeMay?

A: Yes, he was a classmate of mine.

Q: Is that right?

A: But I never knew him because he had finished his civil engineering work there at Ohio State and then when I was there, he was down at Kelly Field taking his air training. But he did get his degree in 1932. I'm not sure whether he came back for the graduation or not because I wasn't with the regular group when they graduated. I had to go another quarter. But his picture is in the picture with all of the rest of the 1932 class.

Q: Well, he went on to have himself quite a career, didn't he?

A: Yes, he sure did.

Publications

Q: Okay. I want to ask you a little bit about some of the publications that you had. Now, we talked last week about some of them, like your synthetic unit hydrograph paper.

A: There's a copy of almost all of my publications in there. I had to scramble for them. I told you wrong last week. I said that the University of Wisconsin, it was the University of Wyoming that had established this repository_

Q: I pretty much thought that's who it was, because that group is pretty well-known.

A: That Wisconsin just came out. I sent them copies of all of my publications. Also a manuscript. After I retired, I continued doing some research for the Corps. I published a manuscript on it, which they chose not to publish, but I only have one copy of that left. I sent one copy out to Wyoming, I think. But there's pretty much everything there.

Q: Well, if you would entrust me with that, I could have copies made for you.

A: Well, I don't know that you want it. It's that thick.

Q: That's all right. They'd like it for their collection.

A: You think so?

Q: I think so.

A: Of course, I submitted one.

Q: You know how the Corps of Engineers is about these things. Maybe later on if you have a copy, I could make a few more copies for you and you could have them for your use.

A: Well, if you'd like to have it, I have it handy downstairs.

Q: Okay.

A: Just a mention on the publications, there's one paper labeled "The Conception of Runoff Phenomena," which I think is the best paper, best work I ever did, and yet no one has ever paid much attention to it. Yet there's stuff in there that they're still discovering and thinking--of course, nothing is ever new. There's always something happened before, but there's some ideas in that conception there that they thought was great stuff when they discovered it recently.

Q: Now, that's the paper that you published in *The Transactions of the American Geophysical Union* in 1939. What led you to write that paper? Was that a product of your Pennsylvania work?

A: Well, it was also, I mentioned before, that when I was with the Geological Survey, I developed this idea of this third-type of runoff, of the sub-surface runoff. It was not until '39 that I had a chance to really present it. The synthetic unit graphs came out fast, but it was another situation. So it was '39, when, by that time, all of the research I'd done while I was with TVA and the Pennsylvania studies just came together, I had a rather 'more complete picture of the runoff phenomena.

In other words, when I was down at TVA on weekends, if it was raining, I used to go up in the mountains and watched the water to see where it came from. You could see the places where the surface runoff goes off quick. But after the stream had gone down, the water would still be coming out of the banks, coming out of the ground, but coming out rather quickly. That was just a verification of that subsurface runoff that comes off in between the surface runoff and the ground water runoff. But, I was ready by that time to put out my ideas.

Q: Now, most of this work was research that you did. It was, basically, office work and then you went out and you verified it by field observation?

A: Well, I always say, my hobby was hydrology as well as my work, so I did an awful lot of it on my own time.

Q: You seemed to spend a lot of time outdoors in going, working in farms, and surveying. Did that contribute to your ability to observe these natural phenomena?

A: Oh, yes and no. I think that being out was more sort of vice versa, more of the result of my wanting to observe, rather than being out developing my desire to observe. It was just because of my analysis of the situations that I wanted to verify things. You can sit in an office and theorize for time immemorial, but it pays to go out and see what's going on, too.

Q: Okay. Let me ask you about another paper that you did for the *AGU Transactions* and that was the one you did in 1940, "Predicting Headwater River Stages Directly from Precipitation."

A: That was just an empirical thing that I developed while doing those flood forecasting procedures in Pennsylvania. What did you say the date was?

Q: It was 1940.

A: Yes, that was during the time I was in Pittsburgh. We had basins where we would have rainfall information and river gauges, but no discharge information. So this was rather empirical, it didn't have any scientific background. It was just, you did this and you got certain results. There wasn't any scientific basis to it, but there seemed to be a relationship. You could analyze it and, I guess theorize as to why it worked, but it did help in forecasting stages in places where we didn't have any discharge information. But it never received any notice or anything.

Q: All right. Let me take you to another paper. This was in *Transactions of the ASCE* for 1940, and that's your paper on flood routing.

A: That was work. That was my official work at Knoxville.

Q: Okay. So that was your TVA?

A: There were two other joint authors on that, who were in the same branch I was in.

Q: So that came from your TVA work?

A: Yes.

Q: You won a medal for that one.

A: **Yes**, I did. W.G. Hoyt was the man that I worked for in the Geological Survey. He always encouraged me and helped me out. He probably had something to do with me getting the medal.

Q: Now, what was the primary thrust of this article?

A: It was operating the TVA system of dams, because the way they worked, when they were under normal power operations, each dam had a pool behind it. But then during flood times, they gradually would open up their spillways and the river would convert from a series of steps into an open river condition. These were routing procedures, and the flood wave would move through those areas. They were deeper than they would normally be, and the flood wave would move through there faster than what you would expect. These routing procedures were developed almost primarily for the TVA system. I don't know that anybody ever tried them anywhere else.

Q: So it's primarily to keep the releases under control then so you wouldn't get certain river stages too high?

A: It was more to find out what the levels would be, because when the flood got real bad most of the main stream dams would be opened as much as they could open them so they wouldn't be causing backwater. But Chattanooga got flooded every once in awhile. It was more for use in studies. I don't know that the flood forecasting people ever used it. We were in a different branch from the people doing the flood forecasting. I think Jim Goddard was in charge of their field work, and I mentioned that Dembowski (also at Camp Rocking) from Ohio State was in the field. I think Jim was in charge of that sort of thing.

Q: I also noticed that you had a number of discussion papers that you submitted, or had submitted, to the *ASCE Proceedings* in '35, '38, '39, 40, '41, and '44. Do you recall what the primary subjects were and why you wrote those articles, those discussion comments?

A: They would all have been in the field of rainfall and runoff relations, flood routing, or flood forecasting, that sort of thing. Writing a discussion of a paper is a way of getting some of your own ideas out in the open, too. I'm sure that's what most of

them were, although sometimes somebody will ask you if you would write a discussion. I don't remember the motive behind them all, but I imagine in most of them I had something I wanted to say, in addition to discussing the paper.

Q: Well, your record of publication, less than 10 years after you graduated, is quite large. I mean I'm sure compared to most of your colleagues, you far exceeded them in the output of your work.

A: The output, yes.

Q: That's not something I would expect to be normal for a lot of young engineers who were just working their way into the profession.

A: I don't know why. It might be because W .G. Hoyt, you know, encouraged me to do that sort of thing. Well, I guess it was selfish, too. I guess when a person writes a paper, he wants to get a little credit for it.

Q: It's a good reason. You want to get your ideas out.

A: Certainly, it's one way to advance your career. Of course, in the university teaching profession, you have to do that. What do they say, "Publish or die?"

Q: "Publish or perish." In some cases we used to call it, "Publish and perish." I notice a number of your articles appear in the *Transactions of the American Geophysical Union*.

A: I think maybe you could get through quicker and smoother than ASCE. You would get your paper approved and then present it at the annual meeting and it would be published. Also, the AGU was deeper into hydrology than the ASCE. I also participated on a number of committees for both the ASCE and AGU. I still belong to the organizations, although most of them I'm some sort of honorary member so I don't have to pay dues or anything anymore. But I see these instructions on what you have to do to submit a manuscript. I suppose it's easy for someone that's up on all of the modern methods of reproduction and whatnot, but they sound awful confusing to me.

Q: Well, almost everything is done on computers now. Send a little disk in, you know. That's the way it is. Modern technology. What was the influence of an organization like the American Geophysical Union? Do you think they had a lot of influence in the development of hydrological science?

A: Yes, I think I mentioned before, one of the consultants on that U.S. Geological Survey project that I started out on was Robert E. Horton. He was the top man in hydrology. I don't know whether they called it hydrology when I joined in 1935. But that's probably where the name, more widespread use of the term hydrology was due to the American Geophysical Union. He would come to the AGU, when I was working for the Geological Survey. They held their annual meetings in Washington at that time and we could go to them and you got to know all of the people.

I can still see Robert E. Horton come striding in with a cigar. He was quite a character. He was a real smart man. He had a lot of odd characteristics, but he was quite a scientist. He made his money, he was a consultant when the Great Lake states, there was a big case back in, I guess in the '30s, when the states were suing the federal government on the amount of water being diverted at Chicago and he was a consultant in that case. I understand that's where he did well financially so that he was able--he had a private hydraulic laboratory up in New York State, and he did a lot of private research. He was quite interested in hydrology. He wrote a lot of papers in the field of hydrology. They say that when he was busy, he'd stand in the middle, he had two or three secretaries, and he'd be dictating to them all at the same time, keeping them all busy.

Q: So he was one of the prime people involved in developing hydrology as a science?

A: Yes. When he died, he left, I don't know how much, but the American Geophysical Union has two prizes that they award each year from the funds that he left. He left part of it to the hydrology section, and part of it to a general fund, I think. Then each year they award, I don't know how much money is involved, but they have a Robert E. Horton Award each year.

Q: Do you think that that work that was done in the American Geophysical Union then helped to influence the development of hydrology in organizations like the Corps of Engineers?

A: I think so. In the beginning, I don't think there were too many Corps people involved. But they were as time went on. The publications were probably utilized.

Ralph Wilson out of our branch in the Chief's Office was active in it, and he was general secretary for years of the International Association of Scientific Hydrology until he died.

The American Geophysical Union is related to the International Union of Geodesy and Geophysics. The AGU is the U.S., I don't know what you'd call it, the U.S. body that participates in the International Union of Geodesy and Geophysics. They have a big meeting about every four years. One of these papers I delivered in Brussels in 1951 before the IASH of the IUGG.

So the AGU was, I guess to answer your question, they certainly were in the forefront that brought hydrology to the recognition that it has. Even now, they're still talking like they have to make a science out of it. But then in the international field, all of the other countries had people who were getting interested in the same subject called hydrology.

Q: A lot of the issues that you addressed in hydrology had really not been well-addressed by major engineering organizations like the Corps of Engineers, had they? I mean they really hadn't studied those subjects and brought them forth in their planning and surveying process.

A: Well, up until 1942, I don't know much of what was going on before. Most of the engineering design of hydrologic features were based on empirical relationships, such as CIA for urban storm runoff. But shortly before I went over in '42, that's when Hathaway got them involved in designing the spillway capacities on an adequate basis. I suppose that got all of the field offices involved. They had to start digging into that subject. But I can't really say what they were doing before 1940. But from then on the people involved in the district and division offices were probably in the hydraulics section or division, but they certainly had people start working on hydrology.

Q: Okay.

A: Is Bob Pafford on your list?

Q: No.

A: Up until two years ago I exchanged Christmas cards with him. Mrs. Snyder always took care of Christmas cards and did a real good job of it. So when she was ill, we didn't get any out in '93, and '94. When you don't do that, you stop getting replies from other people. So I haven't heard from Bob Pafford for a year or two. He wasn't Chief of the Engineering Division, but he was number one man in the field of hydrology and hydraulics in the Missouri River Division. He retired and went to work for the Bureau of Reclamation for awhile out in California. That's where he was living the last I heard from him, but he was quite a live wire.

Q: Do you know what area in California he was living in?

A: Well, I have his address.

Q: Do you? Okay. Maybe I can get that from you later.

A: Okay. Each of the division and district offices ended up with quite satisfactory hydrology people. It was sometime later on when Roy Beard went out to the west coast and started working up computer programs for different hydrologic functions, flood routing and that sort of thing.

Q: The Hydrological Engineering Center?

A: Yes. That really put the Corps' name in the public eye. I get these notices, you know, everybody's giving seminars these days. You almost always find, in this field, you'll find that they'll be discussing one or two of those programs worked up by the Hydrologic Engineering Center.

Q: You had mentioned before the importance of Merrill Bernard to your career. What other now essentially famous hydrologists did you work for in the early '40s?

A: I mentioned that an engineer from St. Louis, W. W. Horner, was one of the consultants on that Geological Survey project. He had an engineering consulting firm, and there was a chap in his office that wrote papers on the unit hydrograph. I don't know that I knew him though. I mentioned before the chief engineer of the Pennsylvania Water and Power Company, who was active in the AGU. I met him through the AGU meetings. He was quite interested, ahead of his time for a private

firm like that to be interested in hydrology. It was unusual at that time because almost all of the activity was university or government.

Q: When the war in Europe ended, we talked about. . .

A: Let me say, and I don't know whether you have that or not, but Al Cochran gets a lot of credit for that Hydrologic Engineering Center. He's the one that Roy Beard worked for when he came into our office for awhile from one of the field offices. Roy might have spurred him on, but Al Cochran is the one that planned, and set up, and got approval from the Chief's Office to set up that Hydrologic Engineering Center.

Civil Works

Q: Now, after the war, after your time in the Rhine Flood Prediction Service, you came back to the Corps of Engineers again, and you returned to work for Hathaway in Civil Works.

A: You probably know, Hathaway got the Legion of Merit for his work on the Rhine River project. He became a special assistant to the Chief, and Al Cochran then became head of the branch. I actually was under Al Cochran then, although I was Hathaway's suitcase carrier from then on. I don't know whether you want to get into that now, but. . .

The Saint Lawrence Seaway

Q: That would be fine, sure.

A: The St. Lawrence Seaway was being constructed, and Hathaway was a Corps' representative on the Lake Ontario Board of Engineers. They always have a working committee, so I was on the working committee. Then after the studies were completed for the operation, the Board and working committee were working primarily on operating studies for the project, he became a member of the St. Lawrence River Board of Control. Each week, the Board approved the operating plan for the dam controlling the outflow from Lake Ontario. It was mostly routine. But there again, I was on the working committee. Then when Hathaway retired and went to the World Bank, I became a member of the Board of Control. You'll find a picture in there when I resigned.

It was interesting. I retired in '66, and it was '74 before I got kicked off of the Board of Control. What happened, and I was joking when I said I got kicked off, but I did have to resign. The North Central Division Engineer is always a member of these International Joint Commission (IJC) committees and boards. The Chief of Engineers had a representative, which meant the Corps of Engineers had two people on this board and on the St. Lawrence River Board of Control, but the U.S. Seaway Authority, that was actually operating the project, didn't have a representative.

So how they left me on there for, let's see, eight years, I don't know. But finally, it was so obvious that the Corps wasn't entitled to two people on the board with the operating agency not even being represented, so it was in '74 when I resigned from the Board of Control. The Corps was writing my travel orders and everything, and paying my subsistence.

Q: Let me ask you now. What were you doing with Hathaway on the St. Lawrence? What kind of studies were you doing?

A: Well, we had almost a hundred years of record on the lakes. You'd think it would be easy to use forecasts, particularly with all of the storage in the various lakes. The project was supposed to raise minimum levels and lower maximum levels on Lake Ontario. The new dam project dam was way down the St. Lawrence River, but the control of the river actually backed up and controlled outflow from Lake Ontario, the amount going out of the lake and the inflow control the level of Lake Ontario. So an awful lot of our time was spent in running that hundred years of record with different restrictions on how the project could be operated, and setting up a plan of operation that would meet the requirements of raising minimum levels and lowering maximum levels. This is jumping ahead of the story, but the Lake Ontario Board of Engineers submitted their studies to the International Joint Commission in 1957. I don't know whether you are familiar with the IJC or not. They meet in the spring in Washington and in the fall in Canada. All the Boards that they have report to them at the meetings. In the meantime, the Saint Lawrence River Board of Control took over the responsibility for further regulation studies. Regulation of Lake Ontario began in 1960.

Of interest is that in 1962-63 a more critical dry period occurred and in 1985-86 a more critical wet period occurred than had happened in the earlier 100 years. Deviations from the operating plan had to be made. You would think it would be easy to use forecasts in operating, particularly with all the storage in the lakes, but because of the storage successful forecasts of the rainfall would have to be for periods longer than are possible.

Starting over again, there was a Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data composed of three representatives of Federal agencies in each country having responsibilities for such data. Hathaway was Chairman of the U.S. Section. The Committee collated data in Canada and the U.S., adjusted the lake inflow and levels to present diversions and channel conditions. I took that job, too, when Hathaway retired. The group also provided an acceptable set of data for the regulation studies. They established an official network of stations that Canadian agencies, and the Lake Survey, agreed to maintain and publish the records. They were published. The stations were also used in the forecasting, but that was done by an Operations Advisory Group that prepared each week's operating plan.

In the original studies, the Canadians, who did most of the computations, started doing it manually. It was a backbreaking job. We worked with monthly data. But to run a hundred years by hand to test an operating procedure is quite a lot of work, and the Canadians began to work out a computer program where they could speed-up the procedure.

In the meantime, though, I had ideas on how to do it, too. So with help during their spare time of a couple of people in the office, I ran through a proposed method of operation. I introduced some--they wouldn't accept forecasting--but I introduced some ideas that really were sort of forecasting. Some of the decisions were made on the basis of forecasting based on past relationships. We ran through the hundred years of records. Well, that sort of broke the ice, so then the Canadians did another study and went further into that sort of predicting business. Their plan was the one we finally adopted.

Q: Was their use of a computer program something pretty new at that time? This was 1950 sometime?

Computers

A: Yes, it was just getting started though. I have an interesting story for you about the Corps' computers. I think the Corps was, other than the Army who had the big Univac, one of the first government agencies to get into the computer business. Colonel Whipple, the executive officer in the Civil-Works Division, was a really smart man. He was too smart, actually, because he was in an executive position, but he sometimes tried to do our engineering work for us, which didn't go over too well with the engineers.

But he was interested in computers, in getting into computing work. I'm kind of a stick-in-the-mud. I don't like to change too much. I didn't think too much of the idea. At that time we had a program we called Civil Works Investigations. We got a little money each year for research, but we could not call it that. It was parceled out. The districts and divisions would propose projects, and they would get a little bit of this money to do the investigations.

Colonel Whipple thought we should get into the computing business. I didn't argue with him. So he wrote a contract with [John] von Neumann, the father of computers. He was consultant to us for a few days. We had a big meeting here in Washington. The two divisions primarily involved at that time were the North Pacific, who operated all of the Columbia River dams, and the Missouri River Division, with all of their dams. They were all in here. and Von Neumann heard what their problems were and he thought computers would certainly be useful. So then both of the divisions got money to work on computers. They both ended up with computer programs to operate their projects. I think they were ahead of the game. I don't know of any government agency that really got involved that much that early in the business. I have copy of a July 1952 letter assigning CWI money to field offices for Electronic Computers.

Mississippi Basin Model

Q: Gail Hathaway went to be a special assistant to General Wheeler when he became Chief of Engineers.

A: Yes, I think that's probably about the time. One of my activities was the Mississippi Basin Model Board. Should we get into that now or not?

Q: Well, sure.

A: That was an interesting assignment. After WES made some of these studies for the model, the recommendations came into the office and some reviewers recommended against it. General Reybold said, "Build it." That's all, there was to it. He just told them to do it. You know, the **recommendations** were pretty much against it.

Q: Now was that the one that was started during World War II with the German prisoners?

Water Resources: Hydraulics and Hydrology

A: Yes, they had German prisoners as labor to do the rough grading of the land. During the construction and after it was operational, the Model Board consisted of the pertinent division engineers, the Waterways Experiment Station director, and a representative of the Chief of Engineers. Hathaway was the Chief's representative, and I was on the working committee. We met probably a little more frequently than the board did to work with the Waterways Experiment Station on the design and completion of the model.

When Hathaway left, I think, I'm not really sure, but I think I took his position on the board. The Mississippi River Commission make an inspection twice a year, and I have a picture there of everybody standing on a steamer, and I'm one of them. I remember when the Model Board arranged this particular trip. None of the working committee are in the picture, and I was there, so I must have been on the board, or at least a representative of the Chief.

Q: Well, tell me what were you doing with the model? What were the major concerns?

A: Well, the instrumentation, primarily. The type of resistance they were using. There was still foot dragging by some of the field offices. They thought that they could-- by this time, the computers were in wider use, and they thought they could do just as good using their computers as they could on the model, but that opposition gradually disappeared. The model was used a lot for verification of levee designs and things like that. Up to the time I left, I don't remember any major floods.

By the time I left, it was sort of mothballed. In other words, it was put in a standby. They quit using it for design studies and sort of put it in a standby position. But then several different times for major floods it was placed back into operation. It did a lot of help in showing which areas might be subject to flooding so that the people doing the emergency sandbagging and everything had a lot of help in where they could spend their efforts most profitably on the floods. I don't know whether it's still in 'a standby position or not.

Q: No, I think it's largely gone. Most of it, I think, has disappeared. There are parts of it that are still there. Not used for much, but I think they still have it there, as far as I recall.

A: Yes.

Q: I've been down there a couple of times.

A: I made a lot of trips down to Vicksburg, of course, when we were working on that.

Q: Do you remember any major technical problems with the model? Or any disputes, philosophical disputes, or scientific disputes?

A: Well, no, what resistance there was was subdued. There were always the problems of how best to get the measurements during the tests, and the Waterways Experiment Station did all of the real work on the design of the instruments and channels. But that was always a problem to be able to record all of the information when they were running a test. It was set out so they could use pieces of it. They didn't have to use the whole model at one time. They could operate one section of it at a time

Q: Whatever part they were interested in?

A: Yes, particular when they were doing design work for the field offices. There were inflow points off every tributary. The model didn't go very far up into any of the tributaries, except maybe one or two of the major tributaries. So the field offices had to supply, for whatever study and even for the floods, the field offices had to supply what the inflow was at all of these points where water was coming into the system. So the field offices had, particularly during a flood, a major job to supply that information. When a particular office had a study being made, why they had to submit that information to the Waterways Experiment Station before they could run the experiments. They had to know what was coming in at all of the inflow points.

Q: You mention the inflow. What were the changes in the way that those kind of measurements were taken? Did you basically use the same kind of gauges over the years?

A: Are you talking on the model now?

Q: No, on the rivers themselves, where the district would say measure the inflow from a tributary to the Missouri River.

A: Oh, they all had operating and forecasting procedures for their own rivers so they, other than just the work of doing it, there was nothing new. In other words, they

Water Resources: Hydraulics and Hydrology

were prepared to supply that information under whatever conditions were wanted. That goes back to the network that was set out with the Weather Bureau and Geological Survey, but even though the Weather Bureau was the official government agency for river forecasting the Corps always sort of did their own, too.

Q: You said Hathaway's gauges were critical to all of this?

A: Well, I was thinking of the program that he set out for the recording rain gauges which were not involved in the model. But by that time the Geological Survey was operating a lot of stream gauges for the Corps.

Q: Let me ask you since we talked about it, about WES itself, the Waterways Experiment Station. When did you first work with WES and get to know what they were doing down there?

A: Well, it would have been, I've tried to think whether I, I ever had any real business with them before the model or not. I don't remember. I reviewed their reports, in design studies that came in from the field offices. They did a lot of work on spillways, and on levees, and that sort of thing. I'm sure I was familiar with their work and reviewed their reports. But I don't believe I had much business with them until the model got started.

Q: Did you know Joe Tiffany?

A: Oh, sure, sure. He was the key civilian. I have a letter from one of the directors, who, when he left, wrote a real nice letter to me.

Q: How critical was Tiffany to the success of WES?

A: Well, of course, I don't have any personal experience, but I would say he had a big hand in it. Even after he retired, he was still a consultant to them, wasn't he?

Q: Yes.

A: I would say he had, I don't know whether he was better in administration or in technical, but I suspect he was pretty good at both. There was one of his assistants.

I don't remember his name, but that's another story. He got a, because of a special activity there, he got a P-16 rating for his activities there. Just before I retired, I sold the office on getting out of, not that I was doing much administration, but getting out of the routine work to do some special research in rainfall and runoff relations to get a 16. Civil Works approved it, the Chief's scientific adviser approved it, and the Chief of Engineers approved it, but the guy in charge of personnel didn't like the idea. He never did let it go through.

Q: Yes, some of my favorite people are in personnel offices. I imagine they must have been favorites of yours, too.

A: Yes, yes.

Headquarters, United States Army Corps of Engineers

Q: Okay. Let's go back to the Corps of Engineers. So Hathaway went to this other job and Al Cochran replaced him as the head of what, the Hydraulics Branch?

A: Yes, he replaced him as head of the Hydrology and Hydraulics Branch when Hath became special assistant. So he'd been in there for some time when Hath went to the World Bank.

Q: So that was some time after the war, some years.

A: Yes.

Q: So that Hathaway was head of the Hydrology and Hydraulics Branch in the Engineering Division, and Cochran and you, and who else worked for him in that Branch?

A: Oh, of course, that changed over the years.

Q: Well, I mean the key people.

A: Well, Mark Gurnee, he worked there for just awhile until they found a better job for him when he came back from the war.

Q: He went over to Construction and Operations?

A: Yes, he became Chief of Operations. I don't think he did right away, but he eventually did.

Q: No, eventually, yes.

A: He passed away. He was a good friend of ours, I mean my wife and his family. After he retired, I used to play golf with him until he moved up to New Jersey. First his wife passed away and then Mark passed away a couple of years ago. Roy Beard came in and out. Bryce Hobbs, who's still living here. He's older than I am. He was a sedimentation man. He came in from one of the field offices. He came from Arkansas, the same place Al Cochran came from. I think they went and played football together. Later on, Hagen came in.

After the war was over, another chap came in. I don't know whether you're interested or not, but I think he was in my section. I was Assistant Chief in charge of the Reservoir Regulation Section where we reviewed all of the plans for reservoir operations. The districts had to submit their plans through the divisions for operating the reservoirs, and the Chief's Office approved them. Then in Section 7 of the 1944 Flood Control Act, Congress passed a law that any dam built with Federal money for space for flood control had to be operated in accordance with plans approved by the Secretary of the Army. He designated the Chief of Engineers to execute his authority.

Being in the Reservoir Regulation Section, we handled this. This included a number of the Bureau of Reclamation dams. We had several private dams built by river authorities that we issued regulations for. This was sort of a diplomatic job. The field offices had to work with the people that were operating the dams and work out a mutual agreement as to how the flood control storage should be operated. These were submitted to our office for review, and then the Chief would submit them to the Secretary of the Army for approval. They would be published in the *Federal Register*. That was part of the branch's work; part of the time we reviewed the hydrology studies for the different projects.

But this chap I was trying to think of his name, he came back from the war and ended up in my section. He was deeply interested in transmitting materials in pipelines using a fluid transmission. That's all he worked on. We couldn't get him to do any of our work. So finally he moved on to something else.

We had a draftsman, Charlie Pletcher. He was a jewel. Anytime you wanted something or you wanted something done by other parts of the office, he would arrange it for the branch. Anytime you needed something, why Charlie could take care of it for you. He eventually left because he got into more professional work in one of the other branches. He's been long retired. I still correspond with him. He's up in State College in Pennsylvania. But he was a big help to the office.

I'm trying to think of the name of the man that was the chief after Al retired. It was Verle Farrow. He was a hunting dog fancier. He raised dogs and acted as a judge at trial meets.

Q: When did Al retire, in the '60s sometime, wasn't it? Did he retire before you left or after?

A: No, it was after. It must have been probably at least '70, I would think. We visited them and still correspond with, or my wife did with his widow. She lives in Columbia, South Carolina. They were the ones that brought the champagne back from their trips. Colonel Lyles that I mentioned being in Paris had a consulting-engineering business in Columbia, South Carolina, and Al went down there to work for him.

But when Al retired, one of the men in the branch, Verle Farrow, succeeded him. This was, of course, after I had retired. It was a number of years afterwards. I don't know whether there was someone else in there, between him and Hagen or not. At some point after I left there, they combined hydrology and structural hydraulics with Douma still in charge of hydraulics and somebody in charge of both.

Q: I know Jake told me that he didn't want the job as far as running the hydraulics and the hydrology branch. He just stayed with hydraulics.

A: Yes, I don't know how that worked out. I think maybe they had originally been together and they separated them. That was before my time.

Q: They have separated them since.

A: Again, they're separate?

Q: I guess they are, yes. One of these things that comes back and forth. What was Al Cochran like to work for? You worked for him for a long time.

A: He was fine. He didn't have a selfish bone in his body. He would push, help anybody get ahead regardless. But, like everybody, he had some characteristics. If someone was out of favor with him, why, he kind of gave them a bad time. But, I never had any trouble with him. He was very good at planning and writing up proposals and projects. He never worried about someone getting into his territory. I had a [GS] 15, the same as he did the last few years there. This was based on special considerations in that I represented the Chief's Office on a lot of foreign things, and did a lot of things outside of the office, and, as I say, he supported that fully.

Q: You were like a senior consultant in the Corps.

A: Well. ..

Cop Consultant

Q: Besides running whatever. ..

A: I don't know whether you'd call it consultant. I represented them on, well, on the St. Lawrence, on the Mississippi Basin Model Board. I got, fairly early, into the international business. I was the representative on the Commission on Hydro-meteorology of the World Meteorological Organization--that was new to the Meteorological Organization. They set up the commission and the meteorologists couldn't stand calling it hydrology, so they called it hydro-meteorology .

It was organized at a big meeting here in Washington, and the U.S. had three representatives on the commission. The main one was the Weather Bureau man, here was one from the Geological Survey, and I was the Corps of Engineers member on that. That went on for years. I don't know how many times I went to Geneva or other places for commissions or working group meetings. Mrs. Snyder went with me on a number of times.

I remember one time when we were in Geneva, it was just after the Russians had invaded Czechoslovakia. The Russians were always at these meetings. They loved to give parties and see how drunk they could get you. But word came to us to show our disapproval. At that time there was a Water for Peace Program on. I don't

whether you ever heard of it or not. But a friend of mine was the President's representative on Water for Peace. He came to Geneva and brought us the word that we couldn't go to the party, except for one official representative. The U.S. Weather Bureau man, Max Kohler, was president of the Commission. So he went to the Russian party, but none of the rest of us could go.

It was interesting, I've forgotten the details, but the commission, at one of their meetings, were voting for an officer. One of the candidates was a Russian. I think they took secret ballots. But the Czechs were there. They were represented on the commission. They had no love for the Russians. I forget the details now, but it was quite interesting to see how that voting came out.

The International Hydrological Decade

Q: So you got involved in a lot of these international political squabbles?

A: Some. Then there was a ten-year program that was called the International Hydrological Decade. I was a member of the U.S. Committee for one term. I was on working committees also. It was sponsored by UNESCO, an organization of the United Nations with their headquarters in Paris. So when we had meetings in Paris, why we met at the UNESCO building, which was on the Left Bank. There were a lot of nice little hotels around there to stay at. We had one meeting in well, it's St. Petersburg now. Back then it was?

Q: Leningrad.

A: Leningrad. We met there, I think, for a month, or at least two weeks. I was joint chairman with a Russian engineer of a committee on floods. We organized at that UNESCO meeting in Leningrad. We stayed at the Astorid, I believe, the hotel that Hitler had picked out for his hotel. He never quite made it.

Q: No.

A: But there was always a flower arrangement in the rooms. The fellows would come in, and they'd go over the flowers, "Testing one, two, three." Oh, we had a meeting there at the house where Rasputin was poisoned. It was just a few blocks from the hotel. I don't know why we would be meeting there or not.

Q: Well, those kind of things have been taken over by the Communist Government.

A: We heard all of that story. But the main thing I remember is when I made my travel plans, there wasn't time to go to Moscow. But after we got there, they shortened the meeting, and they planned an excursion where we traveled by bus from Leningrad to Moscow and stopped at one of their hydrologic laboratories out in the field. It was about half way between Leningrad and Moscow.

So a week or two before, I went to the travel agent to change my, Mrs. Snyder was with me, to change our trip to include, instead of flying from Leningrad back to the West, to go to Moscow first and fly from there. So about a week later I went back and they said, sorry, they couldn't do anything about it. I'd have to wait until I got to Moscow.

So as soon as I got to Moscow, why, I went to the Aeroflot office and told them what I wanted to do. We had a friend, he was the commercial attache in Bonn that we wanted to visit. So in reorganizing the trip, I eliminated one trip across the continent so I shortened our travel a whole lot. When I went back to get my tickets, they changed everything the way I wanted it and then they told me how much I had to pay. I said, well, I felt that since I eliminated a thousand miles or so of flying that there hadn't ought to be any charge. I said, "What happens if I don't pay?" She said, "Well, you won't leave Moscow."

It was an interesting thing though when we landed in Vienna, we just sort of had a feeling of lightness or a feeling of relief or something. When we were in Russia, there it wasn't quite as bad as it was a little earlier. I remember hearing one man give a talk where on a trip he made, everywhere they went, there was a, what do they call, the secret service people they have. ..

Q: The KGB.

A: Well, anyhow, they had a government man with them. In one place, the man said they were looking at a dam or bridge and he started taking a picture and the guide said, "You're not allowed to do that." He asked her, "What if I do?" She said, "I don't care. All I'm supposed to do is tell you you're not supposed to do it." He also said that one morning when they got up, or the night before they went to bed, they said, "We're going to give you a real American breakfast in the morning." So they had hot dogs and Coca Cola.

But when we were there, we didn't have anyone following us all of the time. We just were never sure about what the security was. But you could take a taxi and go places by yourself. We went through the art museum. That was in Leningrad not in Moscow. But when we stopped at that hydraulic laboratory, the wives of the staff there took Mrs. Snyder on a mushroom hunt in the woods. That night at dinner, they made a great howdy-do about serving us those mushrooms. Mary was afraid of them so she said, "Well, how about sharing them with the rest?" They had brought them to the table where the English-speaking people were. The French table, they were very eager for the mushrooms. I think Mary got rid of them without having to eat any of them.

Q: The Russians are pretty generous with that kind of stuff though, basically.

A: Yes, when we got to Moscow, we went to the new hotel near the Kremlin. I think it was the largest hotel in the world at the time. They had one wing of it, one part of it finished. The rest was not finished. I don't know how, I think it took us an hour to get registered. Stand in line, and the kind of equipment they had. The cash registers they had were out of this world.

At the official meetings in Leningrad at the hotel, they set up a special restaurant for us. It didn't matter much at dinner, but at lunch time, you couldn't get in there and out of there for less than an hour-and-a-half. We figured that the waiters must come and take the orders, and then they must go back and do the cooking. But I'm sure they didn't, but that's what it seemed like. It was terrible, the time it took. The food was all right, but the service was just out of this world.

Q: Service is not part of their business.

A: **No.**

Q: I was there in '93, and it's not very good.

A: The thing that's really interesting about this, of course, we were getting a per diem and UNESCO, this was a meeting sponsored by UNESCO, although I think WMO might have been jointly involved.

Q: I'm going to stop you just for a minute.

Water Resources: Hydraulics and Hydrology

- A: So, without anybody knowing about it, UNESCO paid us our expense money in rubles. When I signed up for this trip to take this excursion, which they had arranged because of the changing of schedules, to go from Leningrad, to the laboratory, to Moscow, they wouldn't take rubles. Had to give them dollars. So I had rubles coming out of my ears. I had brought dollars, figured I'd be spending dollars. But one of the chaps at the meeting, he must have heard me joking about it, he was in a position to spend rubles so he took, I don't know how many, some rubles off my hands. He sent me a check later on for them. But we still had a lot of rubles, and so we bought a lot of canned fish eggs.
- Q: Caviar?
- A: Caviar and stuff like that. They had foreign shopping stores, where you could only spend dollars, too.
- Q: They don't have many any more, I'll tell you that. They don't have much of that any more.
- A: I don't suppose, but we bought a lot of little toys and gifts, and things that we brought home to get rid of those rubles.
- Q: Yes, it's not in a very good condition there, the last time I was there. They're not doing too well.
- A: That's a shame.
- Q: What about the quality of the Russian hydrology and civil engineering that you saw from those trips? How good was it? Was it fairly good?
- A: It was pretty good. I think in working with the Russian people on these committees, in some things, particularly in a lot of things where you use a lot of mathematics, they were pretty far along on the mathematical end of it. The laboratory was, I would say it would have met our standards. They were doing several things that I was quite interested in I think partly on this sub-surface flow business which nobody had done too much here. Although later on the Forest Service did more, I think it was the Forest Service. The sub-surface flow is a lot more noticeable in the little more rugged territory. One man did publish papers on it.

But I'd say there were some areas that they were probably behind us. They knew me from the synthetic unit graph. That was surprising. One time a Major Lovovich--he was here in Washington on some official business, but he was a hydrologist. He came to the Chief's Office for a visit with me. I don't know whether he visited anybody else or not, but he was interested in hydrology. But they were great on publishing their material. I've got a Russian book or two that they gave me.

Q: A present for you?

A: Yes.

Civil Works Division

Q: Well, let's go back to the Civil Works Division there after the war. I guess it was a division then or a directorate. Who was the chief of the Engineering Division then? Well, let's see. It wasn't Francis Slichter yet, was it?

A: Not yet, no. He's still living. Mary and Mrs. Slichter were good friends. We went back and forth, and they moved. She had trouble with her knees, and she had a sister in Kansas City. They moved there to be near her sister and her husband, and I think the sister died shortly--but anyhow, Mary Slichter died a few years ago. Slich went out to Utah where his son is. His son was from a first marriage that I think was originally out in Oregon. I let him know when my Mary, his wife was Mary, too, I let him know when my Mary died. I got a short note from him. He must be in his 90s. I'm 84, and I'm sure he is at least 90 by now.

Q: If you have an address for him I'd like to get that from you.

A: Who, Slichter?

Q: Yes, because I thought he was dead.

A: Okay. You want it tonight?

Q: Yes, tonight would be fine.

Water Resources: Hydraulics and Hydrology

- A: When we get through. But Johnson came after Slichter. Margaret Johnson lives up the street here. I'm trying to think who was ahead of Slichter. Shorty Hearn was Slichter's right hand man. Shorty was quite a character. He liked to play the stock market, I think. He went to Florida when he retired. We visited him down there once, but he's passed away since then.
- I'd recognize the name right away, who was ahead of Slichter. I think it may have been R.W. Stuck. Because you know who the recent ones are, because after Wendell Johnson--Joe Stillwell, I think. Then a hydrologist was chief for awhile. He still lives out in Bethesda. Homer Willis. He's a good friend of mine. When he was out in the Ohio River Division, we used to go on field trips. He was in hydrology work out in the Ohio River Division.
- Q: He is a nice guy.
- A: He came in here and ended up being chief of the division for awhile. I'm thinking who was ahead of him for awhile. You're thinking more about the older ones?
- Q: Yes, I'm trying to think about those folks. I need to do some more work on that. I'm just trying to get some names of people that you might have worked with.
- A: When I was first there, there were three old timers there--McAlpine, Giroux, and Steele. They were the guys that you walked around. You didn't get into any trouble with them. Mr. Giroux got an exceptional civilian service award at the same time I did. Mr. McAlpine got several extensions of the compulsory retirement age. He played tennis, and he was still there for quite a while. A Mr. B.R. Wood was in charge of Flood Control. I haven't really thought of them for a long time.
- Q: What I need to do is to get you some of the organization charts from the 1950s and see if we can add some names in there.
- A: Yes. I believe Mr. Steele was head of the Structures Branch before becoming a special assistant. The head of the Geology Branch, Mr. Burwell, picked up a bug overseas some place that killed him. Later on, Mr. Bloor, head of the Structures Branch had a secretary that thought she should marry him, or that he should marry her. He had trouble. A lot of little things like that. There was something wrong with her.

Q: Interesting what happens in offices.

A: Yes.

Q: Now, Slichter came in with Lewis Pick, right?

A: From the Missouri River Division, yes. You know how the Pick-Sloan Plan got approved?

Q: Well, I know what I've read, but I'm not certain that that's accurate.

A: Well, quite often when there was a big flood the Chief would fly and overlook it. I got to go on several trips. But the one I'm talking about, I wasn't on that trip. But anyhow, there was a big flood in the Missouri River Division, and Pick took President Truman out there. I can't think of the name of the town where Truman was from. But it's a little town.

Q: Independence, Missouri.

A: Yes. He brought the name up and Pick showed him right away where it was on the map so from then on Pick got his way. That was the story I heard. Had you heard that?

Q: Well, I didn't hear it from that, but I knew that Truman was very much committed to Pick, very much in favor of Pick, but I didn't hear that particular story. What did you do in your branch on the Pick-Sloan Plan? Did you have any work on that.

A: Not directly.

Q: That was mainly a plan to prevent flooding, right? Some navigation, but mostly flood control.

A: Well, a lot of power.

Q: Well, power, I mean, yes.

Water Resources: Hydraulics and Hydrology

- A: Because all of the local people had organizations that got in on the power part of it.
- Q: I mean I was thinking, it's a multi-purpose project, a whole series of projects. But the real inspiration for it was the flooding in places like Kansas City, St. Louis, and other urban areas.
- A: Yes, there was a big flood control story. The upper dam had been -built a long time before.
- Q: Fort Peck was built in the '30s.
- A: Fort Peck, yes. Hathaway and, I think Hathaway, Cochran, and this Homer Willis I mentioned, they all came from the Missouri River offices, either in districts, the Kansas District, or the division office, into the Chief's office.
- Q: But that's true for about 30 years isn't it, that that happens, from about the '40s to the '70s?
- A: Yes.
- Q: That a lot of those--Wendell Johnson was from MRD.
- A: Wendell came from there, too.
- Q: Lloyd Duscha was from MRD.
- A: Oh, yes. Is he still?
- Q: No, he's retired. He's been retired for about six years, five years.
- A: I saw him a couple of years ago. I knew him to speak to him. I saw him at funerals and places like that. I saw when he got into the National Academy of Engineering. He became active in the Civil Engineering Section, tried to get them to reorganize some of their procedures. I don't know how he made out. I don't go to their meetings anymore.

Q: How much did things change between Pick and Wheeler? Were there any significant changes that you noticed or was it mostly project work?

A: Well, of course, in the beginning, my acquaintance with the front office was pretty slim. In other words, in Pick's day I didn't really ever get involved in anything that was going on, except what I would learn from Hathaway, so I don't really know how he operated. Later on I got to know the Chiefs. I always liked General Stratton. I saw his name just the other day. I got to know General Wheeler probably about as well as any. He was interested in Pakistan while at the World Bank. The World Bank had a big project, the Indus Water Plan.

Q: He was involved in a lot of that, wasn't he?

A: Yes, and Hathaway was, too. The Pakistan engineer that had worked on that plan, he'd been over to our office to talk to me so I got to know him fairly well. I think it was Pakistan that gave a big party that General Wheeler attended. Mary and I went to the party. Probably it was after the plan that they worked out had been approved. But, he was the one that gave me my Exceptional Civilian Service award. I've got a nice picture of him giving it to me in there.

Q: Let's see. What does it say here? That has to be Wheeler because, it is Wheeler, because it's 1946. That's Wheeler.

A: When was Reybold the Chief?

Q: Late November of '45. He left in November of '45. So that's Wheeler.

A: That's a xeroxed copy of one that I didn't have any extras of. That's Cochran, Hath, and I.

Q: Cochran on this side and Hathaway is there, right?

A: Yes, I'm in the middle.

Q: Okay.

A: Cassidy was also one of my favorites.

Q: Yes, Bill Cassidy?

A: Yes.

Q: He's the one Chief of Engineers we can't get to talk to us.

A: Is that right?

Q: For whatever reason.

A: Is that right? I'm trying to think of who was Chief when they had the dedication of the St. Lawrence Seaway.

Q: Itschner?

A: Yes. Mary and I flew up to the dedication on the plane with him.

Q: Because Sturgis came after Pick.

A: I don't remember him very well.

Q: Itschner was late '50s.

A: I don't know whether Itschner was there when Whipple got the computer business started. I'm not sure about the timing of that.

Q: I remember Hagen talked about Whipple pushing them in that direction and getting some of the first computers in the government. The new type computers, the IBM computers.

A: Yes.

Q: Okay. Do you remember any of the other key civilians in civil works when you were there?

A: In each field there were the heads of the various sections. They were all experts in their field. Burwell was a well-recognized man, the one that died from an infection he got overseas. Bloor, the head of structures went to the World Bank when he retired, so he was a pretty well-known man. Middlebrooks was a recognized expert on soils.

Q: A lot of those folks were going to the World Bank then.

A: Yes. I got to know, I think it was a **Jim** Casey in the real estate. Being involved in those regulations for other peoples' projects and stuff, I had a certain amount of contact with the Chief's legal advisor. Judge Kimball was really a fine man. I used to say that all lawyers should be drowned when they were born. Well, I've known two that that doesn't apply to. Kimball was one of them. I also talked to him about problems other than those reservoir regulations, but he always had a good answer for you.

Q: Could always provide the answer you needed?

A: **Yes.**

Q: The whole business of reservoir regulations. That was relatively new on the system wide basis, wasn't it?

A: That's right. It was sort of like I mentioned earlier, going around trying to get these Weather Bureau people to put their ideas down on paper so that it would be a matter of record. It was a little bit like that with the offices operating the reservoirs. We put out an engineering manual which I wrote on reservoir regulation. The requirements went out, they had to have a written operating procedure and get it approved. Now, I think everything is decentralized.

I remember one time, I think it was in the Missouri River Division during one of the floods, in order to get a little more storage they put sandbags on the spillway and

they really got chewed out for that. But that was the sort of thing we wanted to avoid. There is always a problem. You've got so much reservoir space and you have a flood. Well, should you use all of that space for that flood and then not have any left if one comes next week? Or how much should you use on the first flood, and how much should you save for future floods? So there's always a problem there in deciding how to operate. That was the thing we specialized in figuring out ways to do that.

The big problem, really the big problem, in reservoir regulation is the releases. When they make the studies and justify the economics of a project, they have a theoretical channel capacity downstream, so they make the study assuming that they can leave out X-amount of water. Well, after the project is built, if they leave out X-amount of water, everybody downstream yells, "Murder," because it's affecting them. So it's pretty hard to preserve your storage space. As soon as there are flood conditions, you should leave out all you can unless you're in a special situation where you're coordinated with some other project downstream.

In a normal situation, you leave out as much as you can so that you're saving all of the space that you can. With the people downstream screaming their heads off, it's pretty hard to do that. It's pretty hard to cause some damage downstream even though you're supposed to do that. The pressure gets pretty heavy not to leave out as much water as you should. And so then when the additional floods come in, you lose control because you've lost all of your space.

The people upstream scream for being flooded and the people downstream scream. It's just a situation where, I guess, it takes diplomacy as well as everything else to get the people downstream to recognize what you're doing. I'm sure some offices do that better than others.

Q: That's a very difficult thing to do. I mean people don't like to be flooded. They're sitting on those rivers and saying "Why did you build that dam up there to prevent floods and now you're flooding me."

A: Right. Sometimes you only have the one flood and so you have, after it's over and you put out this X-amount of water, space left in the reservoir. The people can't understand that.

Q: They don't understand there has to be space or you're in big trouble, right?

A: Yes.

Q: Now, that's a particular problem on a river like the Missouri, isn't it, where you have a cascade of big dams that have to be regulated?

A: The coordination has to be pretty good to get your maximum benefit. Some projects, I don't know that we have very many, but, occasionally, you have multiple-use storage which under certain conditions you fill it up for power. But also, during the flood season, you try to draw it down so that you'll have it available for flood storage. That gets a little more complicated, too, when the same space is used for different purposes. There is space allocated, or there used to be, for multiple-use. In other words, it's not strictly power, it's not strictly flood control.

Q: Yes, because in some you've got water supply, navigation.

A: Well, that was beginning to be a lot more significant towards the end of my service. The local people were partially paying for the, I guess in some cases they paid the full cost for space for water supply. That adds to the complications of operation. I see now in the journals here, I see paper after paper studying how to operate reservoirs. I often wonder what they're doing.

Q: Whether they've ever learned anything from what you guys did before?

A: I'm sure they're making studies on computers.

Q: I think it's all computerized.

A: Yes.

Q: I don't think there's any, some dams are all computerized-operated, I think. There's no operators on them anymore, that I know of. There may be maintenance people, but everything else, I think, is taken care of automatically. These very sophisticated programs they've developed.

Water Resources: Hydraulics and Hydrology

A: The Missouri River Division before I left had worked out computerized operating procedures for all of their dams, and they had a big display there to show everything that was going on all of the time.

Q: Like the railroads, a control room?

A: Yes.

Q: They had a little problem there last year, two years ago, didn't they?

A: They had so much water. It did almost look like they were going to have it again this year, but I guess it didn't get so bad. I think the peak at St. Louis was 6-8 feet lower than it was back in, what was it '93?

Q: '93.

A: Yes. But people don't like to get two 100-year floods two years in apart. They can't understand that.

Q: Well, they ask you why they're 100-year floods, right? Or why you call them 100-year floods. But we'll get into that. Okay. So you did have some involvement with some of these multi-purpose projects that came in after World War II, as far as not only the regulation of the reservoirs but also in the planning, the survey part of it?

A: Oh, well, yes. We reviewed. ..

Q: Their plans.

A: In the office, I guess, the Reservoir Regulation Section theoretically would review the reservoir section of it, but I think routinely one you had a report to review, the engineers probably would review the whole thing, except maybe for certain specialties. In other words, the section wouldn't review just the reservoir operations, we'd review all of the hydrology for the spillway design and everything.

Q: Anything that had to do with the water part of it.

A: Yes.

Q: The water management part as well as the planning.

A: Yes.

Q: The computations as far as runoff and storage?

A: One of the main items was this Maximum Probable Flood for the design of the spillway, for the functional design of the spillway.

Q: I was going to ask you about that because apparently there's a lot of different ways that different organizations look at these things.

A: Oh, yes. The private sector took a real dim view of those probable maximum floods. They still kick it around. The National Academy of Engineering (National Research Council) about five years ago, set up a group to review the situation, and they published a report. Also about that time, Bob Buehler, who was in the same position I was down in TVA, got quite interested in trying to evaluate the value of life so as to make it an economic decision as to how big the spillway should be. There were always people and organizations trying to tear down the idea of using a probable maximum flood for spillway design because it cost money. The TVA, I'm sure, had a lot of dams that weren't quite up to the standard that the Corps was trying to produce. Same with the Bureau of Reclamation. The Bureau of Reclamation got onboard rather reluctantly. The TVA sort of did also, but used a different name.

Q: Apparently the TVA had a Standard Project Flood. Was there a definition?

A: Yes, that was part of the Corps' procedures, but the TVA definition was different from that of the Corps.

Q: Part of the Corps?

A: Yes.

Q: But the Corps went then to its National Probable Flood.

A: I am not familiar with that. We had the Standard Project Flood to serve some other purposes, mostly with deciding on the degree of protection that could be provided. The Standard Project Floods you tried to protect against when justified.

But Cochran developed this concept of a Standard Project Flood which often was half as large as the probable maximum flood. It was used for functional design of a project. The idea was to use it as a rating basis. In other words, your project still might only provide protection against 75 percent of the Standard Project Flood, but it was an index to work against for actual protection or whatever you were trying to accomplish.

Q: But the spillway would be designed for what, the probable maximum flood, which was a different criteria then.

A: Yes. It was to save the dam from failing. That's what it was for. As time went on, there was a congressional action, the Corps was to evaluate the safety of all of the dams in the country. They started working with the states. This was after my time. I've got one paper there which I thought would be a big use in it, but they took another channel, another approach to determining what the standard, what the spillway design criteria would be.

But they did develop the idea that if there's a dam where it's failure wouldn't cause any appreciable damage downstream, well then you don't have to design for the probable maximum flood, although I don't think there are very many dams in that category. You never know. There's somebody down there camping, or driving along a road or something. Particularly in the private sector and the states, they set up some standards where the Standard Project Flood would be suitable for the spillway design and not the probable maximum flood.

Q: Well, I understand that's sort of what TVA does. They use the Standard Project Flood as the ...

A: Well, I don't think they would. I think they define it differently. I don't think they would argue that the Corps' Standard Project Flood would be adequate for a spillway design. I don't think they would get themselves in that box. I think they

probably, I don't know for sure, but I think their Standard Project Flood would be different than ours because I'm sure they would not, on a major project, now be satisfied with a flood half of the size of the one that's possible. No one would get themselves into that box.

Q: I don't know enough about it to ..

A: Yes, well, as I say, I'm a little hazy, too, about what their position is. But I imagine there are still a lot of people that think our probable maximum flood is absurd. But every so often there is a flood that happens that converts a lot of people, but it doesn't necessarily convert them all.

Q: I guess Teton Dam is one of those, the one that went out in the '70s in Wyoming? That had one of those situations where it wasn't big enough to. ..

A: A lot of organization are gradually upgrading existing reservoirs, improving their capacity.

Q: Even putting, what, higher. ..

A: Well, generally they combine it with increasing spillway capacity and adding some additional storage.

Q: Adding freeboard to the dam to get more?

A: Beg pardon?

Q: They add more to the dam to give it greater capacity or something?

A: Yes, they could increase the spillway capacity when they're rebuilding the dams. Then at the same time, if they can get more storage--I just read an article the other day where some old dam down in the Southwest, I don't think it was a government dam--was reworked. I think it was owned by a local water supply.

Q: What, Roosevelt Dam?

A: I don't think it was.

Q: That's in Arizona.

A: That may have been rebuilt.

Q: The Salt River Project.

A: This was the McClure Dam in New Mexico where they put on some special gates. I never heard of them before. There was a picture. It was in *Civil Engineering* several months ago. They put what they called fuse gates on it that apparently will fail when the water level gets so high. It works hydraulically, and they can set them differently so they don't all fail at once. Which reminds me. I don't know, are you familiar with Lake Barcroft?

Q: Just a little bit. Not very much.

A: Well, you know, there's a dam there. It failed once. The other lawyer that I admired was Armistead Booth, who was a member of a law firm founded by his father in Alexandria. I did a lot of consulting work for him when the reservoir that supplies Alexandria with water--oh, there've been all kind of housing developments built around it. I can't even think of the name of the stream.

Q: Occoquan?

A: Occoquan, yes. There's a big water supply dam on there. It was owned by a water company to begin with. They were increasing its capacity so they had to go all around the reservoir and buy additional land, and Armistead Booth was their attorney. They had a lot of law suits. I was always his expert witness. He was also involved in lawsuits on Lake Barcroft before it failed. One time there was a big flood and the people down in Alexandria got damaged. Its gates were hinged at the third point so that they would tip when overtopped.

The people downstream sued and claimed that all of the gates tipping at once and sending a flood wave downstream is what damaged them. These gates were wooden structures and as soon as one gate tips, why the water level will drop a little bit and

that releases the pressure on the others. There's no way that anyone can build those gates to tip physically at one time because of the friction on the side, and the way they were hinge. Particularly, because as soon as one tipped, the level dropped down and so it would be a little while before another one would tip.

But in the law suit, I think that was one we lost. There was an engineer on the jury, and we all thought, "Well, that will be good having an engineer on there. " We found out, Armistead Booth always knew everybody. He'd walk down the street in Alexandria and everybody in Alexandria knew him, but anyhow, he knew the bailiff, whoever took care of the jury. He found out that it was the engineer that lost us the case because he insisted if those gates were all hinged at a third point, if that's the way they were designed, they were all going to tip at once. Actually, there's just no way with something man-made like that that that would happen. But we lost that law suit. So you never know.

Q: Not at all. Well, do you want to call it a night?

A: What got me into that?

Q: Lake Barcroft. We're talking about dams.

A: Yes, yes.

Q: Maximum Probable Floods, and spillways. But if you'd like to call it a night. ..

A: Whatever your pleasure is.

Old Timers in Civil Works

Q: Okay. Let me begin by going back and mentioning some names to see if these were the people who you were thinking about as the old timers in Civil Works.

A: Of course, I found them.

Q: Did you find those?

Water Resources: Hydraulics and Hydrology

A: I found those. Carl Giroux was one. McAlpine was, I think maybe McAlpine was chief of engineering, maybe before Slichter. I found an organization chart of the Construction Division in '42 and that had military officers as the heads of all of the branches. There may not have been an Engineering Division.

But after that, McAlpine, Giroux, and Hathaway, were all listed in different categories, but they were generally special assistants, although they called them something else back then. This one here in 1949 had McAlpine, Giroux, and Hathaway, Stuck, and Steele as the Board of Review. They'd all been chiefs of branches or divisions before they got into that special category. So I just couldn't find anyone ahead of Slichter when I went there. My 1942 chart, of which I have a copy for you, indicates there was no separate Civil Works engineering division. There was just a Construction Division with Brigadier General T.M. Robbins as Chief. Lieutenant Colonel J.M. Stratton was Chief of the Engineering Branch, and B.R. Wood and Giroux were the heads of the River and Harbor and Flood Control Sections.

Q: I also found that Carter Page was in planning. Do you remember him at all?

A: Oh, yes. I think he died rather early. George Beard followed him, and he was the one I knew better. Then he, later during his career, resigned and went out to Portland with the big power company out there. Of the people close to the front office, I knew Gene Weber better because he was on the International Joint Commission for many years when I was on all those working committees and boards.

Q: Now he was a special assistant to the Assistant Chief of Civil Works in the '50s, wasn't he?

A: Yes. Then he spent a lot of time with the International Joint Commission until he had to transfer. The geologist that I was trying to think of, his name of was. . .

Q: E. E. Burwell?

A: Ed Burwell, yes. Bousquet was in Project Planning. He went off to the committee up in Congress that held the Corps' budget hearings.

Q: Was it then called the Public Works Committee or Water and Power Committee?

A: I don't really remember. I just went up once to testify about something or other. The interesting story is Joe Tofani. The highest ranks in the office were [GS] 16s for the chiefs of divisions. Joe became the principal presenter of the Corps' budget. One time the committees wrote into the legislation that he had to be made a [GS] 17. That tickled everybody. There wasn't any other way he could get it, I guess.

Q: Yes, he told me that story.

A: Someone else told you?

Q: No, he told me.

A: Oh, he did. Oh, you talked to Joe.

Q: Yes, I talked to him some years ago about some other things.

A: He's down in Florida now. He was up in Harrisburg on that flood control study when I was there.

Q: He started working for the State of Pennsylvania, didn't he?

A: I think he had been with the Bureau of Reclamation for a short time. He got married while in Harrisburg. He married a girl that was a friend of my wife, and so we have had a certain amount of contact with them ever since then. I don't know how many by-pass operations he had. Everybody thought that he was the one who would go first. He lost his wife a few years back.

Q: He's remarried now.

A: Oh, yes. I still get Christmas cards.

Q: I gather he married his high school sweetheart or something like that.

A: We got a note from him about that.

Q: He's quite a character, isn't he?

A: Yes, he is. In the office, what they call Hall of Fame, generally, I guess they don't elect people until after they retire, but I've been retired quite a few years. Joe was on the committee with some officers that made those selections. Apparently my name came out, and Joe put that through without any delay.

Q: I think they call that "having a friend in court."

A: Yes.

Q: Well, he was up here as the President of the Water Resources Congress for a long time.

A: Yes, yes. The chap I was trying to think of that was head of structures and went over to the World Bank was Ralph Blour. The heads of all of those branches were pretty well-known or pretty competent in their fields.

Q: Well, they would have been pretty senior people, wouldn't they?

A: Yes.

Q: I mean they would have had a lot of experience, a lot of years of service.

A: The soils man was Middlebrooks. He was well-known in his field, too. I think it was Thomas Middlebrooks.

Q: What was McAlpine like?

A: He was kind of, he was a little bit like that Robert E. Horton I told you about. I never really had any business to speak of with him, so all I would see him was in the hall and what not. He was just observing from a distance, a rather stem, somber

looking individual? but we all did admire him. He was still playing tennis at quite an old age. That was more outstanding than anything else.

Q: How long ago did. ..

A: I got to know Carl Giroux some, but I never did know McAlpine to speak of.

Q: They weren't around much into the 50s, were they? They pretty much retired before that.

A: Right, they were before that.

Q: In the 1950s, did you have much to do with Colonel Starbird, [Alfred] Dodd Starbird?

A: Some. He had quite a career when he went over to the Atomic Energy Commission I just had the normal contacts, but after he went over to the Atomic Energy Commission, I forget who the head man was. He had a farm down some place in Virginia, and he wanted to build a small dam, so Starbird had me come over and talk to him. The designing of a small dam wasn't my field, so it ended up by someone else helping him out. But I was over to wherever the Atomic Commission people were then at Star-bird's suggestion.

Q: One of the reasons I ask you that is because in the mid-1950s Starbird was the Assistant Chief of Civil Works for Flood Control. That was a relatively unique position then. Was that something created for him or was there so much emphasis being placed on flood control that they created that position?

A: That surprises me a little bit because there were always several officers helping the Assistant Chief for Civil Works. In 1949, the chart shows an executive, a Deputy Chief for Rivers and Harbors, and a Deputy Chief for Flood Control. There were always reorganizing and changing titles. Colonel Starbird was always asking questions, so we had a file folder Labelled "Starbird Questions. "

Q: Now, he was more of an equivalent of an assistant to Itschner. He had his own little box under Itschner when Itschner was Assistant Chief for Civil Works.

A: I don't remember anything about that particularly.

Q: I want to ask you about some hydrologists that you may have dealt with in the '40s and '50s. One of them I want to ask you about is Garbis Keulegan. Remember him?

A: Keulegan, I recall him. I don't know the proper way to pronounce it, but he'd been with the Bureau of Standards for years and years, and then he was down at the Waterways Experiment Station. He was hydraulics not hydrology. I never knew him personally. I may have met him down at WES or someplace, but I did never know him personally. But I knew him by reputation. He's done a lot of writing on a special area. I don't remember just what it was now. He was wellknown.

Q: Let me ask you about somebody I know you know and that's Hunter Rouse.

A: Well, I just knew him. He was at the University of Iowa, which I mentioned before may have gotten into hydrology very early in the game. I knew him by reputation. I think I wrote a chapter in a book that he edited, or was it Vin T. Chow?

Q: Well, apparently it was his book, edited book, *Engineering Hydraulics*, and you did a piece on storm runoff.

A: Yes, I remember writing a chapter. I wasn't sure whether it was that one. Vin T. Chow was editor and got one out some years later, and wanted me to do a chapter but I just didn't feel like I was up to it at that time.

Q: What about Rouse. He's got a very central position in the development of hydrology, doesn't he?

A: Well, he was more in hydraulics.

Q: Not in hydrology?

A: A lot more in hydraulics. I don't really remember him at all as having a lot of hydrology. That doesn't mean that he didn't do hydrology, but I'm just not familiar

with it if he did. Being there at Iowa, of course, hydraulics was their outstanding field, and how they worked hydrology into it, I'm really not familiar with it.

Q: Okay. Another hydrology lab that was set up, I gather in the '30s and functioned in the '40s and '50s, was the Soil Conservation Service Lab at Cal Tech. Did you deal with any of the people out there like Hans Albert Einstein?

A: Yes, we dealt here in Washington with the Soil Conservation Service, but the one that the Corps dealt with a lot more was Einstein at the. .. I have trouble with those California universities.

Q: Cal Tech, wasn't he?

A: Where all of the radical students are outside of San Francisco.

Q: Oh, that's Berkeley, UCB.

A: Berkeley. That's where Einstein was. Was that Cal Tech?

Q: No, Cal Tech was down south.

A: This was at Berkeley where Einstein was. He was on a consulting group for the Mississippi Basin Model, so I got to know Einstein pretty well. He always had lived in the shadow of his father. I remember one time after a meeting in Vicksburg we flew together to Memphis and when we got off the plane there were some reporters there wanting to talk to him.

One time when that International Union of Geodesy and Geophysics held their meeting in Berkeley, Ralph Wilson from the office and his family drove out there. I drove out there with Mary and our three children. Mary, she always liked to get people together, so she gave a little reception for people there at the meeting and we invited the Einsteins to come. They came, and they brought a box of candy for Gregory and signed it for him. Greg kept that for a long time, but I don't think he has it anymore. But Einstein died early. Let's see. His name was Hans Albert. I guess that was his father's name.

Water Resources: Hydraulics and Hydrology

Q: Albert, yes.

A: I don't know which way it was. One time I was calling him either Hans or Albert and he says, "Why don't you call me the other one? That's what my friends call me." I forget which way it was and why it made any difference, whether it was Hans or Albert or not, but it always struck me as interesting. He, or the University, had the contract for developing the electronic flood operations model for the Missouri River Division. Hans was, of course, quite an expert in the sedimentation field, which was one of the problems of the model. They had to worry about the effects, how the real sedimentation would have affected the model results. They developed some material that was supposed to act the same as the sediments in the river.

Q: For use in the models?

A: Yes.

Q: Now, apparently Einstein was involved in some work on the Old River Control Structure in the early 1950s with WES. Were you involved in any of that work?

A: What was it?

Q: The Old River Control Structure?

A: Oh, I guess, maybe. Mostly, it was just reviewing. I don't remember being involved in any model studies. But I guess it was mainly because our office had some concerns about it when we were reviewing the reports in the Chief's Office. I don't remember ever actually working on it as far as the experiment station was concerned, or with Einstein. I think Jake Douma, probably, in the design of the structure and everything, Jake Douma was probably involved in that more than I would have been. There wasn't a great deal of hydrology other than sedimentation in that. I guess you know during that one flood they almost had a disaster there.

Q: '73?

A: Yes.

Q: It almost went out.

A: Yes.

Q: Well, apparently Einstein had done some sedimentation studies and developed some kind of format.

A: Well, yes, that was one of the major concerns as to how the sediments would divide up in addition to the way the water would. They could control the water, but they couldn't necessarily control the sediments. It was a problem. I don't remember the details of it, but it was a factor that they were concerned about quite a bit when they built the structure.

Q: It apparently was primarily a sediment problem, where it would go down the Atchafalaya or down the Mississippi.

A: Down the river, yes.

Q: How about Arthur Ippen?

A: He was MIT, I guess. I don't remember having any direct relationships with him. It might have been at meetings, at technical meetings, but it was nothing--I had no direct relationship with him.

Q: How about Vito Vanoni?

A: No, I think he was in sedimentation.

Q: Well, these are some figures that we're trying to ..

A: **Yes**, yes.

Q: Lorenze Straub.

A: I knew him and probably had some meetings with him, but other than that I had no relationship. We had, I didn't mention before, but one of the things that the office was involved was inter-agency committees. First, the Federal Inter-Agency River Basin Committee, then it was an Interagency Committee. Later on, it was the Water Resources Council, I believe.

Water Resources Council

They had subcommittees on sedimentation, and hydrology, and power among others. Al Cochran handled the subcommittee on sedimentation, and I had the subcommittee on hydrology. There were representatives on the subcommittees similar to the main committee. The chairmanship rotated each year between the different agencies. So there were times when I was chairman of that subcommittee just like everybody else was. The subcommittee on sedimentation set up a field operation-- I forget its name--in Minneapolis... was Straub there?

Q: There was a St. Anthony's Hydraulic Lab in Minneapolis.

A: The agency set up a project to develop equipment for measuring sedimentation in the rivers, and I think Straub was involved. He was there at the university that had that laboratory. But I don't recall that he was active in this project that I mentioned. His name was, I think, involved in that operation. I don't remember who ran project.

Q: Now, what kind of things did your subcommittee deal with?

A: Well, I suppose basically the idea was to coordinate activities so that nobody got too far ahead of the rest of the pack or they could eliminate problems before they developed. You might ask what was the main committee, too. But that was their function also. The members of the main committee were the secretaries, but the people that actually operated were their representatives. But the members were really the agency secretaries, or the department secretaries. So it was a fairly high-level committee.

Well, you've got a good question there. We published a set of river basin maps for the country showing the hydrologic stations. We also controlled the assignment of radio frequencies set aside for transmission of hydrologic data. I remember one time the frequency of floods was a problem. The frequency is a major factor in the economic studies and the different agencies were using different procedures and

getting different answers for the same hydrologic data. Much of the initial pressure for standardizing frequency procedures came from non-federal sources. The problem was first referred to the subcommittee in 1956. We bounced it back, but over the years it came up several more times.

We hired some experts in the field of statistics, not in hydrology, but in the field of statistics. When they realized what a small set of data we had, why they just said there's no way you could come up with a good answer.

We were lucky if we had 50 years of data. Then when you start getting figures for 100-year floods, they can be pretty wild. So we made a lot of people unhappy, I guess, but we insisted that you couldn't say that one procedure was better than another because the data itself were inadequate. The various methods would give essentially the same results for frequency of floods of the same duration as the period of record. The difficulties arose when the data were extrapolated to longer durations for various purposes. In the meantime, a subcommittee work group prepared a study of the various flow frequency methods. In 1966, the subcommittee received a rather specific assignment from the Council on the matter. Before I retired from the Corps that year as chairman, I established the panel or working group that was to achieve standardization.

Q: Was that what eventually led to the Water Resources Council issuing that what, "Principles and Standards" or something?

A: It could well be. I'm not sure just what the mechanics were for getting out the flood frequency mandate. When something was agreed to by everybody, it was usually up to each agency to pass the word on to their own field offices. But there might well have been another action. The council could well have adopted the subcommittee report and put their cover on it as a document.

Q: I think this was after the introduction of the NEPA, the National Environmental Policy Act, wasn't it? Reuben Johnson was there. He'd been in the Corps of Engineers.

A: Now, that's a familiar name. I'm trying to remember.

Q: He'd been out in the San Francisco District, and then the San Francisco Bay Model. He was out in planning out there.

Water Resources: Hydraulics and Hydrology

- A: Of course, another problem was beginning to surface. I had retired by the time they started hassling with flood insurance, when Congress passed that law. I'm sure the interagency groups hassled with that for some time.
- Q: I think one of the problems they were having was trying to set up uniform guidelines because of the differences in cost-benefit analysis for water projects with the Corps doing it one way, and then BUREC doing it another way, and Interior a different way.
- A: Yes. That certainly was a factor on the flood frequency business. Of course, on the question of spillway designs, I think we had some studies on it. There were always people attacking, taking a dir-n view of the Corps' procedure because it gave pretty severe results. I don't remember when that got to the interagency group. It did later on. I think they did finally publish, I think either the subcommittee or the main agency published some reports on those spillway design problems. But Bob Buehler, an engineer that I worked with in Knoxville, became quite active in the group and insisted that you could do it on an economic basis by assigning a value for life and that sort of thing--deciding from economics how large the spillway should be.
- Q: Were you involved in any other kind of interagency groups?
- A: Well, I probably was, but I don't remember. This Water Resources Council and its predecessors were the main interagency activity for a large number of years.
- Q: Okay. Let me go on to another question. In the late 1940s and the early 1950s, the Corps of Engineers and the Department of Agriculture were involved in an upstream-downstream controversy. This was largely fought out in the Federal Interagency River Basin Commission. Did you have any involvement in this?
- A: I don't believe so, no.
- Q: Did you have any views on it?
- A: I think it was more political than anything else.

Q: Did you have any knowledge of what was going on and any views of what the controversy was about?

A: Well, of course, I don't know whether it's a matter of history or not. I remember it as a big argument, but, there was some sort of an agreement. I believe it was actually legislative rather than a mutual agreement. The Corps and the SCS kind of split the game up. In other words, they handled projects of a certain size, with certain objectives, and the Corps took the bigger ones. I'm not sure just what the language was. Had you run into that before?

Q: I know there was some kind of size discrimination made between the Corps and the Soil Conservation Service on those flood conservation service projects.

A: I think it was mainly legislative. There was some legislature covering it, dividing the territory up.

Q: Well, apparently as a result of this controversy Howard Cook and Richard Hertzler left the Department of Agriculture and joined the Corps of Engineers.

A: Who was the second one?

Q: Richard Hertzler.

A: Oh, yes, both of those were friends of mine. Howard Cook, I think, was married to Robert E. Horton's daughter. He had worked at the laboratory up in New York where Robert E. Horton was. I think Howard worked for him before he got into the Federal activities. I'd known him before he came to the Corps. Then after he came to the Corps, I got to know him better. Richard Hertzler, I forget. I think maybe I met him in Pennsylvania. I've forgotten just what my relationship with Richard Hertzler was, but I remember when he was on the Washington scene. Where did he work?

Q: I guess he must have worked in OCE.

A: I think maybe it was in the office of the Assistant Chief of Army for Civil Works.

Water Resources: Hydraulics and Hydrology

Q: Well, I'll have to check that.

A: He must have moved on. I think he went back up to Pennsylvania on some activity. Another chap I knew well that worked for the Corps for a long time and then went to the Bonneville Power Administration was Morgan Dubrow. He had quite a career moving around from one job to another. Another well-known in the field, not only in hydrology but government activities, was Schad. I'm trying to think of his. . .

Q: Ted Schad?

A: Yes. I got to know him. He's a member of the Cosmos Club. He was at the Library of Congress when I first met him. He was active on the Washington scene. That's how I remember. Ray Linsley, I suppose you've run into his name.

Q: No, I haven't.

A: He was down in Knoxville when I was there, and he was in the group that did the river forecasting.

Q: He was the one you couldn't remember his name last time?

A: No.

Q: Well, that's a new name for me.

A: Oh, the one that became chairman of the TVA was John "Red" Wagner. That wasn't Ray Linsley. But after I joined the Weather Bureau, I think Linsley came to the Weather Bureau via the SCS, but anyhow, Merrill Bernard hired him for the Weather Bureau and sent him out to Sacramento to set up a river forecasting district out there. Linsley became a, heck, he was one of the outstanding hydrologists of the country. He was on several presidential commissions. After he left the government, he became a professor at the university just south of San Francisco.

Q: Stanford?

A: I think it must have been Stanford. He was first the head of civil engineering, and then I think he became the head of engineering, but he started doing a lot of consulting work. He developed some models, river forecasting models, and what not. He started a company, a consulting engineering company.

One thing I mentioned, the Corps was building a project that was going to affect the campus. The president of the university was quite concerned about it, and he wrote the Chief a letter about his complaints and said he had the outstanding expert of the world, Professor Linsley, who was going to straighten this out. It didn't phase the Corps very much. I forget what the problem was, but it was a hydrologic problem of some sort that one of our projects was going to affect the university's property. Ray died a few years back.

Another chap at the Weather Bureau was Max Kohler. He was the first president of the Commission of Hydro-meteorology of the WMO. He was the Weather Bureau representative, and I forget who the Geological Survey representative was. The three of us were on it. So Max Kohler is one of my very good friends. Max was a field rider taking care of rain gauges or something out in the Los Angeles area. Bernard met him and brought him into Washington. He became an outstanding figure in the field.

Q: Were most of these people who came into hydrology meteorologists?

A: I don't believe so.

Q: Were they mostly civil engineers?

A: Probably. I forget what Max's basic training was, but I think it was engineering. Meteorology is a big part of hydrology. You might argue whether meteorology includes hydrology, but I think the other way around, hydrology would include meteorology. But I belong to the American Meteorological Society and a lot of the hydrologists do. I'm sure Max Kohler, particularly people working for the Weather Bureau, would be inclined to. Then, as time went on, the American Meteorological Society started having an interest in hydrology. It's quite proper that they do. So getting back to your questions, now one of the men in the office, Dwight Nunn, left the office and went over with the Nuclear Power, what do they call the commission?

Water Resources: Hydraulics and Hydrology

Q: Nuclear Regulatory Commission?

A: Yes, and he developed probable maximum floods for them, because when they build a plant, generally along a river or a lake, and they're just as concerned about the probable maximum flood as anybody else. Now, I think he was a civil engineer to begin with, but during the war he went into meteorology. He was trained as a meteorologist, so he worked through the war as a meteorological officer. So to answer your question, I would say there are probably more hydrologists other than the ones that came through the engineering route, there's probably more of them came from other sciences than did from meteorology, although certainly there's probably a fair number of hydrologists that had meteorological training.

Q: I gather there is somewhat of a discussion about whether hydrology is a true engineering science or is a skill.

A: Yes. Now, it's pretty well a dead issue. There's still, every so often somebody wants to set up a project to demonstrate, I guess, that it's a science, but I think it's pretty well accepted as such. At any rate, it's pretty well accepted now by all of the organizations as a field of its own.

Now the people that write papers for the American Geophysical Union Section of Hydrology used to discuss that problem. There were always people wanting to set up projects to help make it more of a science, but I don't know what you have to do to make it a science. That's a problem that never bothered me. I didn't care what they called it, whether it was a science or not.

It does draw on many different fields. In other words, the groundwater, it involves the soils people, it involves the rainfall, it involves the meteorologist. It involves the sediment, which brings in the sediment people. It does involve so many fields, I guess that's why it's difficult to call it a science by itself.

Q: Much more of an argument in the '40s and '50s than about exactly what it was?

A: Yes, I was not concerned about it, and I certainly didn't get involved in it. There was always a discussion of it, but I don't know of any reason why there should have any strong feelings about it one way or another. I don't see that it makes a whole lot of difference except possibly in getting research money. There were discussions of it, but I don't remember any severe difficulties involved in it one way or another.

Q: Okay. What were the main issues facing you as a Corps hydrologist in the 1950s?

A: You mean technical?

Q: Technical, organizational--technical, first.

A: Well, we had procedures for routing floods in the rivers and for synthesizing the hydrographs and what not, but the main thing that I was interested in, that you might say concerned about, was developing relations, given the amount of rainfall, trying to determine how much runoff there would be. That was the thing that intrigued me more than anything else, and I did a lot of research. I've got files downstairs, if I didn't give them away, I've got files on projects that I started investigating, some river basin here or there which I never had time to finish. Collecting the rainfall data and the stream flow data, and trying to relate the two. So that was my main interest I would say outside of the routine.

Q: Beside the regular work you were doing. Now, you were still in the Reservoir Regulations Section at that time?

A: Yes.

Q: So you did this as an additional. . .

A: Well, to regulate the reservoirs you have to know how much runoff you're going to get and you get the rainfall reports, but you have to go from the rainfall to the runoff and develop the flood before you can determine how to regulate it. Because that's why, when I was at Pittsburgh, I developed, I never did quite understand why it worked, I developed a relationship going directly from the rainfall to the river stage without figuring out how much runoff there was going to be. It was a real empirical thing, but on the few rivers I used it on, it worked pretty good. It was just a coincidence, I guess.

Q: Now, how would you work that out? How would you develop that figure you would use, or ratio, or whatever to figure that out?

Water Resources: Hydraulics and Hydrology

- A: It was a graphical relationship. It would just be a matter of, for a given area, determining how many inches of rainfall and plotting that against how much change in a river stage occurred at a particular gauge that rainfall fell above. It's just a case of accumulating the data and just plotting it out to see if there was a relationship. It was just like those flood relation charts for the Rhine River. It was just a matter of plotting the data and drawing lines through them, a graphical analysis I guess you would call it. There wasn't any great--well, it took a certain amount of skill to know when you could disregard something and when you'd have to worry about it. No matter--there's always some points that don't plot good, particularly on the flood frequency business.
- Q: Something that goes off somewhere. ..
- A: Yes. They call them "outliers", I guess, in the flood frequency analysis.
- Q: Those they ignore as the abnormal piece of information?
- A: Oh, well, that's one way of handling it. The other way is to handle it, too, I guess. You can't completely ignore it, but ordinarily you'd have to theorize a little bit about it.
- Q: Did they really give you much time to do these kinds of things with your procedures?
- A: When I was in the Chief's Office?
- Q: Yes.
- A: No, not much before I was married. Most of that was done when I was with the TVA and with the Weather Bureau. I guess I mentioned before that I met my wife in Harrisburg. We were married in Pennsylvania. I still did some at home when I was with the Corps. I think I must have written some while I was with the Corps. I suppose I snuck a little bit in at the office, but not like that chap I was telling you about the other day that was studying the transport of fluids and we couldn't get him to do anything in the office.

But I suppose some of it was strictly in the reservoir regulation business. Some of that was strictly business, trying to develop procedures for handling the reservoirs. When we developed something that we wanted to send into the field, I forget what we called it, but I remember sending one, it wasn't a directive, it was just a procedure that was recommended for use. It was a procedure for determining how much of your reservoir surcharge storage it was safe to use on any given flood with the threat of possibly a bigger one coming along later on. I don't even know whether I have a copy of it anymore. But, of course, we also sent out directives. It was things like that I had to do research on before we could send them to the field.

Q: Well, they had things called *Engineer Circulars* and *Engineer Letters*.

A: Yes. *Engineer Letters*.

Hydraulics and Hydrology

Q: What about the changes in the organization of hydraulics and hydrology? Hydrology remained a portion or a part of hydraulics in the Corps of Engineers in Civil Works in the '50s.

A: Yes. I'm trying to think of who, whether Hathaway had a hand when they split it. It didn't come back together until after I was gone.

Q: I thought it was together. I thought hydrology and hydraulics were together.

A: Until when?

Q: In the '50s, weren't they? I know they were in the '60s, the late '60s and the '70s, they were together.

A: Well, yes. The branch was called "Hydrology and Hydraulics." See, I retired in '67. It was after I retired that they came back together again. What makes the organizational situation confusing is that there are two kinds of hydraulics. The hydraulics involved with structural design, which was Douma's field. The other hydraulics is that involved with river flow. The latter was always combined with hydrology. The structural hydraulics is what was shifted back and forth.

Water Resources: Hydraulics and Hydrology

Q: Came back together?

A: Yes. When they separated, I think it was during my early days there. I'll really confuse you. Bill Cave's name. He was the head of the Electrical Mechanical Branch. I don't know that he was well-known nationally, but he ran the branch. Well, now this says Hydrology and Hydraulics Branch with Al Cochran as chief. The darn thing doesn't have a date on it, but Potter was the acting head of Civil Works.

Q: Bill Potter was the Assistant Chief of Engineers for Civil Works from April '49 to February '51.

A: Yes, Potter, and Arnold. I'm trying to--I forget when Douma came in to the Chief's Office.

Q: Late '40's, I think.

A: Late '40s.

Q: Because he had been in the Los Angeles District.

A: Yes, yes.

Q: I think Cochran brought him in.

A: Oh, Cochran is still the chief here on this chart. I'm trying to figure out where some other people were at that time. There were some hydraulic people, John Harrold for one, that were interested in the model studies and that sort of stuff that was going on down at Vicksburg. I don't think they were in our branch. I don't remember whether Douma was in our branch to begin with before he went to structures.

Q: I'd have to go back and look at his interview, but I thought he was.

A: I'm a little hazy about that.

Q: Because he worked for Cochran for a short time.

A: He did?

Q: Eventually, he was doing structural.

A: That's where they were. The Structures Branch had a group that were interested in the hydraulics of the structural design on the dams. In other words, Douma was probably in structures most of the time.

Q: I'd have to check, but I think he was.

A: Yes. That's where they were. I said I was sure there were some hydraulic people that weren't in our branch. Our hydraulics was mostly river hydraulics, where the hydraulics in designing the gates, the passages, and stuff through the dam, was in the Structures Branch.

John Harrold, who was probably over Jake to begin with, had a brother, Lloyd, that was on that project that I was on in the Geological Survey. There were two brothers and both in hydraulics and hydrology. When I went to the Corps, I'm not sure where John Harrold was at the time.

Q: Okay. So there were really, there were hydraulic engineers in other places besides your branch.

A: I think that's the way they kept people happy.

Q: But there weren't any hydrologists anywhere else.

A: No.

Q: You had all of them in hydrology.

Water Resources: Hydraulics and Hydrology

- A: Civil Works hydrology was all there at that time. Whether originally all hydraulics was in that branch or not, and as things developed, some of the people to get ahead maybe were in the structures or whether the structures had it all of the time, I'm just not clear. However, OCE was instrumental in the establishment of a Military Hydrology Unit. They put out a lot of studies on the application of hydrology to military operations. I don't remember whom they reported to. Based on what happened in Bosnia, the Army must have forgotten about hydrology.
- Q: Was that part of the development of hydrology itself, that it was assumed to be a subordinate part of hydraulics and hydraulic engineering, and then as it matured, it broke out?
- A: I suppose so from an organizational viewpoint, from the people up front that had to approve the organizations. To begin with, it was hydraulics. There wasn't any such thing as hydrology. But it eventually found its own notch. The branch that had the river hydraulics had hydrology. I think though maybe sometime to give Douma or somebody their rating, they set up a hydraulics branch.
- Q: Yes, because I believe there were two.
- A: Huh?
- Q: It was called hydraulics and hydrology. I think there was a hydraulics branch and a hydrology branch, but that may have been after you left.
- A: Yes.
- Q: Because I think Jake Douma had the one branch, and Vern Hagen had the other.
- A: Yes, yes.
- Q: And there was a question about who would be the division chief.
- A: But I think a Hydraulics Branch Design Unit in Structures was there when Cochran was there.

Q: I think you're right.

A: When I was still there. In other words, Douma was always separate. Whether he was ever under Co&an--he said he worked for Cochran?

Q: I think so.

A: I just don't remember the details of that. But for years he had his own separate unit and for awhile, the man in charge was John Harrold. He would have been Douma's boss in the structures. I believe he was senior to Douma for awhile. I don't know whether he retired or what.

Q: The last time we talked about paralleling the changes in OCE, and you said a lot of the districts, a lot of the divisions especially, had hydrologists, like MRD. Did that become a permanent part of the field structure to have a hydrology office?

A: Well, I think it was the same thing. It was in hydraulics. Just like the Chief's Office, they probably had hydraulics branches in the engineering division. As the work developed for hydrologists, I'm just sort of theorizing a little bit, they sprouted up in the hydraulics branches, and if they got strong enough, they got separate. Otherwise they probably were kept, or maybe they gained a joint name like hydraulics and hydrology, or actually had separate branches or sections. I never worked in a field office, so I'm not too sure. But I'm sure, I do feel that a lot of people that I worked with in the field were hydraulics people as well as hydrologists.

Q: Besides MRD, and I think last time we mentioned the North Pacific Division, were there any other divisions that had very strong hydrology programs, with hydrologists in the division offices?

A: Yes, they did. The South Pacific Division did. But getting back to the North Pacific Division, they had, other than the routine work where they needed hydrologists for the functional spillway design and what not, the operation of all of those Columbia River dams which required a hydrologist to set up their forecasting procedures and what not. They had quite an operation going there.

Here, again, Mark Nelson was the head of the operation, but he was an operator. There was a younger chap who did most of the hydrology work there. The division

Water Resources: Hydraulics and Hydrology

sort of ran the dam operations rather than the district. Of course, there was a Portland District, too, at the same time. I think I generally visited the division office, though, rather than the district office.

Q: Would that have been because the Columbia River ran across several districts in order to give unified forecasting, you'd have to deal with all three districts?

A: Yes, the Willamette Basin was in the Portland District.

Q: Was it?

A: Yes.

Q: Was Walla all in the ..

A: I remember that district.

Q: Well, that's still there.

A: Is it? It was involved with the nuclear work?

Q: No, it had the upper part of the Columbia, the Snake, and all of that.

A: Oh, yes. The Snake River goes way over into Canada. That's funny. I don't remember ever visiting the Walla Walla District.

Q: It had everything east of the mountains, I think.

A: Yes. I'm sure I've gotten in touch with them, but it wasn't any major activity that I had with them. There was a period when I went around to all of the division offices, and we held, I don't know what you'd call it, seminars or conferences where all of the district people came in. In connection with reservoir operations, reservoir regulations, we had sort of training sessions for the various offices.

Q: Because **you** had training sessions, was that after **you** had issued your Engineer Manual on reservoir regulation?

A: I would think probably, yes. I got four folders of travel orders downstairs.

Q: You were going somewhere.

A: My daughter always wants me to write a history. If I could find my diaries, I would try to do that for her. If I can't find those diaries-I could go through all of those travel vouchers and figure out a lot of stuff that happened. But getting back to your question, I'm not sure. I think we rewrote the manual once, so I don't remember when it went out the first time. I've got copies downstairs that are probably dated. It might well be that those training sessions were before the manual went out. But I don't really remember.

Regulating Reservoirs

Q: Did you find that there was any opposition to setting up a standardized set of procedures for regulating reservoirs? You had mentioned before that, like with the Weather Service, there was a lot of local knowledge kind of thing but not a lot written down on reservoir operation.

A: No, I didn't. I don't remember any. If there was any, it was pretty well hidden. There certainly wasn't anything in the open. In the case of the Weather Bureau River Districts, they'd been going on for years and years. Whereas this was all a little new to the people in the Corps' office so they were sort of in at the beginning of it. And, oh, I'm sure some of the offices had some old timers that thought they knew how to do things better than the new people did, but they were probably not involved in our activities because I don't remember any difficulty in that area at all.

Q: So it was pretty much accepted?

A: Yes, yes. The procedures weren't standardized, but they were, you might say, systematized. I mean they were approaches that needed to be considered, but there never was any standard that said, "You have to do it this way. " There never was any of that to begin with.

Q: So it was just a system, how to regulate reservoirs, and factors you should consider in doing it.

A: Yes. A matter of analyzing past floods. One factor is the effect of a reservoir on the concentration of flood waters. I don't know whether I ever sent out a paper other than the manual on that or not. It's involved in operation, but also has a significance in the design. Suppose you're building a reservoir at a place where you've got a river gauge. Well, you can study, get your unit hydrographs at that river gauge, and everything. They wouldn't do you any good for design or operation other than providing the coefficients for use in that synthetic procedure.

You see, when you build a reservoir, it provides a deep body of water. So when the floods come down the tributaries, they travel rapidly through that reservoir. The velocity equals the square root of gD much faster than in the natural channel. When you get an inflow of water from a tributary at a deep point, it's effect is found almost immediately down at the dam so that changes the whole time of concentration of your flood. So when you study the reservoir then you have to develop unit graphs, unit hydrographs, for the tributaries where they hit the reservoir. Not down at the dam site, but where they hit the reservoir. It makes the computed flow at the dam higher than it would have been before the dam was built. That was just one factor. I don't know how I got into that.

Q: Let me go back and ask you now to explain to me what the square root of gD is?

A: Well, that's the velocity of waves in deep water. That's the way, when you have an earthquake out in the ocean, they have those, what do you call them--I can never . . .

Q: Tsunamis?

A: Well, that's the velocity. It's just like Force = MA. It's just a physical fact. It's the velocity of waves in deep water. That's the speed with which they propagate across the ocean. There may be a little friction factor in the reservoir. In other words, maybe it's only 95 percent of that, but the inflow still travels very rapidly through the reservoir.

Q: Now that's G as in George or V as in Victor?

A: No, g is gravity, whatever units you're working in. D is the depth. So the deeper it is, the faster it goes.

Q: All right. I'm a completely blank slate here. You've got to explain these things to me.

A: Fine.

Q: But it didn't take long for you to get this whole procedure accepted, a systematized procedure for reservoir management?

A: No, the procedures for presenting a report and designing a spillway capacity that was almost standardized. That got accepted pretty early in the game. We didn't have any arguments about it. The field offices had to do it that way. They had to come in and request a study from our unit over in the Weather Bureau to develop a Probable Maximum Precipitation for the area that they were working on. They just started off of that.

I don't know whether I mentioned it before, but one of the projects that Hathaway started with the Weather Bureau was a storm study program, where all of the large storms of record were studied. The field offices would develop the data with standard instructions on how to present it, and then it would go over to the Weather Bureau for a review. After it got straightened out, it was published as a storm study with all of the data for that particular storm. The data was presented in usable form so that the field offices could use it then in design studies and frequency studies. I suppose that's still going on.

Of course, when you go back through the records, in addition to doing it for current storms, they gradually were doing it for all of the old storms. So that became a tremendous task, it was quite a project. It took a lot of money to do all of those studies. But that data was available for the field offices and Weather Bureau when they were studying a reservoir project. The reservoir business has gone by the board now, or has been for some years.

Q: Well, basically in the hydrology you were working for the Operations Division people as far as helping them with regulating reservoirs?

Water Resources: Hydraulics and Hydrology

A: I'm trying to think how the field offices were organized. I suspect that most of the field offices, the Engineering Divisions had a say in this functional operation. Of course, the province of the operations people was to provide maintenance and operating personnel. I imagine that in most of the offices the forecasting and the functional operation was in the Engineering Divisions. I don't really know for sure.

Q: So you think they controlled the reservoirs?

A: The functional operations. The instructions would go to the dam tender. I'm sure he worked for the operations division. It was required that the dam tender be provided with a set of operating instructions for normal use and for cases of lost communications. During emergencies, the Weather Bureau and the Corps worked together on forecasting. I suspect that that was in the engineering, stayed in the Engineering Division.

Q: So you worked with operations people, and you also worked with the design people, people who did the designs. You had to review their materials plus also provide them data, didn't you?

A: They what?

Q: You had to provide them with analysis of the data.

A: The Engineering Division, of course, would develop the requirements for the spillway capacity. The structures people would be in the Engineering Division, too, so that was a family affair as far as the design was concerned. Then the hydraulic design people took care of the gates, how the gates worked, the machinery, and the design of the tunnels. That was another thing that Hathaway, I don't know just how it started, but every once in a while a project would come in where a dam design would not have a low-level outlet. Hathaway just wouldn't let anybody build a dam that couldn't be drained.

Q: Why would that be? I mean not letting them do it, but why would they. ..

A: It cost money to build low-level outlets. It cost money to put them in through a dam, and in some cases they were not required for normal operations.

Q: Like the ones they put in at Boulder Dam, through the rock walls?

A: Yes, those went around in the canyon walls or in the sides rather than through the dam. They were part of the diversion schemes, see. During construction, you had to divert the water. So those tunnels served both purposes.

Q: So they became outlets, too?

A: Yes, they also have some tunnels for spillways.

Q: So Hathaway looked at all of these designs himself when they came in? Or was it Corps problems identified. . .

A: No, he just worried about big things. He didn't worry about the details. I think this was after I got there or shortly after Cochran took over as the head of the branch and Hathaway became a special assistant. But, this sort of thing was what he did as a special assistant. I mean, worry about major items like that, and he was real good at cultivating people so he could get his way through the front office. He, generally, had a good reason for it.

Q: Was he mainly brought in on the very difficult problems, controversial projects?

A: Well, I'm sure he was on even things beyond hydrology. I don't remember anything in particular, but I'm sure he worked on things for the Chief or the Army that weren't strictly hydrologic in nature. Particularly on some interagency stuff, there was some interagency group that he was active on. I remember one time when I accompanied him to a State Department meeting. The group was drafting a U.S. position on some item for delivery to the U.S. Ambassador to the U. N. But he knew all of the people in similar capacities in the agencies.

Q: So he had all of these cross-agency connections. What about the development of the laboratories? We had talked about Hydrologic Engineering Center, but that didn't come until the '60s. Did the various Corps laboratories, especially WES, significantly improve their hydrologic capabilities until the '50s? Or were they already so strong they didn't need to do. . .

Water Resources: Hydraulics and Hydrology

A: I don't think WES ever got too interested in hydrology early on. They were kept pretty busy taking care of the straight hydraulics. I think the model probably came as close to hydrology as they got up to that time. I can't think of any particular hydrology experiment that would have been assigned to them to do like they did on the Mississippi Basin Model. Sedimentation is a part of hydrology, and WES did a lot of work in that field.

Q: Are there any other things about your experience with hydrology in the Chief's Office that you want to touch on? I've got some more questions here for you, but I thought since we were talking about that. ..

A: Well, I should have been thinking about that in advance, I guess. Rather difficult to come up with anything. I was very fortunate in that I got to participate in all of these international and outside activities that gave me opportunities of traveling and meeting people, and things which I would not have had if I had not represented the office on so many different activities. So that was very fortunate. I suppose that was sort of a natural evolution in that I was Mr. Hathaway's backup; and, as a result of that, I gradually got into activities like the Hydrology Commission of the WMO, the International Hydrologic Decade, and the St. Lawrence River activities.

Q: But you were encouraged by the Corps' leadership to be involved in those professional-type activities, besides the point that in some cases there was actually a Corps position involved. You were encouraged to participate in the International Union of Geodesy and Geophysics?

A: Yes. Yes, you saw those papers that I wrote.

Directors of Civil Works and Assistant Chiefs

Q: I want to ask you some questions about some of these engineer officers who you may have worked with in your time there. We talked some about the Chief of Engineers, but you said you didn't see much of them or you weren't at the level that you saw them. So I'm going to ask you about people who were the Directors of Civil Works.

A: Yes, the Assistant Chief of Engineers.

Q: Yes. James Stratton. He was in Civil Works in 1945-46.

A: There was a big engineering firm that he went to after he retired.

Q: **Yes.**

A: I was thinking that one of the leaders of that firm had a brother that was active in our circle. I started to say it was General Stratton, but it was McCarthy.

Q: No. It was Tibbets, Abbott, McCarthy and Stratton.

A: McCarthy. There was a McCarthy in the Washington circle here. His brother was in the firm. I'm sure I had some contact with General Stratton. Would he have been here the same time as Wheeler?

Q: Yes.

A: Yes. I think at that time, I probably had more contact with General Wheeler than I did with General Stratton. I had some contact with them, but I don't really remember much about it.

Q: Okay. He was replaced in '46 by Peter Feringa. Feringa was Civil Works until 1949.

A: I don't think I had much business with him.

Q: Then he went to the Lower Mississippi Valley Division.

A: How do you spell that?

Q: F-e-r-i-n-g-a. Feringa.

A: Yes, I just don't--that's **funny** now that I don't--I remember General Stratton, but I don't remember Feringa.

Q: Well, Feringa apparently had a reputation as a very good engineer, a technical person.

A: You say he went to MRC?

Q: Yes.

A: Did he go to the Panama Canal then?

Q: I don't think so. I'd have to check and see.

A: Well, it doesn't matter.

Q: I do know that he did not get along with Lew Pick.

A: I just don't have any. ..

Q: We mentioned already Bill Potter.

A: Yes, yes, I remember him. Of course, I think in all of those cases, we would have had, in the branches, we would have had more contact with the executive officer than we would have with the assistant chief.

Q: What I'm really looking for is any observation that you have on their style, or the impact they may have had directly on civil works.

A: I'm afraid you're not going to get much.

Q: Well, I'll persist in this anyway, because if you can think of anything that comes across your mind. ..

A: Yes, yes.

Q: He was replaced in 1951 by Claude Chorpening.

A: That one. ..

Q: He would have been there with General Sturgis, when Sturgis served his first year as Chief of Engineers.

A: Yes. No, that leaves me cold.

Q: Okay. One you do know is Emerson Itschner, who was Director of Civil Works from '54-56, before he became Chief.

A: Yes. For some reason, I guess because of the Columbia River activity and the IJC. Let's see, the IJC set up a Columbia River Unit, I don't know if it was a board or . . .

Q: Authority or River Basin Commission?

A: I think Gene Weber was a member, but Itschner came from that area, didn't he, or he went there?

Q: He went there.

A: He went there, yes.

Q: He retired to Portland.

A: He died just recently?

Q: Yes. He'd been North Pacific Engineer, I think, before he came in.

A: Before he came in, yes. Because of the work on the IJC, for some reason or other, I felt that I knew Itschner more than anyone that we've spoken of so far. We decided that he was the one that I flew up to the Seaway dedication on his plane with Mary.

Q: When he was Chief?

A: Yes.

Q: Because he was Chief from '57 to '61.

A: Oh, that's when he was Chief rather than when he was in Civil Works, yes?

Q: Yes, '61, right. I think he was a deputy before he became Chief. I think he was Itschner's Deputy Chief of Engineers. Then he replaced Sturgis, I mean. He replaced Sturgis.

A: Yes. Was he probably either the Assistant Chief of Civil Works or Chief of Engineers when Colonel Whipple was Executive.

Q: Whipple is the guy apparently that pushed the computerization program, and he's the one that was involved with John von Neumann.

A: What?

Q: He was the one involved with John von Neumann. Remember you talked about Von Neumann? Because Whipple knew, he was associated with people at Princeton.

A: I see. That's where he knew Von Neumann.

Q: And he got Von Neumann apparently to come down and do that seminar you were talking about.

A: Yes, yes.

Q: Because after he retired, he went to Princeton to teach civil engineering.

A: Yes, I had some contact with him because he was active in the government passed legislation that gave money to the Geological Survey to parcel out to the states that set up Water Resource Centers. I think Whipple was in charge of New Jersey's Water Resource Center at Princeton.

Q: He was the head of their Department of Natural Resources or something?

A: Yes. An ASCE foundation sponsored research seminars in various fields. Week-long meetings were held in the summer at universities with quarters available and decent weather, mostly in New England and on the West Coast. There were a number of such meetings on water resource research. We worked in the mornings, at leisure in the afternoons, and worked again in the evening. Colonel Whipple, then General Whipple, was active at these seminars, which Mary and I attended a number of times.

Q: Anything else you can remember about Itschner, whether it's Civil Works or as Chief of Engineers that you dealt with him beyond the St. Lawrence Seaway.

A: No. I am thinking of an officer. He was assistant, or what do they call the number two man?

Q: Deputy.

A: Deputy Chief, Robbins, do you remember that?

Q: Thomas Robbins, World War II.

A: Yes. When they were designing the St. Lawrence Project, he was on a design board. I don't know whether it was an IJC board, or a board set up by the power entities, but Robbins was on one of the boards that reviewed the design of the project. He had two sons, of course, and one or both of them were in the Corps. I knew the boys casually, but I knew General Robbins. I just don't know how I got acquainted. Probably partly due to the St. Lawrence.

After his first wife died, he married a secretary from the office whom we all respected. I'm trying to think. We'd been at some function. I guess it was somebody's funeral, and on the way to the cemetery, his car broke down. I

Water Resources: Hydraulics and Hydrology

happened to be going by, so I don't know whether I knew who it was or not, but I stopped and gave them a lift-to where they wanted to go. I never did get to the cemetery. But they never forgot that. They really thought that was something special, that I stopped and helped them out on the way to the cemetery. So from then on we exchanged Christmas cards and everything. Of course, the last few years, I've kind of lost track--I think the boys, I don't know whether they both died or not.

Q: I know the General has been dead for a long time.

A: Yes.

Q: I don't know if the boys--I'll have to check and see.

A: I think at least one of them has died, and maybe both of them even. Oh, that was the one thing that I meant to mention you know, Gail Hathaway had two boys, twins. He was really proud of those boys. They were both successful, one of them with a large corporation, working for some big company. I forget what the other one did. But Hath used to always brag about both of those boys making more money than he was. The sad thing was they both died years before he passed on. They died in their thirties, I guess. But anyhow, I hadn't mentioned that.

Q: Sort of tragic, isn't it?

A: Yes. That hit him pretty hard. But anyhow, General Robbins, I always liked him.

Q: Okay. After Itschner was John Person from 1956-59.

A: From what?

Q: Jack Person.

A: Oh, yes, yes. I don't have any particular remembrance of him. Of course, I left in December of '66.

Q: Okay. The next one was '59-'62, Bill Cassidy. You knew Cassidy.

A: Yes, he must have been in, you're talking about when he was Chief?

Q: Director of Civil Works first.

A: Oh, Civil Works.

Q: Then he was Deputy Chief and then he was Chief.

A: When was he Chief?

Q: He was Chief from '65-'69.

A: Oh, so I was wondering how I ..

Q: He became Chief like about a year-and-a-half before you retired.

A: Well, for some reason or other, and I don't know why, I got to know him when he was in Civil Works. I remember taking him home from the airport one time when Mary picked me up. I don't know why I felt I knew him better than the others. I always liked him. I don't remember any-4 was trying to think if he was involved in that Florida project that they're now redoing. I was sent down there to help the district when they were designing the streamlining of the river project.

Q: Okeechobee?

A: Yes. We were straightening the channel of the Kissimmee and St. Johns Rivers, speeding it up and everything. Now we're just trying to reverse the conditions. I saw something the other day that was crazy. These environmentalists! The way it is now, there's one place that they want to put back into a flooding condition, but the environmentalists won't let them because there's some bird or something in there now. It came in after they built the project, that they don't want to disturb it.

Q: So what did you think of that project when you went and looked at it?

A: Well, I tell you, frankly, I didn't have any overall thoughts about it. The hydrology, the hydraulics people, had a job to do and we just did it. I don't think I had any feeling, or knowledge, or concern about the authorization, or whether the construction went one way or another. There was a given objective, and we met the objective. I mean the objective may have been wrong, but that was set by Congress. So all the district was doing was building, designing, and building the project to do what was desired, and it did do what they wanted it to do, but it did it too well, I guess.

Q: Well, that's the problem of an organization like the Corps when it responds to political mandates.

A: Yes.

Q: Even though it has to establish a procedure to analyze and decide upon projects, the political powers that be still are, can get stuff done, as you well know. The views of the population and of the engineering community have changed over time on what's good engineering, what's beneficial engineering.

A: The public gets into everything more now. I guess anybody that wants to do anything now, if he's smart, he gets everybody, even though he's going to go ahead and bypass them, he has to give everybody a chance to put in their two-cents worth. Apparently, that does make people happy, I guess.

Q: At the public hearings?

A: Yes.

Q: Of course, you left before the big environmental movement hit the Corps with the NEPA and all of the consequences of that.

A: Oh, yes, yes.

Q: You were out of the target area, so to speak.

A: When I read what's going on now in all of this reorganization and everything, I say to myself, "Thank God, I'm not in this."

Q: Well, it's sort of clear to us that they don't know where they're going, from what I can see. What they're going to end up doing, as an old Deputy Chief of Engineers told me, they'll just reinvent what used to be there at one time before. There's no new ideas coming up even though they think they are. You go back in the Corps' organizational history, and you'll find somebody one time or other thought of that.

A: Oh, yes, yes.

Q: But these guys have to think that their. ..

A: Something new.

Q: Something brand new.

A: Reinventing the wheel, huh?

Q: Yes, that's what they say. You're right about that. After Cassidy was Robert MacDonell.

A: That I. ..

Q: Jackson Graham?

A: Of course, General Graham was--I feel like I knew him. I'm trying to think why. I met a lot of generals while they were on the Mississippi River Commission and the Model Board. I know what he did after he retired. But I felt like I knew him before he retired. I don't know whether we were on some trips together or not. Every so often we'd fly out over a flood zone, but I don't think it was that. But anyhow, I always liked General Graham.

Q: And then when you retired, it was Walter Leber.

Water Resources: Hydraulics and Hydrology

A: Yes. He was, let's see, he's the one, did he come in from North Central Division?

Q: I'll have to check.

A: Well, anyhow, he's the one in that picture.

Q: Your retirement picture?

A: On the St. Lawrence, which meant he was division engineer up in Chicago.

Q: He's also in your retirement picture with you.

A: Oh, wait a minute now. I'm confused--Bachus was the man.

Q: Walt Bachus?

A: Yes, in Chicago. Leber was the one that gave me--he was from ORD and the Deputy Chief then, wasn't he?

Q: He was the Director of Civil Works.

A: Oh, yes, that's right, yes. That was my retirement.

Q: Right.

A: I'm trying to think. Some of the Chiefs, after they've been Chief of Engineers and head the Mississippi River Commission, they end up as Governor of the Panama Canal. One of the ones that I knew was down at the Panama Canal when Mary and I were down there on a trip. We stopped in Panama City for a few days.

Q: I think Potter was.

A: Probably was, because it was somebody I felt that I knew well enough to make a contact.

Q: I think it was Potter.

A: Yes. We were probably on our way to Bogota. I had a half a dozen consulting jobs in Bogota. Ingitec was the name of the engineering company.

Q: Well, I'll check that.

A: Well, anyhow, I called the Canal office and the Governor was away, but whoever was acting for him was very friendly-and it may have been somebody I knew, too. We were invited to some reception they were giving. I always remember that.

Major Projects

Q: Do you remember any of the major projects besides the St. Lawrence that you may have worked on?

A: Well, of course, the Pick-Sloan.

Q: We talked about that. Those were a lot of large pieces of work there, Garrison and Oahe.

A: Yes, I remember those were tremendous projects. And, well, of course, the Columbia River. Los Angeles always had a lot of projects in the mill for their flood control, and after they authorized water supply in Corps' reservoirs, they started putting water supply in some of the projects.

Q: Did those flood control dams in Los Angeles present a problem because they were dry most of the year?

A: Yes.

Q: Did they cause you more difficulties to forecast those things because of the runoff and the nature of the terrain?

Water Resources: Hydraulics and Hydrology

A: Well, I don't know. The big problem was the debris. In other words, whenever they had a heavy storm in those gullies and everything, the debris was always a major concern. It's pretty hard to predict how much of that you're going to get when *designing them and during operations. Generally, I guess, in their life, there was enough allowance for it and it hadn't really caused too much trouble. I suppose as time goes on, and maybe even now, some of them have been filled up quite a bit.

Q: I think they clean them out all of the time.

A: Yes, some of them which are primarily debris dams. Since they're dry part of the year, why they can do that. On some of the dams I worked overseas on, it was always a concern as to how much reserve capacity was needed. Some of them they tried to design so that at a certain time of the year, they would let a fair amount of water through the lower conduits and try to get rid of a lot of the sediment. There was always an argument whether you could accomplish that or not.

Q: I was going to ask you about the problem of contaminants or polluted materials in the sediment in the dam because that's something that Verne Hagen talked about becoming a problem for the Corps during the environmental era. But when you figured, you were doing your estimates, how much did sediment figure into your calculations on regulating the reservoirs?

A: Well, there were fairly definite criteria. Of course, I don't mean as to estimating. They had to use procedures. I don't mean that those procedures were definite as to estimating the amount of the sediment. But having made an estimate, well then the requirements for providing space for it were pretty clean cut and everything so that the design just went ahead.

Another project that Hathaway pushed was to get the Corps and other agencies that had dams to establish permanent surveying facilities so they could measure the amount of sediment that was actually deposited in the various projects. I'm sure the Corps is still doing that periodically. The subcommittee on sedimentation coordinated the program and has published a number of reports. As each dam was surveyed, why the data would be compiled and published. That was a major activity of the sub-committee on sedimentation. Hathaway was one that was able to make sure that the field offices would establish the markers and do these surveys from time-to-time. It took money to do it, and they'd have to budget for it.

Q: Did Hathaway have very good contacts in the Congress? I mean on the staffs of the committees? Did he have really good contacts?

A: No, I don't think he worked on that end of it very much. That was up to Tofani and the others. I don't know whether Hathaway did any Congressional work. In the beginning when we asked for these funds for installing the recording rain gauges all over the country, setting up the hydro-met section in the Weather Bureau to develop our probable maximum storms, and transferring funds to the Geological Survey for installing and operating stream gauging stations, he certainly sold the Chief's Office on it. He probably testified in the beginning when I wasn't knowledgeable, but I don't recall him getting involved. He would have been good at that.

Q: I was thinking he developed a lot of programs, a lot of initiatives.

A: Oh, yes.

Q: I was thinking, he may have had somebody up there who was. ..

A: Well, of course, Bousquet went up there. And, let's see. .. There was somebody. I saw another name, Joe Brennan, on there that went up to the Congress from our office. They might have helped.

Q: Because a lot of his programs seemed to be interagency initiatives.

A: They involved a transfer of funds to other agencies, yes. The other agencies then, I don't know whether they also showed, I supposed they showed it in their budgets, too, and defended it in effect one way or another. I'm not sure just how that worked, as far as the other agencies were concerned. But the money was appropriated definitely for transfer. There wasn't any variation after the budget was prepared, why, the amount involved was specific. It was transferred.

Major Changes in the Cops of Engineers

Q: Okay. Let me ask you. In your time in the Corps of Engineers, in the '50s and '60s especially, what were the major changes in hydrology that in its use in the Corps?

Water Resources: Hydraulics and Hydrology

A: I don't think the model, the mathematical models, they certainly weren't prolific in the '50s. I suppose by the '60s, a lot of people like Ray Linsley, I mentioned, and some people in the Geological Survey, and Roy Beard out at the Hydrologic Engineering Center, they were all developing mathematical models to do the things we had been doing more by hand previous to that. I suppose that was a major change. Of course, the only way you could do that was to use computers. I guess that was just a normal development. Probably the same thing was happening in every other field also as the computers became more usable. I've forgotten when the Hydrologic Engineering Center was established.

Q: Early '60s, I think, wasn't it? '62, '63, '64, something like that.

A: I thought it was in the '60s. It was after we had the meeting with Von Neumann. That must have been back in the '50s. But the Hydrologic Engineering Center, that was around the low '60s or late '50s. They were in the forefront of that change that was going on.

Q: Now, in an area like hydrology, computers were very critical because of the large amounts of data you had to analyze?

A: Just like I think I mentioned when we were studying regulation procedures for Lake Ontario, to run it through 100 years of data, even though it was on a monthly basis, doing it by hand was a horrible job. Whereas the Canadians started developing computer programs for it where they could do it a lot faster than I could. It's just like when I was in Paris I decided I wasn't going to learn French. I never did get very deep into being able to program, to write programs for computers. I just never really had any opportunity, and I didn't have any burning desire or something like that.

Q: So you had somebody else do that for you, right?

A: Yes. Well, the people that were good at mathematics--a lot of problems, hydraulic problems maybe more so than hydrologic problems, such as the flow of water. The theory was available on the flow of water and the mathematics were available, but it was too complex to solve by hand. But as the computers became available and the people were able to solve these equations with the computers, why, then they did begin to become a little more scientific, use more scientific procedures in solving water problems. Gosh, today when I read these publications and stuff of the things

that they're writing the mathematics for and then solving with computers, it's out of this world.

Q: They can do an awful lot, can't they?

A: Yes, of course, sometimes it's not all that good. I mean sometimes the mathematics is not right. There's that saying, what you put into computers is what you get out. The main trouble is you don't know whether something has gone wrong internally. Take hydrologic problems such as forecasting. Unless you have some practical knowledge and are able to recognize when the computer is giving you a bad answer, you can really go haywire.

Q: We found that out with the Intel pentium chip.

A: Yes.

Q: Of course, those were calculations to the what, ninth decimal point?

A: That was in a limited area; but it was there nevertheless.

Q: How about other Federal agencies beyond the Corps? How did they mature in their use of hydrology?

A: I think everybody sort of came along together. The Weather Bureau started setting up river centers to replace the local offices who maybe had only one river basin. The river centers developed programs for flood forecasting. But I think I mentioned when there was a large flood, the center at Harrisburg, which includes the Potomac River and the Susquehanna River, got flooded out and lost their computer. All of the agencies had competent people. There were probably people from time-to-time that led the way, but I don't know of anyone that fell way behind.

The Soil Conservation Service was always active in all of these interagency activities. They still are. I still see peoples' names writing papers and stuff. They developed a procedure for estimating the amount of runoff from rainfall and had a family of curves and it has survived pretty well. I still see people referring to it in articles. Each department on the Interagency Committee had a representative on the subcommittees. We received permission for the TVA to be on the subcommittees.

Water Resources: Hydraulics and Hydrology

Departments like Agriculture had one official member of the subcommittee that usually was rotated among the SCS, Agricultural Research Service, and the Forest Service. Representatives of all agencies could participate in the meetings. Also representatives of other interested agencies could participate. We had someone from the Weather Bureau. Were they in Agriculture then?

Q: Commerce, weren't they?

A: Yes, Commerce. Commerce was a member of the main family. But anyhow, the TVA had a representative on the subcommittees, and we would meet down at Knoxville, occasionally. I'd spent a couple of years or a year and a half at Knoxville.

Q: Like you said, the TVA was always very busy with the flood forecasting business because of all of the dams they had.

A: Yes, yes. Well, anybody that operates dams has to worry about that. They have large tributary dams like Norris. Norris was the first one of the large storage projects. All of the main stem dams don't have any storage to speak of, so they have their gate operations. They have to open up their gates as the flow increases so that they don't cause any troubles. So they were in the business fairly early.

Q: How about non-Federal institutes, such as universities and these private research labs and private firms?

A: As far as what?

Q: Their contributions to hydrology. I imagine the universities have a lot of theoretical development.

A: Well, the universities became more active after the state water resource centers were established. The universities, I believe in the early '60s, organized a "Universal Council on Water Resources Research." They are still quite active. In the earlier days, of course, at the professional organizational meetings, there were always university people giving papers and participating. Not necessarily real early in the game, but some of the universities began being interested in having hydrology, teaching hydrology. That started rather slow, I think. I don't remember which

universities led the way, but there were a number of universities started developing hydrologic programs in their courses. I don't really remember which ones led the way.

The AGU was always heavily weighted with university people. I'd say the majority of the members were, maybe still are, university people. Hydrology was alive, even back in 1934 when Robert E. Horton was on the scene in AGU. I'm not sure where it was on the organization chart. Now it's a section just like everything else. Sort of equal among ten or twelve different units. I joined the AGU in '35, and started going to the meetings since I was in Washington on that USGS study. The attendees were mostly university people. But as I mentioned before, one of the men that was active in the hydrology was the chief engineer of the Pennsylvania Water and Power Company that had a couple of dams that they operated and was interested in hydrology.

There were some private companies that had, I suppose they'd be consulting engineers, hydrologists on their staff. They would have probably been in the AGU early in the game. Later on, the big engineering company on the West Coast. ..

Q: Bechtel?

A: Bechtel, yes, they've for years had several fellows that I know out there as head of their hydrology. They get involved in building dams and stuff like that where they have to prepare spillway designs. I suppose a lot of projects require discharge computations of one kind or another. One man there for awhile was from the TVA. I have known the last three men that were out there in charge of their hydrology divisions. I'm sure there are others.

Any large consulting company that did work in water resources would have gradually had to have a hydrologist, or someone capable in that field. They had hydraulic people, too. It may be that in the beginning like every place else, hydraulic people did their hydrology for them.

Q: Then the demand built up so that it went back to the universities to develop hydrology as a field of study. A more legitimate field of study because of the demand for the use of their services.

A: Yes, yes.

Q: Well, that's about enough for tonight, I think. We've gone pretty far, and I do want to come back again. I have some things I need to return to you anyway.

BG William Whipple Jr.

Q: I want to start by asking you if there is anything else that you wanted to talk about of the many things we've talked about? Was there anything that you can think of that you wanted to talk anymore about from your Corps days?

A: I'm not really sure about everything that we covered. But something came to mind. You remember Colonel Whipple, who was pushing the computers. I don't know whether he's gotten credit or blame for it, but he was one of the first people that started a new view of stream pollution.

After he left the Corps and was up in New Jersey, he pointed out and illustrated that much of the pollution in the streams was not from the sanitary sewers and treatment plants, but it was from the non-point street runoff and non-sewered areas. He established some gauging stations to prove his point. Congress has passed legislation. All of the cities have to develop plans for controlling that pollution, too. It's almost an unsolvable problem.

But, he's the one. I don't know whether he was actually the first, but he was one that really brought that problem out in the open. Everybody was concerned about sewage treatment and everything. He discussed at meetings that the pollution, there was more of it maybe coming from the non-point sources than there was from the sanitary systems.

Q: How much did you get into that?

A: I never did get into that, no.

Q: Other pollution issues. Of course, that was before, you retired before that really came in.

A: Oh, yes. I retired a long time before that.

Q: NEPA.

A: Yes, I think he was at the university when he was doing that research.

Q: Princeton? Was it Princeton?

A: Yes. I don't know whether he's gotten credit for that or not, but he certainly started the ball rolling.

Q: Well, he must have done that when he was with the State of New Jersey in what, water resources or Department of Water Resources, or something he was in?

A: Oh, the Congress set up a program where all of the states established, I think they called it Water Resource Centers, didn't they?

Q: Yes, there was something like that.

A: Yes. Almost every state established one. The Geological Survey budgeted the money for them. Now they're cutting back on that. I think he probably was teaching, too, but I think he was in charge of New Jersey's Water Resource Research Center.

Q: Well, he worked for the State of New Jersey.

A: Yes.

Q: May even have been the Department of Natural Resources or something. I can't quite remember. Now, getting back to your suggestion, I don't know that, as I say, I'm not really clear on what everything, or I don't remember exactly everything we've talked about anyhow, so I don't really. ..

Consulting Engineer

Q: Well, one of the things we didn't talk about was your time as a consulting engineer. That was quite a significant amount of time from 1966, or starting in 1967, but you had done consulting before that.

A: I had done it five, I don't know, five, ten years before. I would take leave. Gail Hathaway got me into a lot of that work in the beginning while he was with the World Bank and then later on, Wendell Johnson, after he retired and was doing consulting work, why, he also got me into a lot of projects.

But most of it was in connection with the spillway, the hydrologic spillway design of large dams all over the world. I think I must have worked on six or seven down in Columbia out of Bogota for Carlos Ospina. He had an engineering company of his own, Ingitec, a pretty big company. I guess, probably, my contact with him was probably through Hathaway. I'm not sure. They retained me a number of times to either develop or review their spillway designs. Mostly it was to develop them and that's when I formed a partnership with Dwight Nunn. I don't know whether you've run into his name or not.

Q: No.

A: He was in our office, in the Chief's Office, and then he transferred to the Nuclear Regulatory Commission, and he was a principal hydrologist there. When we formed our partnership, he had retired from the Nuclear Regulatory Commission. We got a lot of work from the Nuclear Regulatory Commission, too. I had been working in South America before he retired from NRC, but he had meteorological training during World War II. After the war was over, he was in the Chief's Office. So he did the meteorological, he developed the probable maximum storms and then I would develop the floods. They would use these for the spillway design studies then.

Q: Were there any unusual conditions you had to consider in those South American dams?

A: What about them?

Q: Any unusual conditions, hydrographic conditions?

A: No, except most of them were in pretty rugged country. Carlos Ospina, who's still active, I guess he's an associate member, I see him at the meetings of the National Academy of Engineering. He totally subscribed to the idea of using these maximum conditions for the spillway design to be sure that the dams would be safe. A lot of people didn't do that, but he was one that did.

It's an interesting thing. One of his structural consultants was Barry Cooke. A couple of months ago I got a phone call from him in San Francisco. Dam building has sort of quieted down in Colombia like it did here. But apparently, they were going to work on another project, and, at Ospina's request, Barry called me up and wanted to know whether I was available. I told him I just wouldn't be able to do it. I had retired and I wouldn't be able to do a good job for them. But I thought that was real interesting after, I guess it's been ten years or more since, even probably more than that since I'd done anything for Ospina.

Q: That's a nice compliment, though.

A: Yes, yes. It made me feel good.

Q: Was there anything about the designs of any of those dams that was different from the way the Corps would do it, the Bureau of Reclamation?

A: No, I don't think so. A lot of them were concrete, and Ospina was right up on the top of things. He was active in the International Commission on Large Dams, an international organization of dam builders that meets periodically. I guess that's probably where he met, where he got acquainted with Hathaway and Wendell Johnson. But I don't know of anything--there may have been structural problems, but I don't recall getting involved in them. He was a great believer in doing everything right. It was real nice work because quite often we'd go out and visit the dam sites and see some real rugged country.

Bogota is right at the foothill of the Andes. We had to go up over those to get back up into the country. There were areas even then where it wasn't safe to go in Colombia because there were always some rebels. I don't know whether they were in the drug business then or something else. But there were places that you couldn't go safely in Colombia thirty years ago.

Q: I guess that's occurring more frequently now again, too. Beyond the drug situation, it's also political.

A: Oh, yes.

Q: I think leftists guerrillas. . .

A: It's gotten terrible.

Q: **Did** you work in any other South American countries?

A: No. I did a job in Mexico. I reviewed a job in Mexico once, but I didn't even go down to Mexico. I think it was mostly reviewing a design and someone else had done on a dam in Mexico. The different projects are listed in the resume I gave you.

One of these, one job in South America in Colombia there, we went out by jeep to a camp they had, and then from then on, we went on horseback. They wanted to know whether I was a rider. Well, I had ridden horses, but not very much. We went on horseback from the camp to the dam site. During the night, someone took off with some of the horses. I don't know whether they stole them or just what happened. So when we went to the dam site, some of the local help didn't have horses.

I remember when we came back from the dam site, I guess he was one of the natives there that was taking care of the horses, he hung onto the tail of my horse and the other people were sort of ahead of us. They didn't slow down a bit so we were going fairly fast. That chap hung onto the tail of that horse, and he was really flying through the air to get back to the camp.

One of the nice jobs, it was one of the first ones I got after I retired, I was at an International Union of Geodesy and Geophysics meeting in Helsinki. I got a note there asking if I would stop in London on the way home, which I did. My wife was with me. She came on home, and I got off in London. This was for a British firm that had the World Bank contract on the Roseires Dam out on the Blue Nile in the Sudan. It's been built, too. They raise a lot of cotton there and they need lots of water--this was on the Blue Nile just shortly after it comes out of Ethiopia. They set up an international panel on flood discharges consisting of A. Bleasdale, a

meteorologist, Thomas Thompson, a geologist, and myself. We spent about three weeks in the field. So we had quite a trip there and they really took care of us.

We spent a week in Ethiopia, because that's where most of the water came from out of Ethiopia into the Sudan. The Italians had taken over Ethiopia for a number of years. They established a lot of rainfall stations and not so many stream gauging stations, but a lot of rainfall stations. So there was a lot of rainfall data available. Some of it was published, too, and we collected some other data, too.

We had an appointment to see the Emperor Haile Selassie. Then the party broke up and some of us went one place, and some went another, and so they canceled the meeting. But previously, I guess it was in Helsinki, that my wife and I had met a Jesuit who was from, what's the capital of Ethiopia?

Q: Addis Ababa?

A: Yes. This Jesuit was in Addis Ababa and apparently he was Haile Silassie's right-hand man on weather forecasting, so I looked him up when we were in Addis Ababa and we had him in for dinner. He told us, I forgot what the story was, some interesting story about how he had gotten Haile Selassie's attention and became his favorite weather forecaster.

Thompson, a geologist, was looking at field indications of past flood levels to get an idea of the historic, or non-historic events that might have happened. He was scheduled to go on a helicopter trip. The day before he was to go, the helicopter was out on some other job and it crashed and killed one of the pilots and one of the passengers. So he figured maybe he was lucky he just missed it by one day.

I don't like helicopters, although I flew from Athens all of the way, I suppose it must have been 200 miles up to the northern part of Greece to see a dam site in a military helicopter. There wasn't any landing place for a regular plane and because of time schedules, they took me up in a helicopter. But that's diverting. But anyhow, we had quite a nice stay in, I'm trying to think of the capital of Sudan.

Q: That's Khartoum, isn't it?

A: Khartoum, yes. We stayed at an old English hotel which had a view out over the Nile River. Some places we'd only use bottled water, and other places we could use the regular water. But I guess we were using bottled water in Khartoum. We were

sitting at the bar one night and there was sort of a dividing wall, between the bar and the dining room. The waiters would come to the opening there at the wall to get drinks and stuff for the dining room. Several times the waiter took the cap off the bottled water and then rubbed his hand across the top of the bottle, so I figured they weren't gaining very much by having bottled water.

Q: Cleaning it off, huh? How good was the historical data that they had on the rainfall in a country like Ethiopia?

A: On the rainfall itself? I forgot when the Italians took over.

Q: '35.

A: '35. There were some records predating that. But they were just the routine records. I don't remember any extraordinary events that had been recorded. Thompson developed some estimates of historical flood discharges based on his field investigations. Bleasdale prepared the estimates of probable maximum rainfall and I computed a spillway design flood. Our results were presented in a joint report.

We went on a safari up to the dam site. We flew to the nearest airfield, and then we were met by our safari group, and boy, I'll tell you it was something. There were two or three of the Sudan officials with us plus the three consultants. We must have had thirty or so in the crew, waiters and helpers, and boy, I tell you, it was really a first-class safari. We were out in the wilderness, but we had linen and silverware, and everything.

The first thing we did when we got up near the dam site was to go and visit the local tribal chief. It was the thing to do, I guess. We had an audience with him at his village there. He had a chair. He had someone with operating a fan and everything over him. This guy was quite interesting, too. We were camping on the banks of the Blue Nile. We saw a lot of native animals around. It wasn't safe to go swimming. I guess it was rhinoceros or hippopotamus, but there were some of them around.

Q: Something there.

A: One evening, we could see a big fire. One of the native villages burned up across the other side of the river. In that country with a lot of rainfall and everything, the

grass grows real high. At the villages they clear an area around so that if they have a fire, it won't get into their huts. But there was always some funny story about this fire. You got the impression they felt that someone had started it. It wasn't an accident. I don't know that anybody got hurt. But you could really see the smoke and flames. But that safari was quite a deal.

Lake Barcroft Dam

In addition to these large dam jobs from time-to-time, I'd work on some local problems for somebody. I guess it must have been spread out over 10-15 years, I was involved in the problems of the Lake Barcroft Dam. I don't know whether you're familiar with that or not. There must have been during that period of time, four real large storms that hit that area. The first couple of jobs involved lawsuits by people downstream. Holmes Run goes on down through Alexandria past the big Army installation.

Q: Cameron Station?

A: Cameron Station. This creek runs right on the edge of Cameron Station before it becomes Cameron Run. They've rebuilt that whole area. I haven't been down to see it, but there was a railroad trestle there that blocked the flow of the creek. When there was a big storm, why, the water would backup and almost overflow, sometimes it did overflow the railroad tracks. It would back up a side channel in upstream of the railroad tracks, and there was development in there. Those people sued Lake Barcroft saying they had caused their damage.

The dam at that time had wooden gates that were hinged at the third point so that they would tip just when the water overflowed. People would sue and say that they opened up the gates improperly and flooded them downstream. The work was for the law firm of Boothe, Dudley, Koontz--the man I worked for was Armistead Boothe. The law firm, started by his father, who had been a high state official.

Armistead is one of the few lawyers that I respected. Armistead, he was one, and I've known one other that I admire. But he was the defending attorney on this Lake Barcroft stuff. He always wanted to know the truth. He didn't want any bias one way or the other. He wanted to know what happened, then he would decide whether he would use me or not. But he never wanted you to fudge your figures to favor his lawsuit. He wanted to know what, to the best of your ability, what the situation

was. I don't think that's true of a lot of lawyers. But we won. I think we won the first lawsuit.

Then the second lawsuit, there was another flood later on. They claimed that the dam tender opened the gates all opened at once. The gates were set so that the tilting elevation was at several different levels. They were wood gates with hinges and with seals on the edges of the gates to make them watertight. The friction on those gates, it would be different on every gate.

The way they were supposed to work, when the water got to a certain level, a gate would tip and then the water would drop. When it worked up again, when it got to a certain level, supposedly another gate would tip. But the people suing, their attorney claimed that the dam tender had tipped them, or they had all tipped at once, which sent a flood wave down stream.

Ordinarily, witnesses aren't allowed in, during the proceedings. But Armistead always got the permission of the judge to let me sit with him in the courtroom. When they were picking the jury, one of the prospects was an engineer. I don't remember what kind of an engineer he was, but they thought that would be good to have an engineer on the jury. So he was on the jury. We lost the case.

Armistead knew everybody in Alexandria. If he'd go down the street, he knew everybody and he was an outgoing person that was friendly and polite to everybody. He found out from the bailiff, that this engineer had insisted that if those gates were designed to tip a certain way, they would absolutely tip that way. There'd be no friction or anything. It wouldn't make any difference on these gates. So he argued that they would all tip at once. I guess that was the reason we lost the case.

Then, at that time, the Alexandria water supply was owned by a private company out of Philadelphia. The dam there on the Occoquan, they raised the dam and made a much bigger reservoir, and so they had to go around and settle all the land titles. There were a lot of lawsuits in connection with their taking of the land. I was in on some of those cases with Arrnistead Booth.

The Corps has very rigid rules. They only take what they need. But the water company would buy a whole piece of land. They had a lot of land around that reservoir they didn't need. Armistead and I kept talking about buying some of that surplus land, but he was too busy to do anything about it. Then it got to the point where, I guess they figured it wouldn't look right if the water company sold their attorney a piece of land like that. But that land is being used now, all around that reservoir.

Q: I imagine it's pretty expensive, too.

A: Yes, I imagine so. We looked at several, 200-300 acre pieces that the water company had bought. It was easier for them, I guess, to buy the whole property than it was to buy a piece of it.

Another cast was Four-Mile Run, which starts in east Falls Church. Its drainage is from Arlington and Fairfax Counties and Alexandria. It runs down along the edge of Alexandria. It's almost all Hispanic now I think. It's as you go into Alexandria from Arlington and that area got flooded badly a number of times. The Corps finally did a big project on it.

But there part of the problem, too, was that it goes underneath all of the railroad tracks there into the Potomac right adjacent to the airport. The water would back up from those openings underneath the railroad tracks and it would flood that section of Alexandria. So a number of the citizens, the property owners there, hired Boothe to sue the city because of, I guess primarily of negligence. The case was heard in court and we won the jury decision. The dam judge reversed it.

Armistead still had a little money left over so he appealed it to the Supreme Court. But they backed up the judge. I saw that Supreme Court ruling, and I never saw anything so stupid as the justification they used for supporting the judge overriding the jury. From then on, I've always wondered about the Virginia Supreme Court, just what they were, and what good they were.

Q: All political appointees, right? What was your most challenging consulting job?

A: I think the most, maybe I could think of others as challenging, but the most interesting was Lake Barcroft. Finally the dam abutment washed out. There were a lot of lawsuits about that. I had, a friend that was a state senator and had been the majority leader. He is still living, but retired. He's a lawyer, and has a law firm.

On that dam washout problem, Armistead Booth was not involved. This other law firm was part of the defense. So this acquaintance of mine, who was a partner in the law firm retained me as a consultant on that dam failure. It was, I don't remember the year, but it was that storm where they had 15-16 inches of rain out around in that area there. Whether it was '71. ..

Q: Was that when Agnes, Hurricane Agnes. .? That was '72.

A: So I had to do a lot of flood routing and what not to make various estimates of what would happen downstream. The way the dam was operated, it didn't really seem to have added much to the flooding downstream because most of the flooding was due to the backup, these railroad trestles that backed up into that same area again. They also hired some other engineers who were more into the computer- business. I did my stuff by hand and they did a lot of flood routing on their computers. They settled before it went to trial.

They paid the plaintiff's legal costs, so the case never went to trial. But that Lake Barcroft thing, that was something. From the very beginning I had lived close by and when there was a heavy storm or something, I'd go out there, actually during that heavy storm I was out there. Then, right after, I was out there, got some flood marks and stuff and did a little surveying that later helped my computations because you needed to know how high the reservoir got. You needed to know the size of the washout section of the abutment to figure out what went out. I really enjoyed that.

The Most Complicated Job: Bangladesh, Pakistan, and India

Getting back to what was the most complicated. Probably at the time I thought a lot of them were, but I don't remember any as being usually so. I'll tell you what's running through my mind. In the later years, many of my jobs were in Pakistan through the World Bank. The World Bank requires anybody they loan their money to for a large dam, why they require them to retain a highly reputable engineering firm. Then the firms always set up consulting boards.

The work started first in what was then East Pakistan and now Bangladesh. At that time, when it was East Pakistan, there was a firm operating out of a big city in Pakistan. ..

Q: Karachi?

A: Yes, Karachi. That's where their headquarters were located. Their initials were ACE, Associated Consulting Engineers. When they set up these contracts, they generally have an international firm, which often work with a local firm of engineers. This ACE was the Pakistani company. The head of the firm was in Washington.

Q: I'm going to stop you for just a minute.

A: So Mr. Azeemuddin called me, and I went down and talked to him down at his hotel. He was really a character, but we seemed to hit it off pretty good so he saw to it that I got on the board of consultants that would be handling the consulting part, act as the consultants for his company. His was the only firm involved. There may not have been an international company at that time. He was sort of international. I think his company handled the whole business. They were studying a possible dam site on the famous river that just recently they had floods there again.

Q: The Ganges?

A: Ganges, yes. And the capital there of. . .

Q: India is right on it, I think. New Delhi?

A: No, it's Dacca then, Dhaka now. When the river got high, the whole city would be surrounded with water. A later project that I was on was studying the idea of building a levee around the city with a lot of pumps to pump in and pump out. I don't think that ever got off the ground. But anyhow, at this time, they were studying the possibility of a dam on the Ganges just below the Indian border. So I had several, two or three, trips to East Pakistan at that time working for ACE and the World Bank. One time we were there, it was the time when they had a major disaster.

Dhaka is quite a fair-sized city, and there was one of the international hotels there that we stayed in. We flew up to near the dam site. While we were out, they had the typhoon on the Bay of Bengal. That was the one that drowned some 500,000 people. It was the worst one they have had in recent years. So we got word that if we wanted to land at the airport should we get back. So we went back before we planned and landed at the Dacca Airport.

In the newspaper, I saw an Associated Press item that said that a World Bank consulting team was lost in the southern area in this typhoon. That they had been down there and were unreported. As soon as I saw that in the paper, I knew my wife would see it here, so I sent a telegram. She heard about it a day or so before she got the damn telegram and it did worry her. She called up Wendell Johnson and

he called Ralph Blour, the man that headed the structural engineering that went over to the World Bank. I mentioned him once before, and I couldn't think of his name. He followed Hathaway over there.

So Wendell Johnson called Ralph Blour. This was on a Sunday, I think. They called the World Bank and as far as they could find out, everyone was okay. I think they got my wife calmed down. Then about that time, she got my telegram. But, of course, what the paper didn't say was that there were three or four different World Bank teams there. There was a bank team down in the area. They were down there checking, working out a project to build better levee protection. In the meantime, they had built some concrete structures. These people were in a boat, but they had gotten to this concrete structure and they were all safe. But that really must have been horrible. It was over 500,000 people drowned.

Q: They've had a couple more of those since then, haven't they? they've had a couple more of those typhoons.

A: Yes, they have, but I don't think any of the recent ones have been near as bad as that one. I don't know whether they've ever done much--there really is not too much they can do about it. Apparently, it's not practical to build the levees high enough to protect them. They have protection for smaller storms, but not for the larger storms.

But while we were there in Dacca, the relief supplies started coming in. They were piled all over the airport, but they just didn't have any organization or facilities to get the stuff down to where the people needed it. It was just stacked up in the airport. I guess, eventually, they did work something out.

The gentleman's name that was the head of ACE was Azeemuddin. He has died. His son is now the head of the company. I still get seasons greeting cards from him. They have offices in other countries where they do a lot of work other than just in Pakistan. But Azeemuddin had a good sense of humor. He smoked. He'd buy a package of some cheap, I guess they were cheap cigars. It wasn't because he couldn't afford something better, but he would have these cigars, and I'd smoke some with him and that always made him happy.

Bangladesh grows a lot of, it's a regular plant, but it could be made into a drug. The natives chew the leaves--I don't know what they do to it to make a drug out of it. But, well, they make hemp, too. I guess that's what they call it, hemp.

Q: Yes, I guess there is something like that.

A: Yes. But he would chew this stuff. His teeth were really discolored. That was just a natural habit that the people had, chewing that stuff. Certainly didn't do anything for his teeth. But he was, he always did right by me.

Q: Which is all that matters in the long run.

A: Yes, yes. As I say, he had a sense of humor. Somehow or other we struck it off pretty good. But after Pakistan split off, East Pakistan became independent as Bangladesh, why, then we started doing some jobs in Pakistan itself. We worked on a dam site down below Tarbella, the big dam. They were finishing Tarbella, but there was still one possible additional dam site downstream that they were trying to get the World Bank to finance. It was a real difficult site for the structural engineers.

I remember one time, my wife was with me there, too, and we were not operating out of Karachi, but we were operating out of the city of, in the upper country. ..

Q: Lahore?

A: Lahore, yes. One of the consultants was Ed Fucik from Chicago, the Harza Engineering Company in Chicago. He was one of the U.S. members of the board. His wife was in Lahore, too. The Board went on a trip up to the dam site, and Mrs. Snyder got fairly well acquainted with Mrs. Fucik. I think his wife was a Harza and that he was a major owner of the company. A side light--Mrs. Fucik wondered why my wife put a pair of my shoes outside of the hotel room door each night to be polished. Her answer was that people would not know that I was away.

Anyhow, we went on a field trip. They took us by train and pullman cars up as far as they could go and then we went by jeep to the dam site. You wondered how they could find the dam site there. They were working on one, and I think they're still working on it. I don't know whether they got financing, whether they ever started it or not.

But Tarbela, the big dam upstream, you probably don't remember. They had a blowout. The dam was a tremendous large dam. The reservoir was nearly full and a tunnel blew out the whole upper face of the dam. It was an earthen or rock fill

dam. They really were scared. I wasn't involved in that dam, but some of the people I worked with were. Wendell Johnson, I think, was. But they called all of the consultants in from all over the world, wherever they were there because it was nip and tuck just what they had to do to keep that dam. If that dam had washed out, it would have really taken the whole countryside with it. It's a tremendous dam. I think it's 400 feet high. For an earth dam, that's high. I don't know how many thousand feet wide it is. But it's a tremendous dam.

Later on Harza had a consulting contract with Pakistan to study general flood problems. They sent me over there for a month or two. I was never quite sure why they wanted me, but I got interested in some things so I wrote a report on them for them.

But while I was there I decided, and they approved it, so I flew up to Islamabad, which was just getting started then. They had started building their buildings and everything. There was an airport there. That was the nearest airport to Tarbella. They took me out to the dam, and the engineer there took me on a tour down through this tunnel that had blown out and everything. I saw the work they were doing to rebuild it. So that was a little plus. I got to see that dam.

Q: What would have caused that to happen, that kind of thing?

A: I'm sure I knew once or I knew what they thought had happened. I think somebody failed to do something that they should have done in operating some gates. It shouldn't have happened ordinarily anyhow. I mean you have gates on a tunnel, you should be able to use them.

Q: The whole dam, yes.

A: An unusual pressure upstream. So it was not only what happened on the tunnels, but there must have been some weakness in the material on the upstream face. It blew an awful hole in the upstream face of that dam.

Q: Jake Douma did some consulting on some of this.

A: Oh, yes. Later on when they, as they were rebuilding it, they did a number of things, and Jake made a lot of trips over there. I don't know that he was in

originally, but when the rebuilding and the redoing it went on, he was over there a number of times.

Q: Well, he told me in the interview that the quality of the construction wasn't very good in some of those dams. That the tolerances were very bad.

A: The what?

Q: You know, the quality of the construction. He had a problem in one of the dams where the joints just didn't fit right in this concrete spillway. He said it led to a lot of erosion down there, and he said the quality just wasn't good enough.

A: Well, I'm sure whether it was an earth or a rock dam, I'm sure there was a concrete spillway. The spillway was over on the other side of the dam, as I remember. They had trouble with the stilling basin and everything there and I'm sure that's what Jake was involved in. They worked on that, I think some little time even after they had taken care of the damaged part. They were working on the spillway and the outlets over on the other side of the dam for some time.

Q: Yes, because he was working with Harza on that.

A: Yes, Harza or TAMS.

Q: They had him on that one. Are there any other things in Pakistan or that area that you got involved with?

A: When we were in Bangladesh, the beggars were everywhere, and this was years ago. That country's a disaster. I mean there's just no way they're ever going to be able to support themselves. Britain and several of the big countries know this, and so they have a consortium that sort of looks after them on projects and things like that. When -we'd leave the hotel in the morning, the streets would be lined with beggars. There'd be women there holding babies. They told us that they rented the babies just to help out with their begging. It was not a happy situation.

Mary was with me several times in East Pakistan, or at least once. The engineering company had a local office there, and the manager's wife took Mary on a shopping tour and she said that was something, too. They had a chauffeur. I'm trying to

think something about, I think they saw an accident where somebody had bumped into a bicycle rider. Something interesting about it though. Apparently, the bicycle rider, he was the number one. The guy in the car was in trouble, the one that hit him. I guess that may be true in some other places, too, where bicycles are predominant.

Q: I imagine there are a lot of them in those countries because of the lack of money. So mostly rich people and foreigners have cars.

A: I wanted to get something for Mary one time I was there, so Azeemuddin took me shopping, and he knew the ins and outs of shopping. I ended up buying some pink pearls. They're just found in certain places, I guess. I liked those. They have faded. I don't think they were fakes or anything, but apparently they fade. Mary never used them very much. I think they're still in her drawer in there. The last time I saw them they were not very pink anymore. But anyhow, he took me to a place, and got me a special price on those.

Everytime I'd go over there I'd buy a rug. Both Pakistanis and Indians are famous for making rugs. The Pakistanis make a lot of rugs. I got a half a dozen around here and I've given some of them away. I went where they use child labor to watch them working on them. They're probably not the same quality as the so-called Persian rugs. But they're pretty nice. Interestingly, after they get them made, they scrub them. They wash them and scrub them down with water. You wouldn't ordinarily think of doing that. But I guess that gets rid of something that's on them when they're making them.

Q: Those things are so expensive now. Even the Pakistani ones probably are pretty expensive.

A: I suppose so. Well, there's one downstairs when you come in. There's one, you see it in the spare bedroom there, too, lying on the floor in there. I've given a couple to the children. I think I paid about one hundred dollars for them. Of course, I always had somebody that was giving me support when I bought them.

Q: Somebody who knew the dealer.

A: Yes.

Q: Can get you a good price. Figure out how to get it back to the States.

A: I may have brought one back or so, but generally they would ship them for you. You'd pay them for the shipping. That tall clock just around the corner there, it cost just as much to ship it from London as it did to buy the clock. It came into Baltimore. We had to go over to Baltimore to get it. The works, it's an antique, so there's no duty on it, but the darn guy was an eager-beaver and he wasn't sure that the works were old or not. He thought they might be new. So I think we had to, he was closing up shop or something, so we had to come home and then go back to Baltimore again to get that guy straightened out, being an antique. I'll show it to you. That cane over there came from London.

Q: The middle one?

A: The one standing up straight.

Q: Oh, this one.

A: That was made for a Saudi. prince. He never picked it up. That was the story I got. So I'll show you what's interesting about it. It's got a blade in it.

Q: For protection purposes?

A: The trouble is you can't take it, I can't take the darn thing on an airplane or anything. It would never go.

Q: Through the X-ray, would it?

A: Never go through the security.

Q: Maybe that's what he decided. Those guys fly Saudia, so they can do anything they want.

A: Yes.

Q: Did you do any consulting in Canada? I think you did up there, too, didn't you?

A: Yes, yes. They were getting ready to build a dam on the Columbia before it comes out of Canada. The hydrologist in the North Pacific Division, who had gotten in on this computer business early in the game, developed their probable maximum flood. In that situation, there's a lot of snow. It's mostly snow, melting snow, and some rain.

So the engineering company in Vancouver, I don't know why, but they wanted it reviewed. So I reviewed the spillway design flood for them. On one of the trips out there, took the family along. We rented a car and drove on up to Banff and stayed at the famous railroad hotel there on the lake.

Q: Lake Louise?

A: Yes, yes. I don't know just when this was, but it was sometime in the summer and we had a little snowstorm. The kids got a lot of fun out of that.

Q: Yes, Lake Louise Hotel isn't quite what it used to be.

A: **Yes.**

Q: At least it wasn't about 13 years ago when I was up there.

A: You say it wasn't?

Q: No, it wasn't. It really wasn't in too good shape.

A: Is that right?

Q: But the Banff Springs Hotel in Banff, itself, was just beautiful.

A: Newer?

Q: I don't know if it's any newer, but it certainly was taken care of, yes. It was a Canadian-Pacific property. I think so is the other one. Well, there are two big railroads, Canadian-National and Canadian-Pacific. Each of them, I think, had their own hotels. But I think Banff Springs was a Canadian-Pacific hotel. It was still quite plush. I haven't seen it, of course, recently.

A: Later on, I did a job for Hydro Quebec. Wendell Johnson and Barry Cooke were on the board of consultants for this project in Eastern Canada. It was the Quebec Hydroelectric Company that was planning this. They had a half a dozen dams laid out for this stream that drains into James Bay. They were working on just one or two at the time.

Wendell was instrumental in having them set up a hydrology work group and he recommended me as one member. Barry Cooke was there at the time. Wendell got a kick out of it. He says when he suggested me, Barry Cooke said, "Oh, yes. We use him in South America, too." That was typical of Cooke. He was opinionated, but okay.

Q: Who did he work for? Did he work for Bechtel?

A: Cooke?

Q: Yes.

A: I don't know. I think in the beginning he worked for some of the power companies out there on the West Coast. I've seen articles about him in some of the magazines. He's been an independent consultant for many, many years. One time, when Mary and I were in San Francisco, he took us out to lunch. When he called me a month ago, I mentioned that to him. I think it made him happy that I had remembered that.

They had a lot of problems with the Indians, the natives up there, who lived on some of these streams, that they wanted to build dams on. But they finally got everything worked out. I don't know that they built all of the dams, but they built several of them on the stream. Hydro Quebec produces a tremendous amount of power. They sell a lot of it to New York State. They export a lot of it.

Q: Most of that is on the streams that drains into Hudson Bay, isn't it?

A: Yes, these streams drained into James Bay at the southern end of Hudson Bay.

Q: They're draining north into the Hudsons Bay, or west from Quebec.

A: Well, I think it went pretty much west.

Q: West?

A: Yes, into the bay. I don't know that the Hydro Quebec engineers that were on this working group, I don't think they were entirely too, happy having me involved. I suspect that they had done their own designing. I just have kind of forgotten the details. I imagine the Hydro Quebec engineers had designed the project and everything.

I had a little trouble getting all the information I wanted and everything. I didn't find anything wrong with what they had, but I never was really happy with the final approval that was made. It was just, the operation was too big. It was rather difficult to get your teeth into the details of what they came up with. But I wasn't unhappy with the results and with their design, but I wasn't 100 percent happy about it either. We just worked on the first dam. I never heard anything more from them on the other dams. I don't know whether Wendell was a consultant on some of the other dams or not, but they built some. I also worked on a project in Saskatchewan for Acres, International. I don't remember much about it. It's hard to retrieve the information because I gave all my files to the University of Wyoming.

Q: Now, on these World Bank projects, you gave a formal report to the World Bank or to the engineering group you worked for, or both?

A: Well, like the ones in Pakistan, our reports would go to those engineers, but of course, I'm sure they then would, if that was part of their procedure, they would be furnished to the Bank. But then I was on some jobs where I was hired by the Bank, itself. Then we made our report to the Bank. Quite a bit later, the Bank sent a team to Bangladesh on the protection of Dhaka.

It was in the paper in the last year, well maybe within the last six months, they were flooded out again. The Ganges comes down from the northwest, but then there's a major stream, the Brahmaputra, that comes in from the East.

Q: Right.

A: And it's an awful situation. When we were there, a Japanese firm had the contract, I think, the main contract. We were reviewing the plans they had prepared for providing protection around the whole city. I don't think everybody was convinced it was necessarily a feasible thing, but they had the plans for it. I don't know whether it was a matter of approval or not, or more just that the World Bank wanted more information about what was going on, but there was no objection to it that I remember.

But it would have been quite a project because the pumps would have had to be tremendous pumps to pump the rainfall out during the floods. But, also, some of them were to be reversible so that they could pump water in during the low water season. Those people live on these river banks. The whole country gets flooded, so when I say river banks, I guess it means that includes just about everything in certain sections. Their livelihood is dependent on the growing season in between the floods.

Q: That's a big delta, though, isn't it?

A: Yes.

Q: A big delta comes out there so that's why that's such a big problem? It's very low?

A: It's very flat. Yes, because as you go farther south, of course, you get into that area where it gets flooded by typhoons.

Q: The Bay of Bengal?

A: Yes.

Q: One of these two, I forget which one, but they just come right up the coast there, from Burma on up the coast, and just push the water up ahead of them.

A: Yes. Maybe the storms form in the Indian Ocean and can take several different paths.

Q: How did you find the work as a consultant versus the time you spent in the Corps of Engineers?

A: Everybody, including my wife, thought I was crazy when I retired when I did. I didn't have any assurance of how much consulting work I'd get. But I had a taste of it by what I had been doing before so I wasn't really concerned about it. I guess we would have survived whether I got any consulting work or not. Well, I was free of the paper work and the routine of working in an office.

I was pretty fortunate even in the office. I didn't get involved in much administrative stuff. I had my assigned duties, but I pretty much set my own schedule and everything. So I had a favorable position even when I was with the Corps. So I never had any great feeling of change, other than that I was a little freer, I guess, when I was a consultant. But I always enjoyed my work with the Corps so there was no feeling of relief or anything when I retired. I'd been perfectly happy with my work.

Q: How about the quality of the engineers that you dealt with in these various projects, compared to the people you dealt with in the Corps?

A: Well, with the Corps, my dealings were almost entirely with hydrology and hydraulics people. When I was on these consulting boards, although I was a kibitzer, I was in on the meeting of all of the structural, geologists, and everybody else. So there was a little difference in the associations. But I don't recall ever feeling that the Corps people were that I was dealing with were not doing an adequate job. I think they were all quite capable. Some were more talented than others, but the organization was such that the chain of command was such that there's almost always somebody in it that knew what he was doing.

Q: Well, you worked for a lot of top people, too, though.

A: Yes.

Q: You keep on mentioning Wendell Johnson and Gail Hathaway. Those are fairly big names in the business.

A: Yes, yes. You were talking more about, I assumed you were talking more about the bread and butter work. In other words, we reviewed all of the spillway designs for the various projects as they went along. So I got to know a lot of the field people in the hydrology and hydraulics branches.

Q: Now, you did have an advantage that you did deal with a wide spectrum of projects in the Corps of Engineers. A very wide spectrum of projects in the Corps.

A: You mean with the Corps?

Q: Right.

A: Yes, we got involved in the channel and levee designs on the local protection projects. But I was, at least in the later years, I was pretty much dealing primarily with the reservoirs.

Q: So these consulting jobs were sort of a significant change for you as far as kind of thing you did?

A: No.

Q: The same thing?

A: It was much of the same sort of thing, yes.

Q: Now, the environment though was different, more challenging environment, internationally.

A: Yes. And the travel and the people, of course, a lot of different people involved. But they always, it was amazing how nicely the consultants were always treated. I remember one time Mary and I flew into Bogota, and we got in there late at night. We had reservations at an international hotel. When we got there, they didn't have any rooms for us. Apparently, one of the airline companies that used the hotel had a big flight canceled? and they put all of the people back in the hotel for overnight. So I called up one of Ospina's people, and he came down the hotel and he took us someplace else and found us a place to stay. But the next day, they raised cane with

the hotel and we got back to the hotel. The first night we spent in a substitute. But they always took care of us pretty good.

Q: High-price talent?

A: Yes, yes.

Q: They had to treat you nicely.

A: Of course, I don't know whether I mentioned this before, on our trips to Pakistan, that's almost halfway around the world, I would get first-class tickets. Then sometimes I would change the first-class ticket into two regular seats and quite often would take Mary along without it costing me very much. Sometimes, though, I would have a first-class ticket, and she'd have a coach ticket and I'd let her use my first-class ticket and I would sit in coach.

But twice, we went around the world. The first time Slichter was on the board of consultants, and they decided to join us. Mary Slichter didn't want to go to Pakistan, so she met us in Hong Kong. But Mary, I, and Slich went to Pakistan and then went on around to, oh, we stopped in various places before we got to Hong Kong. Mary Slichter had an antique business for awhile. So she nearly bought out Hong Kong. We met her in Hong Kong and then on to Tokyo and Hawaii.

The other time, I guess it was later on, Mary and I went on around by ourselves and hit some other places on the way around. We went up to the snow mountain climbing country.

Q: Nepal?

A: Nepal, yes. We flew up to Nepal in a small plane from Dacca and spent several days in the capital city of Nepal. There again, there were a lot of beggars around. It was interesting though, apparently two of the religions used each others temples, I don't know whether it would be the Hindus and. ..

Q: Buddhist and the Dalai Llama, which is another. ..

A: Anyhow, I had the impression they used each others temples. That doesn't make much sense, and I don't know why, but anyhow, we visited some of the temples. Mary was Catholic, and I'm a Presbyterian. Whenever on a trip, she always insisted on going to Mass on Sundays. So we happened to be in Nepal on a Sunday, and we located a Catholic church and school. We took a taxi cab to the church, which was in a remote area, for Mass. I didn't pay him. I asked him to wait for us. When we came out of church, he was nowhere to be found. For a while we sort of felt stranded there, but someone that we had casually talked to must have seen us looking lost and took us back to the hotel. Several times, I went out and looked at the taxi line trying to find that guy, so I could pay him, but never did find him. So that was, I guess that was the most exciting thing that happened in Nepal. We bought a rug and some jewelry.

But when we came back, we flew back to Dacca to get on our flight starting out around the world. When we got there the airport was jammed. There was a big pilgrimage going to Mecca. All of the families, whoever was going, the rest of the family came down and the place was really crowded. We felt fortunate when we got out of there on our flight. I guess we headed for Thailand. We were on a Thai airline and went to Bangkok, Thailand. We spent several days there. Mary always complained that I traveled too much for the Corps. She was always saying I was traveling all of the time. So when we got the chance, she got all of the travel she wanted.

Q: Gave her something in return, huh?

A: Yes, yes.

Q: My wife complains about that, too.

A: Well, that's natural.

Q: I try to take her some places.

A: Yes.

Q: It's a little difficult during the school year because the kids are still young.

A: Oh, yes, yes. We were kind of fortunate. Some of the traveling was--before we had the third one, Mary's parents lived outside of Philadelphia, in Chester, so we parked the kids there occasionally. Mary had a cousin, a single cousin, who lived in this area, and one time she came over and stayed at the house with the children. She was a chief operator at the Pentagon. I don't know whether you've seen or not, but her assistant was Marian Bailey, who, of course, is the chief operator now, and became so when Mary's cousin retired. She is quite a well-known person around the Pentagon. She is the one that has a private scooter.

Q: Yes, yes.

A: She's a friend of ours. When Mary's cousin retired, she stayed here a little while, and then she went into a nursing home up in the Philadelphia area. Several times Bailey went with us to visit her. I talked to her when Mary passed away. She's way passed the retirement age.

Q: Yes, yes. She's got like 60 years or something. Some incredible number of years.

A: Yes.

Q: She still goes scooting around there. Yes, I saw her buggy out in the hallway here recently. The fringe and all her decals on it.

A: Yes.

Major Contributions to Hydrology

Q: Let me ask you, as we wrap this up. What do you think your major contributions were to hydrology?

A: Well, I think the papers I wrote. There isn't any question about that, the research I did and the papers that I wrote. I got the most mileage out of that synthetic unit graph paper, which was a case of being, I guess, at the right place at the right time. When Hathaway was, this was before he knew me, developing his programs in the Corps of using the probable maximum storms, this unit hydrograph fit right into it. So he was instrumental in most of the field offices using the procedures which helped establish my reputation. It did, for some reason or other, get all around the

world. It was used in a lot of different countries. I don't know exactly why, but it did spread around.

But actually, the best paper I wrote never really got much publicity or recognition. I think I had ideas then that people are still discovering as new.

Q: Which one was that?

A: "The Conception of Runoff Phenomena. "

Q: Oh, okay.

A: You know, in the old days, they would talk of runoff as a percent of rainfall, which would make you think that if you had an inch of rainfall, you were getting one tenth of an inch off of the whole basin, if you were getting 10 percent. That's not the way it happens. Then Horton had his infiltration theory, which is a great theory, but again, it isn't really the case. It's what happens if you take a square foot or a square yard, that's what happens. But on a basin-wide basis, it doesn't exactly work that way. A lot of procedures still use it, and it's still, I guess, accepted as a true phenomenon. But again, it isn't quite what happens on a natural river basin.

So in this conception of runoff phenomena, I hypothesized a basin with the areas lined up according to depth to the ground-water table. There are certain areas which have the shallowest depths and which become saturated first. My theory was that the soil, except for very exceptionally heavy rains, the soils have no limiting infiltration capacity. The soils will take the rain until they get saturated, and then you start getting surface runoff.

I mentioned the subsurface flow before, you're getting subsurface flow, too. The idea of sub-surface runoff was a significant development. However there were several other people working on it at the same time. I hypothesized, just as a model, the areas closest to the channels would saturate first and that's where your surface runoff would come from. So if you're getting 10 percent runoff, instead of 10 percent from the whole area, you're getting 100 percent from 10 percent of the area, and that area always produces the first runoff.

Well, that was in this conception of runoff phenomena. Some 15 or 20 years later, they started talking about partial-area-runoff, which is that same thing, that there are certain areas that always produce the initial runoff and that area expands as the

amount of rainfall increases. If it rains long enough, the whole basin contributes. But, I mean there's stuff like that in the paper that never did get much recognition.

Q: You think that was your best piece of work?

A: That's what I thought, yes.

Q: But your real reputation you think stands with the synthetic unit graph?

A: That really established me, I guess. As I say, it was translated into a lot of other languages and people when I'd go to these meetings, people would know who I was. I think I mentioned once before that they were surprised how young I was.

Q: That's a delightful story. It really is. Let me ask you. Now, that's in your career as a hydrologist. What about your time in the Corps of Engineers? Was it one of those manuals, the engineering manuals, you think? One of those things on reservoir regulation? What do you think was your major contribution in the Corps of Engineers itself?

A: Well, it would have been the reservoir operation procedure. In addition to the manual, a number of procedures for special operations were sent out in *Engineer Letters*. Some items went out as directives.

Q: Circulars?

A: Circulars or letters. I think we mentioned before if you have a certain amount of flood control space, and when you get a certain flood, there's always a question, "Should I use it all now or save some space for the next flood?" In other words, after you filled up, why you can make things worse, than if you hadn't built the darn because the reservoir area speeds the flood water through faster than it would have been in a state of nature. So you can make things worse.

So I developed a procedure that you could sort of take care of that situation of knowing how much space you should save. In most projects, there's some surcharge storage available before you have to pass the inflow. It was mostly how to use up this surcharge storage and still be prepared for a more severe event if it happened.

There was also a procedure for determining the amount of storage required to provide water supplies of different dependabilities.

I remember one time, I don't know whether I mentioned this before or not, I think it was in the Kansas City District, they had a bad flood. They went out and put sandbags on the spillway. I think they got called out pretty severely about doing that because dams aren't designed for that. You're not supposed to store more water than they were designed for. But by sandbagging a spillway, they were able to store some extra water.

Q: Although they weren't supposed to do that.

A: No, they certainly weren't supposed to do that. I think in that particular case, they didn't run into any second, into another storm, but they might have. It's not the thing to do. I think I mentioned before we issued the regulations for other agency dams that were funded -with flood control money, and private or local governments. There were a few dams built by states that were not federal dams, but that also got some money for flood control and we issued regulations for those. That was mostly a matter of just reviewing what the field offices had come up with, but it was still a little bit out of the routine, to be messing into someone else's business.

Q: Telling them how to do it, huh?

A: Yes.

Q: Is there anything else or any other observations you have on your career or the Corps of Engineers that you want to impart before we wrap this up?

A: No, it certainly was a satisfying career. I never hated to get up and go to the office. It was always anticipating something interesting. Hydrology was my hobby. When we lived in Arlington Village, I was running an experiment in the bathtub, timing the waves back and forth, checking out that V equaled the square root of gD . It checked out, too, but the neighbors got a kick out of that.

Q: Bathtub experimentation wave tank, huh'?

A: As I say, hydrology was my hobby as well as my vocation, which isn't necessarily a good thing, but it was enjoyable anyhow.

Q: So it worked out pretty well in your case?

A: Yes.

Q: It's nice to have it that way, makes it a lot easier on you.

A: Yes. It would be terrible to be unhappy with what you're doing and I have a feeling that an awful lot of people these days are in that situation. I don't know.

Q: Well, I think that's probably true.

A: Yes. I'm on a sucker list for all people trying to sell me these financial advisory letters. I do some speculating to keep myself interested. This one I was recently looking at, it demonstrated that taking into account inflation, that the average income now is less now than it was years ago.

Q: Yes, the usable income.

A: Yes. The division between the haves and the have nots is getting worse all of the time, and that's not good. They quoted somebody, "That that's the beginning of the end."

Q: Well, you can never tell.

A: But I don't know how I got on to that.

Q: Well, if you have nothing else, I'd like to thank you for your time.

A: You're certainly welcome. I've enjoyed our conversations.

Appendix A

DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
TECHNICAL LIAISON OFFICE
Room 1031, Bldg. T-7, Gravelly Point, Washington, D. C. 20315
Oxford 55676

FOR IMMEDIATE RELEASE

December 29, 1966

FRANKLIN F. SNYDER RETIRES
FROM ARMY ENGINEERS

Franklin F. Snyder, Assistant Chief of the Hydrology and Hydraulics Branch and Special Engineering Consultant to the Chief of the Engineering Division, Civil Works, in the Office of the Chief of Army Engineers is retiring at the end of December after 30 years of Federal service, 24 years of which were with the Corps of Engineers.

Mr. Snyder has served in his present position since 1956. In this capacity he has represented the Corps of Engineers on inter-agency, national and international committees. Much of his time has been spent on studies in connection with the St. Lawrence Seaway and Power Project for the International Joint Commission and he has served on the International St. Lawrence River Board of Control since 1961.

From December 1944 through May 1945, Mr. Snyder served as Technical Representative in the European Theatre of operations, developing the necessary forecasting relationships and preparing twice daily forecasts of Rhine River stages for information of the allied armies. He received the Army Exceptional Civilian Service Award for his contribution to the success of the Rhine River Flood Prediction Service.

Prior to his service with the Corps of Engineers, Mr. Snyder served as hydraulic engineer with the U.S. **Geological Survey**, the Tennessee Valley Authority, the U.S. Weather Bureau and the State of Pennsylvania.

Mr. Snyder received a BCE in 1932 and a C.E. **degree** in 1942 from Ohio State University. He is the author of papers on various phases of hydrology and co-author of a paper on Flood Routing which was awarded the J. James R. Croes medal of the ASCE for 1940. He has consulted on spillway requirements for dams in Mexico, the Sudan Colombia and British Columbia.

Mr. Snyder **is** a member of the Cosmos Club, Tau Beta Pi, Sigma Xi, a fellow of the American Society of Civil **Engineers** member of the American Geophysical Union **and** the American Meteorological Society, and a registered professional engineer.

After retirement Mr. Snyder will practice as a consulting hydrologic engineer.

Mrs. Snyder is the former Mary Elizabeth Bruton of Delaware County, Pennsylvania. Mr. and Mrs. Snyder have three children: Mrs. Marilyn K. Stack of Arlington, Carol, and Gregory.



Office of History
U.S. Army Corps of Engineers



