The Bancroft Library University of California/Berkeley
Regional Oral History Office

P. H. McGauhey

THE SANITARY ENGINEERING RESEARCH LABORATORY: ADMINISTRATION, RESEARCH, AND CONSULTATION, 1950-1972

With an Introduction by
Linvil G. Rich

An Interview Conducted by
Malca Chall

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PREFACE

The development of sanitary engineering in California since the turn of the century is the subject of a series of interviews conducted by the Regional Oral History Office of the Bancroft Library under a grant from the Water Resources Center of the University of California.

The idea for documenting this history was initiated by Henry Ongerth, chief of the Bureau of Sanitary Engineering of the California State Department of Public Health. In a letter to Professor Arthur Pillsbury, director of the Water Resources Center, he suggested that funds be provided to interview Chester Gillespie, the first chief of the Bureau (1915-1947), and Professor Charles Gilman Hyde, head of the Department of Sanitary Engineering on the Berkeley campus from 1905-1944. David Todd, professor of Civil Engineering, provided leads for other interviews and the series came to fruition. Major funding came from the WRC with some additional assistance from the Department of Hydraulic and Sanitary Engineering on the Berkeley campus.

Mr. Hyde was not well enough to interview, but Chester Gillespie, Wilfred Langelier (chemist and water purification specialist UCB 1916-1955), and Percy H. McGauhey (director of the Sanitary Engineering Research Laboratory, UCB, 1956-1969) did tape their memoirs. As a result there is on record information about administration, teaching, and research in sanitary engineering from 1905-1971, a period which spans the time when the major emphasis of the sanitary engineer was prevention of typhoid fever, to today, when concern is with prevention and control of pollution of the total environment.

These interviews have benefited greatly from the expert advice and assistance of Henry Ongerth and professors David Todd, Erman Pearson, and Robert Selleck.

The Regional Oral History Office was established to tape record autobiographical interviews with persons prominent in recent California history. The Office is under the administrative supervision of James D. Hart, director of The Bancroft Library.

Willa Baum, Head
Regional Oral
History Office

22 February 1971
Regional Oral History Office
Room 486, The Bancroft Library
University of California
Berkeley, California

INTRODUCTION

In the kaleidoscope of one's memories, most people appear and disappear in association with a bewildering jumble of events and associations. They leave memories that reach no further than the events and experiences with which they are associated. Here and there, however, certain people step out of the time continuum and establish a presence that transcends these associations. They make their introduction, they create vivid memories and then they remain to exercise a continuing influence. P. H. McGauhey is such a person.

Mack McGauhey has many accomplishments to his credit. As an educator, he has worked diligently for the elevation of standards in the teaching of sanitary engineering. As a researcher, he has contributed to the technology of water and waste treatment. As an engineer, he has served his profession in many capacities. But, as significant as these accomplishments are, they stand short in comparison with his greatest accomplishment--the enrichment of the lives of countless graduate students who were fortunate enough to have known him. A broad fraternity of us exists who are in debt to Mack, both personally and professionally. Some of us were attracted to careers in sanitary engineering as a result of having had Mack as a teacher. Others made it through the rugged trek of graduate study only because Mack cared. And, doubtlessly, there are those of us who attained their professional niche only because of a recommendation (too charitable, perhaps) that he had provided.

My own memory kaleidoscope include the following vignettes with Mack: the first dinner in a professor's home; a search by match light below a sewer outfall late one night for mint to garnish our juleps; water sampling forays as an excuse for sun bathing and tale telling; Mack's sponsorship in the hospitality rooms at the first professional meeting; week-end explorations of the Mother Lode country, Reno, Yosemite, Lassen, etc.; the introduction to rum drinks with exotic names like the Missionary's Downfall, the Shark's Tooth, and the Vicious Virgin; and the mornings after.

Then, too, Mack has a way with words and phrases, both sense and nonsense. A "slow leak" to describe a time-wasting activity or "I feel more like I do now than when I first came in" to describe an over-indulged dinner. His limericks, though classic had best not be repeated here. Oh yes--Mack is the only person I know who "gave church up for Lent and never went back."

The best way to describe Mack is that he is a humanist with class. It is the humanist in him that touches people. It is the class that makes him an institution.

Linvil G. Rich,
Professor
Environmental Systems

February 1974
Clemson, South Carolina

INTERVIEW HISTORY

Percy McGauhey was interviewed by the Regional Oral History Office in order to document the founding and subsequent work of the Sanitary Engineering Research Laboratory as well as other developments in the field of sanitary engineering.

Sanitary engineering is not a subject likely to inspire excitement among many people, but translated as environmental engineering and brought into focus as near at hand as the daily paper, it becomes a fascinating scientific discipline even to the average man. When this topic is explained by someone as articulate, reflective, and deeply committed as Professor McGauhey, who combines these qualities with a balanced perspective on life and a capital sense of humor, much stimulation can be generated about a facility simply called a Sanitary Engineering Research Laboratory.

On June 30, 1969, Percy McGauhey retired from the faculty of the University of California as Emeritus Professor of Sanitary Engineering and Public Health. One year later he was still diligently carrying on his customary full seven-day-a-week work schedule, completing research, writing reports and articles for journals, and undertaking new consulting assignments. Into this already over-crowded calendar he quite characteristically agreed to set aside time for an additional item--the oral history interview.

Four taping sessions, each approximately two and one-half hours long, were held in his office at the Sanitary Engineering Research Laboratory in Richmond, California on July 16, July 25, September 17, 1970, and September 11, 1971. SERL had been his chief base of operations from the time he joined the staff as research engineer in 1951, one year after the laboratory was organized, through 1969, the last thirteen years of which he functioned as its director.

In 1971 it seemed that everyone in the United States was concerned about air and water pollution, solid waste management, and the many other aspects of environmental quality and degradation which had been undergoing rigorous scientific study at SERL since 1950. The object of the four interviews was to obtain from Professor McGauhey a first-hand account of the origin and

Engineering for "creativeness and leadership in environmental engineering in water, wastewater, solid wastes, and recycling." This is recognized as one of the highest honors that can be awarded an American engineer.

As these honors indicate, and as the reader will quickly recognize, Professor McGauhey represents not only a model of a professor, research scientist, and engineer, but the type of individual now being paid homage during this country's bicentennial celebration: a descendant of pioneer Americans who took literally the promise of the American dream, and who achieved it through the application of strenous physical labor and a never-ending quest for education and excellence.

Malca Chall
Interviewer-Editor

21 February 1974
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University of California at Berkeley

development of SERL, its relationships both to the University's engineering department and to the general community outside of academia, something about the research undertaken during the lab's dynamic twenty year history, and in the course of the telling thereof, to learn some of the pertinent details of Professor McGauhey's education and career.

The major topics to be covered in each taping session were agreed upon in advance by Professor McGauhey and the interviewer who then submitted to him prior to each appointment a general outline of the more specific items planned for discussion. He, in turn, prepared notes to insure that he brought out the many points he considered germane.

When it came time for him to review the edited and chaptered transcripts of the taped interviews which were sent to him in April 1972, Professor McGauhey felt that he had not dealt thoroughly or clearly enough with some matters and decided, therefore, to amplify those portions which he thought he had neglected. Because of his skill as an author of scientific articles, as well as of poetry and humorous essays, the additions fit perfectly into the transcriptions and have improved immeasurably the manuscript as a research tool. The kind of wisdom imparted throughout this volume on so many aspects of life and education cannot be defined in a table of contents or an index. Neither can the wry humor so characteristic of Professor McGauhey's form of expression. The memoir is replete with these aspects of his personality as well as with his grasp of facts and his sense of history.

Even while reviewing the transcript he kept up with other assignments, some of which included travel to Hawaii, Seattle, and other sections of the country. In the summer of 1973 he suffered a bout with illness which circumscribed his activities for a short time. Nonetheless, this slightly-built man with his tremendous stamina and recuperative powers was soon hard at work again. By October, 1973 he had completed his editing and returned the oral history manuscript to this office for completion.

Professor McGauhey's honors and awards were not discussed during the interviews. It is appropriate therefore to record here two distinguished awards. In 1971 Utah State University at Logan, Utah awarded him an honorary doctorate for contributions to the profession and science of water resources. In January, 1973 he was elected to membership in the National Academy of

P. H. McGAUHEY
6819 SNOWDEN AVENUE
EL CERRITO, CALIFORNIA

94530

CURRICULUM VITAE

Born: Ritter, Oregon, January 20. 1904

Marital Status: Married 1928; no children

Education:
- B.S. (Civil Engineering) Oregon State University, June 1927
- C.E. (Equivalent M.S.) Virginia Polytechnic Institute, June 1929
- M.S. (Hydraulic & Sanitary Engineering) Univ. of Wisconsin, Sept. 1941
- D.Sc. (honorary) Utah State University, June 1971

Scholastic Honor Socities:
- Tau Beta Pi
- Sigma Tau
- Omicron Delta Kappa
- Delta Omega
- Phi Kappa Phi
- Sigma Xi
- Chi Epsilon

Professional & Technical Socities:

American Society of Civil Engineers
- President, Virginia Section, 1951
- President, Sanitary Engineering Division, San Francisco Section, 1955
- National Committee of Refuse Collection & Disposal, 1954 - date
- Member Research Committee, Sanitary Engineering Section, 1961 - date
- Member numerous local section committees, 1947 - date
- Chairman, SED Program Committee for Salt Lake Conference, 1964
- Chairman, SED Solid Wastes Research Conference, Milwaukee, 1967
- Chairman, Task Committee on Environmental Research, 1971

American Water Works Association:
- Chairman, Virginia Section, 1945
- Chairman, Purification Division, California Section, 1956
- Member, Executive Committee, California Section, 1961 - 1965
- Chairman, Visiting Engineers Committee, 1963
- Member, numerous local section committees, 1947 - date

Water Pollution Control Federation:
- Member, Board of Control, 1961 - 1964
- Member, Research Committee, 1952 - 1965

California Water Pollution Control Association:
- Executive Committee, East Bay Section, 1954 - 1957
- President, 1959
- Member, Executive Committee, 1957 - 1965
- Member, numerous local section committees, 1953 - date

Inter-American Association of Sanitary Engineers:

National Society of Professional Engineers, 1958 - 1969
Executive Committee, Contra Costa Chapter, 1958 - 1960

American Public Health Association:

American Society of Limnology & Oceanography:

American Society of Engineering Education:

American Academy of Environmental Engineers (Diplomate)

American Association of Professors in Sanitary Engineering

Richmond Engineers Club. President 1961; 1970

Professional Registration:

Certified Professioal Engineer, State of Virginia, Cert. No. 643
C.E. member, Virginia State Board, 1947 - 1951
Registered Civil Engineer, State of California. Cert. No. 7814

Awards

Fuller Award, American Water Works Association, 1950
Harrison Prescott Eddy Medal, WPCF, 1960
Distinguished Service Award, Nat. Clay Pipe Institute, 1964
Service Award, Calif. Water Pollution Control Ass'n., 1964
Outstanding Service Award, Calif. Water Pol. Control Ass'n., 1968
Gordon Maskew Fair Medal, WPCF, 1969
Honorary Member, Inst. of Solid Wastes, APWA, 1970

Experience

Teaching:

Virginia Polytechnic Institute
1927-30: Instructor in Civil Engineering
1930-37: Assistant Professor of Civil Engineering
1937-42: Associate Professor of Sanitary Engineering
1942-48: Professor of Sanitary Engineering
1950-51: Head, Department of Civil Engineering

University of Southern California
1948-50: Professor of Sanitary Engineering

University of California (Berkeley)
1951-57: Research Engineer & Lecturer in Sanitary Engineering
1957-69: Professor of Sanitary & Public Health Engineering and Director, Sanitary Engineering Research Laboratory
1957-63: Chairman, Division of Hydraulic & Sanitary Engineering
1963-65: Chairman, Department of Civil Engineering
1969 - : Professor & Director Emeritus

Research

1930-37: Engaged in research in field of hydrology, mostly concerned with long-range rainfall-runoff relationships, analysis of storms that have caused great floods, and prediction of flood intensities.

1937-48: Directed and conducted research studies of various aspects of stream pollution, paper mill wastes, movement of pollution through reservoirs, effieiency of sewage treatment plants, etc.

1951-57: Research Engineer and Assistant Director, Sanitary Engineering Research Laboratory, Univ. of California with particular interest in groundwater recharge, pollution travel in soils, and solid waste disposal.

1957-69: Research Engineer and Director of SERL, Univ. of California with administrative responsibility for development and operation of an organized research unit involving staff and student research in air, water, and land environmental control problems. Served as principal investigator on projects related to ground water recharge, detergents, septic tank percolation fields, water economics, water treatment, and solid wastes management.

1966-69: Principal investigator of multi-discipline research project on Comprehensive Studies of Solid Waste Management.

Professional and Consulting

1927: (Summer) U.S. Bureau of Public Roads on Highway location

1930: (Summer) Topographer, Newport News Shipbuilding and Drydock Co.

1929-1935: Designed reinforced concrete structures, including major building for Va. Poly. Institute. Designed and constructed small rock fill dam and power plant; laid out and supervised construction of numerous drives, walks, sewer and water lines; made feasibility studies and preliminary design of water supply and treatment works.

1937: Carried out numerous small consulting assignments in the field of sanitary engineering, including water supply, waste water treatment, stream and ground water pollution, and refuse disposal.

1946-48: Served as General Engineer on design and construction of sewage disposal plant, pumping station, and outfall sewer for Va. Poly. Inst. and Town of Blacksburg, Va.

1951: Sanitary engineer for various local groups developing a recreational state park on Claytor Reservoir in Virginia.

1958: Special Consultant to Kuwait Oil Company in Arabia on public health engineering problems.

1957: Special Consultant to U.S. Public Health Service on studies of failure of septic tank percolation systems,

1959: Special Consultant to Building Research Advisory Board, Nat. Science Foundation.

1960-date: Special Consultant, U.S. Public Health Service and Bureau of Solid Waste Management.

1960-date: Chairman, Board of Consultants, Lake Tahoe Area Council.

1962: Special Consultant, Bechtel Corp. on groundwater recharge.

1962: Special Consultant, Ford Foundation on engineering education in Chile.

1963,1965: Sanitary engineering consultant on water reclamation, AID, Israel.

1963: Consultant, Sanitary Engineering Education, AID, India.

1965: Consultant, Calif. State Water Quality Control Board.

1966,1970: Consultant on solid wastes, Calif. State Dept. Public Health.

1965-66: Consultant, Utah State University, Water Resources Institute

1967: Consultant on storm runoff damage, County Court, Contra Costa Co.

1968: Consultant:
Walt E. Disney Enterprises (wastes management at Disney World Fla.)
District of Columbia (waste water treatment)
Nat. Acad. of Science, NRS-NAE, (solid waste policy planning)
New Mexico State University (water resources institute)

1969-1971: Consultant (project by project basis)

Engineering-Science Inc. (various assignments)
TRW Systems (solid wastes management)
Aerojet-General Corp. (solid wastes management)
City of Escondido, Calif. (wastewater reclamation and disposal)
City of San Francisco, Calif. (wastewater treatment and disposal)
Boyle Engineers (wastewater disposal)
State Dept. Public Health (solid wastes planning)
Calif. Water Resources Center (research program planning)
Consoer-Bechtel (water quality studies of South S.F. Bay)
Brown and Caldwell (water reclamation, Contra Costa Co.)
Consoer and Townsend (waste water treatment)
Environmental Engineers (project development)
Utah State University (water resources research development)
Loyola University (educational program development)
Uniconsult Inc. (sludge disposal and water pollution)
University of Hawaii (research project development)

1971 - 1972 Consultant (project by project basis)
Utah State Univ. (water resources research development)
University of Hawaii (30% time, consultant on Sea Grant Program)
State of Wisconsin (Chairman, Bd. Engr. Consultants (solid waste))
G.E. Tempo (consultant on groundwater quality and monitoring)
Brown & Caldwell (consultant, state water resource studies)
CH2M-Hill (Metro Seattle solid waste management program)
Kennedy Engineers (Corps of Engrs. Spokane River Basin studies)
PBQ & D (land disposal of reclaimed water, Corps of Engrs.)
City of San Francisco (Chairman, technical Advisory Board
Lake Tahoe Area Council (Ch. Bd. of Consult., & project director)
Bechtel Corp. (South Bay wastewater disposal studies)
Carollo Engineers (Waste water disposal, Orange County)
City of Escondido (wastewater disposal and groundwater recharge)
Campbell Estates (Hawaii) (solid waste disposal project)
City of Santa Barbara (review of water reclamation planning)
Colorado State University (consultant on engineering research)

I CHILDHOOD, EDUCATION, AND THE FIRST CAREER 1904-1950

Chall: You've been sitting at the top of an important institution for many years. How did you arrive where you are?

McGauhey: I am certain that the route one follows to get from where he starts to where he finishes depends a great deal on probability or chance. But one of the principal factors in my case, I would say, is that I was fortunate to have parents who wanted their children to get an education, and were determined to give them such an opportunity if they showed interest and capacity in learning. Thus the chance which brought me to Berkeley began with the chance to set out on the type of road which might lead in such a direction.

Family Background - Grandparents and Parents

McGauhey: I was born on January 20, 1904 on my mother's homestead in the community of Ritter Hot Springs, Oregon. Ritter is in the dry cattle ranch country some seventy miles south of Pendleton; between Pendleton and John Day. This country in the early 1900s was still in a pioneer state, even though much of the world at that time had entered the age of the railroad. Our ranch was fifty-five miles from the railroad and the "wagon roads" which connected the two were spectacular for other reasons than ease of transportation. So we had to raise stock for a cash crop. Anything that couldn't walk to market was not going to get there in any worth while quantity on any predictable schedule. This meant that we had to do general farming

McGauhey: in order to grow feed for the stock, and to raise stock in order to make a living. The combination of stock raising and farming, I must say, is a very rugged operation requiring the full attention and work effort of the entire family. But, then, my parents came from an ancestry to which work was a virtue rather than a stranger.

My mother was Swiss. She was born in the State of Missouri but her parents both came from the same village just outside of Bern, Switzerland. They met in Iowa at the age of fifteen. I never knew my maternal grandparents. For one thing, they lived in Santa Clara, California. In terms of time, the distance from our ranch to Santa Clara was somewhat greater than from the Earth to the Moon in 1972.

Chall: What were the name of your grandparents?

McGauhey: Grandfather's name was John Senn, and grandmother's maiden name was Anna Bloch. John Senn died from injuries resulting from a runaway team of horses he had hitched to a hay wagon. This may have been before I was born, as grandmother survived him for several years and I can only dimly remember when mother learned of her passing. I was probably about three years old at the time.

My father was of Scotch-Irish and English extraction. His ancestors were adventurers who came to North America about as soon as the continent was opened. My paternal grandfather grew up in the vicinity of St. Joseph, Missouri--Agency, Missouri may have been his birthplace. From there he drove ox teams down the Old Oregon Trail, hauling freight to the Pacific Coast. He met and married my grandmother, Eliza Samuel in St. Joseph. She had gone there to live with a married sister after the Civil War disrupted their established home in Mount Airy, North Carolina. Thereafter, she lived always at or beyond the frontier until it reached the Pacific; always on the move until the final years when she and grandfather lived with us. Grandfather was a restless man. My father always said that if anyone lived within sixty miles of grandfather, he felt the country was getting too settled up, and moved on--a rather interesting commentary on today's environmental attitudes.

McGauhey: As a result of grandfather's migratory instincts the family headed by David Sidney McGauhey, my grandfather, moved often and my father grew up in an impressive sequence of places. He was born in Hiawatha, Kansas and several of his early homes were in western Kansas where ill-timed hot winds, hailstorms, "cyclones," and prairie fires had a way of freeing the settler from his commitment to the land. Charles Sidney McGauhey, my father, was the youngest of four children. He had vivid memories of the family's move to Colorado when he was a small child, probably because the wagon in which he was riding upset in a spectacular fashion. That was in Indian days when Colorado was essentially beyond the frontier. There roving bands of Indians were constantly present intent upon stealing the livestock. Often they killed a family of settlers even though the tribes themselves might not be generally on the "warpath." Grandmother told me in later years that day after day when grandfather was away from home she did not dare build a fire in the cookstove lest Indians know they were there and possibly come to do them harm.

From Colorado the family moved to North Platte, Nebraska. There grandfather stayed longer than usual and my father got a few years of elementary schooling. They lived across the road from Bill Cody, the famous Buffalo Bill. Father loved to ride horses, especially bucking horses which to him was like sitting in a rocking chair. He really loved horses. So as a teen-ager he broke a good many saddle horses for Bill Cody. When Cody took his Wild West Show to England he wanted father to go along. My father declined the opportunity because, as he told me later, he was afraid to cross the ocean. He had, of course, never seen the ocean and, I suppose, shared with other humans some fear of the unknown. However, he left home to work as a cowboy in Nebraska and Wyoming, and within two years he came to California and joined the marines. He then went down to Central America and saw a good deal of the ocean before he got back and left the Marine Corps just prior to the Spanish American War.

My mother, Mary Ann Senn, was born in Tipton, Missouri in 1870. When she was six years old the Senn family moved to California and mother started

McGauhey: her schooling here in the town of Cottonwood. Later the family moved to the Santa Clara Valley where most of its members stayed the remainder of their lives. It was a large family; four sons and eight daughters. Mother was one of the two who eventually moved to Oregon. Her oldest brother, Fred Senn, went there first and bought a cattle ranch. He homesteaded some land and bought up a lot of adjacent land as homesteaders got title to their homesteads; then sold them and moved on in search of a better life. Thus my uncle acquired a fairly large cattle ranch in eastern Oregon. My mother was unmarried when she went to visit her brother in Oregon. He persuaded her to homestead land next to his ranch.

At about that time my father was working in the Sacramento Valley for Walter Pierce, who in later years became Governor of Oregon and went on to the U.S. Congress. Pierce was one of a group of men from eastern Oregon who were trying to extend their wheat growing activities into the dry areas of California. My father was operating a harvest crew for Pierce and had no particular reason to stay in California; so he went along with his employer to continue the harvest in eastern Oregon. There he worked for a series of ranchers, gravitating to my uncle's ranch, I suspect, because he had more wild horses than anybody in the West. Anyway, if there were any wild horses to ride it was inevitable that my father would get into the act. When the Boer War came along, horse buyers seeking mounts for the British calvary appeared in eastern Oregon. The only requirement for a horse to be acceptable was that it had been ridden at least once for a distance of about one hundred yards. My father rode some 1500 horses through this yardage, and enjoyed every minute of it. In later years he often wondered how the British cavalry faired on such mounts, and what the effect might have been on the outcome of the war.

While working for my uncle, my father met my mother. They were married on Christmas Day in 1900 and settled on mother's homestead, although father continued to work for other ranchers and other employers to make their livelihood. When I was four years old and mother had title to her land, father took up a homestead and we moved into a new house he

McGauhey: built on the site. Subsequently, my paternal grandparents came to live with us. After grandfather died, in 1913, grandmother homesteaded land adjoining father's and lived alone in a small house a few hundred yards from ours.

There was quite a lot of open range in those days. So with a few hundred acres and an open range, you could handle stock in scale with your ability to raise feed for them. Therefore, we stayed on there farming and ranching until the time had come when my sister and I were ready for high school. But in this kind of environment you couldn't make enough money to send children away to high school; and grandmother had two years yet to live on her land before she could "prove up" on it and acquire title to it.

Early Life in Eastern Oregon

Elementary School in One-Room Schoolhouses

Chall: You had to go away to high school; but what about the elementary education?

McGauhey: We owned land in two separate school districts--the Ritter and the Three-Mile District. When I entered elementary school each of these districts had a one-room schoolhouse and about thirty to forty children in attendance, although by the time I reached the eighth grade the numbers had dwindled to about a dozen each. At first my sister and I rode four miles to the Ritter school during the fall months. Then when the snow and cold of winter came, mother lived with us at the Ritter Hot Springs and we walked with other children a mile or so, vertically, to the school house. Meanwhile, my father and grandmother looked after the ranch. We did this for only two years.

After that, when I was eight years old, we transferred to the Three-Mile school which was nearer to our house. We then had only three miles to ride. I might explain that these two three-mile figures were unrelated. The school district was named for its

McGauhey: location on the headwaters of Three-Mile Creek. The name of the creek, and of several others, designated its approximate distance upstream from the junction of the Middle Fork and the North Fork of the John Day River. Our three miles were a matter of geography, but I may say they were country miles, and country miles bear somewhat the same relation to a statute mile as a British Imperial gallon does to our gallon.

Chall: When you said ride, you meant ride on horses?

McGauhey: Yes. We rode horses to school because in those time no rancher with any self respect walked farther than necessary to catch a horse. But there was also the matter of severe weather. Small children make limited progress through knee-deep unbroken snow. There was also real danger from rabid coyotes and dogs, as well as from bulls and a considerable variety of wild animals capable of generating considerable anxiety in children traveling on foot.

As to the weather, it was often colder than a witch's heart when we set off for school. Our route was up dark canyons where the sun reached only at mid-day. We always beat the sun anyway. My mother being Swiss and very energetic was up early, living up to all the traditions of the Swiss, including their consciousness of time. She was fearful that we would be late for school--a crime you can't explain to people in 1972--so we got off early. The result was that we got to school always before the teacher, who was like as not to be late. There we would have to build a fire in the stove and try to get thawed out before school started.

But I started out to speak to the point of my elementary education rather than of the rigors of pioneer life. As I reflect upon the teachers in those old one-room schools I must conclude that they did a pretty good job. I think they did surprisingly well in handling eight grades in one group. It wasn't all bad because in a one-room school you learn a lot by osmosis during the recitation period of the higher grades. The level of education of our teachers was not high; eighth grade, or occasionally one or two years of high school. I often wonder, however, how many courses in education would be required today

McGauhey: to qualify a teacher to do as well as my mentors in the one-room school.

In ours there were a lot of children--I shouldn't say a lot--but some, at least, that were not notably endowed and did not learn much. Part of this was the result of family attitudes, hence the kids from many of the farms and ranches would come to school only when there wasn't anything else to do. Come spring plowing time they would drop out of school and perhaps not appear again until the fall harvest was over. Thus they might be nineteen years old and still in the eighth grade. Some quit by the time they were twenty and never finished the eighth. They simply grew big enough that the biggest seat in the school room was too small for them. They they gave up and spent all their time at farming.

I was at the other extreme because in our home schooling came first. At least it was sandwiched in between the morning and the evening chores. I finished the eighth grade when I was twelve years old. I learned to read when I was four because my sister started school then. She was less than two years older than I and in the isolation of ranch life we grew up quite close to each other. So when she started to school, setting off with a new primer, I was anxious to have a primer also. My brother was still a baby just about learning to walk, and so I was pretty lonesome. The folks got me a primer and a slate, and being both unlettered and lonely, I followed mother about as she worked, making the inquiries necessary to learn to read.

Chall: There were just three of you then.

McGauhey: Yes, just three. My sister, Dorothy, and my brother, David, and myself.

By the time I was six years old I could read the newspaper although I didn't know what it meant; I don't yet, but nevertheless, I could read the words. I learned to write on my slate, which was a standard, if noisy, appurtenance to schooling in my day. In arithmetic I did all the routines they taught through the third grade before I went to school. Later when I was in the sixth grade I worked the arithmetic problems for the eighth graders, but I was no

McGauhey: mathematical genius. In between I recall many evenings fighting both sleepiness and such problems as the number of tons of hay in an oval-topped haystack.

The result of my "thirst for knowledge" was that when I started to school there wasn't anything for me to do in the first or second grades. The teacher tried for a while to find something to get me occupied. Finally, he decided upon the third grade and I found something challenging to do. Thus by the time I was twelve years old I had finished the eighth grade.

As I mentioned before, my sister and I had two years to wait before high school was possible because of the residence problem involved with grandmother's homestead. The first year we went to the school regularly as before, and the teacher, who had a good high school education, taught us algebra, physical geography, and English. The next year we didn't go to school at all. World War I was at its height and ranch help was scarce. I took on a full load of ranch activities, and did some riding to look after range stock belonging to a neighbor who had bought my uncle's ranch. Then in 1918, before World War I came to an end, my father leased his ranch and we moved to La Grande, Oregon. There my sister and I entered high school and father went to work for the railroad; and later for a bridge company, as a carpenter. Grandfather had been a carpenter and cabinet maker, and father was likewise an excellent carpenter and violin maker. He could make almost anything with hand tools in metal, or wood, or leather. He had a good mathematical mind, although he did not have a lot of formal schooling by the standards of today.

High School in La Grande

Chall: The family moved so that you could go to high school? The three of you?

McGauhey: Only my sister and I were ready for high school in 1918. We moved on to Corvallis to go to college by

McGauhey: the time my brother was ready for high school.

When we moved to La Grande it was a railroad division point and a sawmill town. Its population was 60 percent Mormon and 30 percent Catholic. The other 10 percent each had its own church, it seems. Public schools were supported by the Mormons; the private schools by the Catholics. There was considerable rivalry between the two. Moreover, the town was not poor in those days because of the big sawmills, the railroad payroll, and a prosperous farming country as well. The result of all these factors was that La Grande had excellent schools. Looking back, I think that the only instance of a less than competent teacher in all my high school classes was that of a young woman whose specialty was typing and shorthand, but who was required to teach plane geometry one semester. I later studied typing under her guidance, by the way, and learned a skill that has been invaluable to me throughout the years.

She learned some geometry before the semester was over from a combination of my sister and me and one of my boyhood pals in high school. For the first month the three of us were totally puzzled. We didn't have the slightest idea what plane geometry was all about, and neither did the teacher. But suddenly it dawned on us. Thereafter, plane geometry seemed too obvious to require more than a single perusal. When this happy day arrived, the teacher would send one of the three of us to the blackboard to explain whatever proposition was assigned for the day. This helped us a great deal in our later teaching careers--and it got the teacher through the semester.

High school filled in a deficiency carried over from our elementary school days--a deficiency in knowledge of the structure of the language. Grammar was a subject assigned in the sixth or eighth grades. I was about to say that it was taught in those grades, but that would be an exaggeration of fact. Our one-room school teachers were, as I previously noted, not highly educated and as the gap between my ignorance and the teacher's ignorance narrowed, as it did in the upper grades, the feedback was minimal. For example, the teacher would tell us by

McGauhey: rote that an adjective modifies a noun, but "modify" didn't mean anything to either the teacher or pupil. So we did a certain amount of parroting and passed the grammar course, our errors probably undetected. This does not mean that we did not use correct English. Reading had taught us to use language but we didn't know the rules.

However, the high school requirement that we study a foreign language for two years was just what we needed. My sister and I elected Spanish because we were oriented to the language by what my father had learned in Central America. In those days you began language study with an in-depth examination of its grammar. So we learned grammar in Spanish and translated it back from Spanish to English.

All the time I was in high school I kept my horses but had little time for riding as I worked every evening on a popcorn stand and every night in a movie house. In summers I worked in the sawmills or in the fruit orchards to make the money for clothing and books. But as the time approached for going off to college both my father and I sold our horses and never owned one again, although we rode from time to time throughout the years.

College in Corvallis

McGauhey: I decided that I wanted to be a civil engineer so early in life that I cannot trace the origin of the idea. I doubt that I had much idea what a civil engineer does, but I had one time been in contact with a surveyor. The persistent rumor that a county road was to be built brought a survey party through our ranch and the men stayed at our house for a while. The road never materialized, partly because the county surveyor contracted Rocky Mountain spotted fever and died and the whole project fell through. Anyway, I came along with the notion that I wanted to study civil engineering. I was offered a scholarship to attend Whitman College in Walla Walla, Washington where I might study music or possibly science. But I didn't get started in music early

McGauhey: enough and I felt I would never make it in that area.

Chall: What music were you interested in?

McGauhey: The violin. I took violin lessons throughout my high school years and played in the school orchestra. Then I had a small dance orchestra in college, and a chamber music and beer-drinking society in later years. I had a lot of fun and I still enjoy playing music, but it was my judgement that I didn't have the fire-power to do it well enough. Besides, the desire to be a civil engineer had been around a long time before I thought of any alternative, so we decided that I should go to what was then the Oregon Agricultural College (now Oregon State University) at Corvallis.

By that time my father had become the principal partner in a leather shop in La Grande. He was an excellent leather worker, among his many talents, and he taught us a lot of the techniques. La Grande, however, is not the warmest spot on earth in the winter; thirty below zero was common in those years. The houses were indifferently heated with stoves and the wind scarcely slowed down as it passed through the old house we had rented. Therefore, father and mother decided the family might as well move to Corvallis. "If you all are going to college, we might as well too," he said. And so we moved to Corvallis.

My sister and I were ready for college at the same time. We had been in the same grade since the third grade and so continued until our senior year in college when I began the summer with an appendectomy and was unable to earn the money for the coming fall.

When we got to Corvallis, my father, who by that time was sole owner of the leather shop, opened it for a while; then closed it and went to work for the county, again as a carpenter on bridge construction. But after four or five years he opened the shop again and kept it in operation until at the age of sixty-eight he closed it and retired.

Chall: What type of leather goods did he make?

McGauhey: Almost any kind that anyone wanted made or repaired. He made boots and briefcases, and he braided leather bridles and trappings for horses desired by the horsey set. He repaired shoes and made special shoes for those who required them. But his local fame rested upon his ability to make or repair anything that someone else said couldn't be made or repaired.

I went to college at Oregon State when it had, as it has today, some excellent professors. Originally I was in the class of '26 but, as I have said, I ran out of funds at the end of the 1925 session. I came to California and stayed with an aunt of mine for several months; then, my health improved, I went back to Corvallis and went to work in a grocery store to get money for my final year. With a little borrowing at the last I finished my B.S. degree work in June 1927.

In 1927, employers were not standing in line to hire college graduates. I took civil service examinations and shopped around for about a month, finally getting a job with the U.S. Bureau of Public Roads. The Bureau was constructing a new highway on Mount Rainier from Narada Falls to Paradise Inn. It was a very interesting summer. It ended in my leaving the west to begin a teaching career, as I shall soon relate. First, a little more of the background that led me into teaching.

Decision to Teach

McGauhey: I might say that although my father was anxious for us to go to school, and made every sacrifice to make it possible, we had to carry ourselves beyond the contribution of food and lodging. I was small for my age and never weighed 120 pounds until after I went to college. The sawmill work in high school years was hard so by the time fall came around I was rich enough to pay expenses and beaten up enough to be glad to get back to school and the night shift in the movie house. In college, prior to my disastrous summer of 1925, I worked on a forest fire patrol on a lookout station during the summers and on the

McGauhey: janitorial force in the winters. I have estimated that I swept an area roughly equal to that of the state of Texas, but that may be an over-estimate. I supplemented my three hours per day on the broom gang with the orchestra and odd jobs. The summertime was somewhat lonely as for more than six weeks I saw no humans, although I reported in each day via telephone. I did observe a lot of detail of nature.

Chall: That was in Oregon?

McGauhey: Yes, in the magnificent forest area of western Oregon later destroyed by the infamous Tillamook Burn.

Chall: With so strenuous a work program, how did you manage to study?

McGauhey: It has taken me overlong to get around to that matter. It was the work program that oriented me to the idea that I was better suited to live by my brain than by brawn, which I did not have. I studied with the same intensity that I worked, but part of my learning technique led on in the direction of teaching. Both in high school and in college I always had a satellite group of fellow students who were concerned to pass their courses and to say in school. They seemed to rely on me to explain to them what they didn't understand--which in some cases was considerable. My father often told me that if I charged my hangers-on I wouldn't have to work so hard. But as I told him, I came to understand the subject matter of my courses by trying to tell my satellites something that I didn't know too well myself. By experimenting with ways to penetrate their darkness I came to see the light myself. I presume I saw it more clearly, as I got better grades than my students without withholding from them any key information.

In high school during my freshman year I assisted my fellows by doing it for them--a practice which I soon dropped for lack of time. I wrote themes for other students and collected fifteen cents per theme. Themes were usually required to be 150 words in length, which seemed to many students to be about a book-length novel. Despite my deficiency in the rules of grammar I could write "by ear," so to speak, on a

McGauhey: variety of topics. One thing about ranch life and hard work, you see enough action for a good many 150-word reports. It didn't occur to me then that writing themes might not be quite cricket, but the teachers never complained, the students passed, and I got the fifteen cents.

Chall: A pretty cheap rate per word.

McGauhey: Yes, although I think I am still writing for about that rate. I didn't gain much; just got so I could write faster and so generate the longer themes required in today's world.

Well, out of this background I began to think that perhaps I would like to teach. The idea developed near the end of my college days when it occurred to me that I really enjoyed matching my ignorance against that of another, working with people, and exploring the depths of natural phenomena.

Virginia Polytechnic Institute, 1927

McGauhey: While casting about for employment prior to going to work for the Bureau of Public Roads, in 1927, I had answered an advertisement in Civil Engineering magazine for an instructor in an unidentified college in the East. As the summer progressed it developed that the opening was at the Virginia Polytechnic Institute (VPI)--Virginia's land grant college--in Blacksburg, Virginia. The need was for someone to teach in the field of surveying and water power engineering. I had taken all the courses offered at Oregon State that dealt with water and water engineering. I am fascinated by water, probably because there wasn't any where I grew up. I neglected to say before that the Middle Fork of the John Day River ran through our ranch, about a quarter of a mile straight down below our ranch house. But we were too busy to go near it and livestock patently preferred the water my sister and I had to wrench from the earth by means of a pitcher pump located in our well.

McGauhey: VPI was beginning a campaign to diversify its staff and I guess my background was about as diverse as one could ask. At any rate I accepted the offered instructorship and moved to Virginia. In those days we got $1500 for nine months. I believe it was actually $1560, the difference being far greater than the affluent instructor of today might think.

During my senior year I had been working in college at surveying and drafting, having graduated from the "broom gang" with the disaster of 1925. At VPI my new boss and Head of the Department of Civil Engineering, was Colonel R.B.H. Begg. Colonel Begg was a lineal descendant of Robert Burns, a delightful gentleman, a good civil engineer, and perhaps the most highly and broadly educated man I have ever known. He put me to work the first day on some surveying and drafting for the college, inasmuch as school had not started, and finding that I was a skilled draftsman he never let me off the hook from then on.

The Department of Civil Engineering was responsible for all the engineering work for the college: mapping, grading, constructing drives and walks, refurbishing buildings, developing and operating the water supply and sewerage systems, and supervising general construction. Thus I had the opportunity to do engineering work right from the beginning, even though I was not in a location where there was outside engineering that the young man could get involved in. In those days, 1927, and the years that followed, fifteen credit hours was a normal teaching load, although few faculty members ever got through the year without at least one quarter with eighteen credit hours of teaching. I often contrast this with the one or two courses we hear about today and through the years have found it hard to shed a tear for the poor overworked professor. But in any event those were pretty heavy loads, especially when doing engineering work along with it. I recall one year in which I put in six hundred hours at drafting besides carrying the fifteen-eighteen hour teaching schedule.

Chall: What subjects were you teaching?

McGauhey: In that first year I taught three or four varieties of surveying and water power engineering. But that was only the beginning. The variety came later, as I shall describe in due course.

At the end of the first year I invested in a secondhand car and drove out to Oregon to marry Marguerite Gerow, whom I had met in college. We sold the car and bought passage on a ship bound for New York via the Panama Canal and Cuba. Back in Blacksburg we didn't have any money and we didn't have a car. We had to walk all winter but felt it worth the price. Our salary was $1800 that year; and we stayed on at VPI because it soon became apparent that the college was going my way in my time. I had begun to do graduate study in what turned out to be sanitary engineering, chemistry, and microbiology. A minor area of study was required as well as a major area, so I selected mining engineering because it was one of the important activities in the coal mining country. I learned a great deal about coal mining which I never practiced, although on one occasion I did teach all the courses offered in mining that quarter because the professor was taken ill. For this presumption I offered no apologies because the professor was a miserable teacher, although a fine engineer, and the likelihood of my doing worse was remote.

Chall: You were teaching the second year as well as taking all these courses; you were still an instructor with that heavy load?

McGauhey: Oh, yes. Loads never seemed to be any great problem. I didn't know there was any other way of life and it never occurred to me that work could be overdone. It is largely a matter of organization and speed of reaction.

In 1929 I received the Civil Engineering degree from VPI--the equivalent of a Master's degree--and was promoted to Assistant Professor at a salary of $2400 per year. I worked that summer on construction and the following summer for the shipyard in Newport News, Virginia. Then I decided to go to the University of Wisconsin to work for the PhD. In those days we had to pay our own way in graduate

McGauhey: school so much of it was done in the summers at Wisconsin. By that time I was teaching water supply and sewerage, microscopy of water, chemistry and biology for sanitary engineers, water power, surveying design, and a few optional courses in applied hydraulics and public health engineering. I also was teaching two courses in photography, mostly at night; and doing a considerable amount of professional photography and writing. By 1934 I had everything done for the PhD except writing the dissertation, for which the research was finished, and completing the language and residence requirements. Then I broke down with tuberculosis.

Chall: You were living in Wisconsin?

McGauhey: No, I was still living in Virginia.

Chall: And studying for the PhD at Wisconsin?

McGauhey: Through summertime classes in Madison and off-campus research during the winter.

Sanatorium Years

McGauhey: My physical breakdown was, perhaps, no surprise to others who have greater respect for the limitations of the human body. But be that as it may, I went into drydock with a 5 percent chance of ever getting out; and, in fact, with scarcely more than a 5 percent chance of living for six months.

Chall: You must have been walking around for some time with tuberculosis.

McGauhey: Of that there can now be little doubt, although I was examined from time to time by the normal routines of that day. Evidently, I came from tough stock and it took a lot of beating to knock me out. And by then the hour was late.

I went to the state sanatorium and as time went by I began to gain in weight and strength. But there was a small cavity high up in the left lung

McGauhey: and neither the pneumothorax nor the phrenectomy procedures could close it up.

Chall: Did you then stay home and rest?

McGauhey: No; I spent more than two years in the sanatorium and in the hospital. My wife stayed on and worked at VPI. Eventually I went to the University of Virginia hospital in which we had a health membership and risked the surgical routines. In those days they were just starting to collapse lungs by thoracoplasty and the percentage of survival was about 10 percent. I elected to take that chance rather than to drag on to eventual certain disaster. The surgery was done in three operations. The first two were done two weeks apart in the summertime when it was as hot as few places can match. There was no air conditioning at that time, so both the surgery and the weather sweat me out but I held on. Eventually a head nurse with a bad cold came in and sneezed in my face and the results were as bad as you might suggest. Again my ancestors pulled me through and the surgery cleared up the TB. So after the drydock years I went back to teaching at VPI. Of course, I rested some in the afternoons for several years, but I had no more trouble with the "bug" and lived on to become somewhat of a medical miracle and as active as ever in all aspects except "ground speed" and the strenuous types of physical labor.

During the two years I spent in bed I had plenty of time to read; and I did read and write a lot and do some study of cartooning.

Chall: What did you read?

McGauhey: I read all manner of things. I had every magazine you can imagine. I subscribed to the weekly newspaper from Mexico City and got so I could read even the Indian dialects. And I read classics, I read history, I read economics. Sometimes I got tired of reading, but I did a lot of it, and thought a great deal about what I had read and experienced.

When I got out of drydock I went back to Wisconsin, did a new round of research, and wrote

McGauhey: a new thesis. But World War II caught me without the required residence and the language requirements. I had either to settle for a Master's degree in the hydraulic and sanitary engineering field or leave VPI and stay around Wisconsin while, as it turned out, I would have been left to do most of the teaching. So I settled for the M.S. and went back to my position at VPI where I became full professor of Sanitary Engineering.

Chall: You never did get your PhD?

McGauhey: No, but that was not a catastrophy. By the time the war was ended it was no longer of any great importance. Of course, if the degree had been the all-consuming goal of my life it could have been achieved. But there comes a time when a man has shown whether he can grow scholastically and professionally. At that time the degree that suggests that the young man has such a potential is no longer critical. Either you have achieved some measure of growth or you are not going to. So in my case and at my age it was more appropriate to look to new goals rather than to achieve the goals of yesterday.

In 1936, when I was back from the hospitals, our sanitary engineer departed from VPI for a government post and I inherited the Division of Sanitary Engineering. I continued to teach undergraduate courses and graduate courses in both sanitary and hydraulic engineering and to keep up the photography courses. I worked one summer for the state on its marine biology boat engaged in shellfish sanitation work on Chesapeake Bay. I designed and built a sewage treatment plant for the town and the college and built several smaller treatment works. I built a small power plant and dam, drilled water wells, and conducted team research on stream pollution by cities and industry. I served for five years as the Civil Engineer member of the State Board of Engineer Examiners, and came to know most of the engineering profession in the state.

In 1948, when I had been professor for some ten years an opportunity arose to move to California.

The Move to California, 1948

McGauhey: My wife and I had always told ourselves that someday we would like to move to California and eventually retire there. We had visited there often through the years and were inclined to the idea that if you have the opportunity you have talked about for years, you ought to take it. The opening was for a professorship at the University of Southern California. After considerable hesitation we accepted.

Uprooting was even harder than we had expected. Our entire married life of twenty years had been spent in Virginia and we were not thinking of any going home in returning West. We loved Virginia and I was at the top of the profession there. So many students had gone through my classes that I felt that we knew everyone in the state. However, there was one deciding factor of which I have not spoken. That was a matter of ragweed hay fever. It had long given me trouble but after the pulmonary episode it moved in in earnest. Thus I was in misery or in the hospital every summer, and the irritation softened me up for another two months of misery when the furnace dried out the house dust in the winter. It was becoming obvious to me that Virginia was not the ideal climate for me much longer with my history of problems and the severity of the allergy.

Once the move was made we enjoyed life at the University of Southern California. We bought a house and settled down with the intention of staying. However after two years, and through no particular fault of the university, it became evident that it could not go my way in my time, so I went back to VPI as head of the Department of Civil Engineering, replacing Colonel Begg who had retired. But an era at VPI had come to an end. All the people who had led the college in my years were soon to be replaced. Dean Earl Norris was about to retire; a new president had been appointed; and a new direction of growth was in order. It struck me that one ought not to linger on as the bridge between the past and the future. So in this mood, and with ragweed season soon to come around, I was receptive to events that were to bring me back to California.

Chall: When did this return to Virginia and California take place?

McGauhey: I went back to Virginia in 1950 and left there at the end of the 1950-51 academic year. A new era was beginning at the University of California under the guidance of Professor Harold B. Gotaas; the Sanitary Engineering Research Laboratory was just emerging, and Professor Harvey F. Ludwig, whom I had known in Southern California, suggested to Dr. Gotaas that he should have an assistant in the Laboratory and that McGauhey should be the one. But that is a story we are scheduled to discuss in a later interview.

Chall: Yes. Let us discuss today more of the background and personal factors which may have influenced your contributions in what you have called a "new era at California." You came to Berkeley in 1951?

McGauhey: We arrived here on July 4, 1951. I think that was the coldest summer Berkeley ever had. I do not recall that the fog lifted during the period July to September that year and, being somewhat of a sun worshiper, I wondered what sort of a place we had gotten into. Either we became acclimated or that was one of the worst years; anyway we have lived here and enjoyed it.

Chall: You seem to have crossed the United States many times during your career.

McGauhey: Yes, we did most of the traveling for the family. We had no children and so we came West to visit relatives a number of times before we made the two moves I have described. My wife had one sister and her parents living in the Vancouver, Washington area. My father and mother lived with my sister in Vancouver, Washington and subsequently in Eugene, Oregon after my father retired. My father lived until five days before his ninetieth birthday. He just finally wore out with age, although he did suffer some in final years from deterioration of the vertebrae injured sometime in his horse breaking days or from accidents on bridge construction. My mother died in 1971, six months past the age of 101 years, as a result of a fall which broke her hip. Her mind was clear until the end. Most of her sisters

McGauhey: lived into their nineties, the last one passing away in the spring of 1972 at the age of ninety-six.

An Attitude Toward Life and Work

Chall: You certainly came from good stock.

McGauhey: I credit my ancestors for the inheritance that made possible my survival. In 1934 I thought I had about used up my credit in that department, but in 1966 I borrowed on it again. No one expected the survivor of a thoracoplasty to carry on for thirty years so we were not surprised when I eventually had some trouble with staphylococcus lingering on after the annual or biennial flu that we all seem heir to. Scar tissue is a good place for such organisms because although they can't immediately get into the blood stream to harm you, you can't get at them either with antibiotics. Thus eventually they caused some small breakthroughs which showed blood.

I took the matter up with Dr. Paul Samson, Oakland's famous chest surgeon who explained the matter to me and suggested that there was no way of telling whether one might live until ninety and die of some other ailment, or experience a catastrophic break in an arterial wall. The alternative was to remove the old lung. Well, even after time had erased many of the memories of the three previous operations, I did not know whether I wanted any more surgery. After considering the matter for some days I said "Let's take it out." So Dr. Samson did just that.

Chall: That's done satisfactorily these days.

McGauhey: Yes they have made real advances in chest surgery. Back in the mid-thirties the survival rate was about 10 percent. Today it is 90 percent. It took me a little longer this time to get back into full stride but I'm better off than ever for having taken the hard road.

McGauhey: I suppose my decision in this matter reflects an attitude toward life that dates back over many years. While I was lying in the sanatorium reading, I had time to reflect on many things. I developed a philosophy of life that leads me to believe that a lot of things that worry many people shouldn't be taken too seriously. I have often said that everyone ought to be required to attend a performance of Gilbert and Sullivan every six months until he learns to recognize opera bouffe when he sees it. This routine would be especially useful to university employees--professors and administrators--who get ulcers or come apart at the mental seams at the things that go on around universities. Misfortune and good fortune left me glad enough to be alive, so that I don't take the comic opera of university life too seriously. After the drydock experience I approached my work with accustomed energy and seriousness of purpose, but when night comes I've been able to go to sleep without danger of ending up with ulcers.

Chall: It's a point of view, then.

McGauhey: It's a point of view, and it was a hard way to learn, but nevertheless, having learned, it becomes mighty useful.

Chall: You were able to use it effectively for quite a number of years; and I should think it would be better to work with a person like you who doesn't tend to take everything as if the next day was doomsday.

McGauhey: Obviously I would hope that such might be the case. One cannot know what other people think about him except if he is universally disliked. I only know that I have a multitude of friends all over the world and that I appreciate them. Instinctively, I like people. In that respect, as in many others, I am very much like my mother. I like people without having first to decide whether the way they behave is the way I want to behave myself.

Chall: You accept them.

McGauhey: Yes. Occasionally the payoff leaves something to be desired, but it strengthens one's character.

Avocations: Photography and Writing

Chall: You seem to have been dedicated to your work and to have developed a philosophy of life which makes your work satisfying to you. Can you suggest what inner goals have led you on?

McGauhey: I have spoken of my abiding interest in water; but I think that the answer to your question is that I have always been interested in anything that is going on. They said of Caesar, you know, "Because he was ambitious, we slew him." I have been to some degree slaughtered at times, probably because my ambitions were to satisfy my interests, rather than to dominate other people. I had ambition to do a lot of things. In fact, there wasn't much of anything I didn't want to do. I wanted to be a photographer; I wanted to be a writer; I wanted to be a musician; I wanted to learn how nature and man had put things together. So I hacked away a little at all of them and had a lot of fun, but was never willing to put all my energies into one of them with the intent of becoming world renowned in that area.

During the years that I taught photography, which I had studied in college, I did some pictorial work. There are some examples of it here on my office wall. I did an endless amount of commercial photography; pictures of machinery, laboratory setups, stock shows, and conference groups. I did some portrait work, especially of children, but didn't like this type of photography. People are no judge of their own portrait and so if you don't charge them an outlandish price they are dissatisfied. Children are fun to photograph but before the photographer can set up his equipment the parents begin poking at them until they get so confused and nervous that good pictures are quite impossible to achieve.

Chall: Where did you do this work?

McGauhey: At VPI. There I had a large darkroom and equipment setup in my home. But after I came to California I did not have any darkroom; and I did not have time to do more than make color slides of our travels.

McGauhey: I have also done an awful lot of writing, and perhaps a lot of awful writing, during the years.

Chall: Oh, you did that too?

McGauhey: Yes, I had to have something to do in my spare time.

Chall: You had some?

McGauhey: Probably it was more energy, or enterprise, than time that I had to spare. Anyway, I filled up most of the wastebaskets in the U.S. over a period of years, writing short stories and essays. I occasionally got one published.

Chall: Under your own name?

McGauhey: Yes, but they mainly served to teach me how to write. I did actually sell a poem; which isn't too common in the world of engineering.

Chall: No, it certainly isn't.

McGauhey: In college I found time to take courses in journalism and in short story writing. This latter course I took with a class of English majors and was one of the two members of the class that got an A grade. I suppose they were thinking about how to apply rules while I was writing "by ear" as usual and from better observation of human beings.

While at VPI I completed a book manuscript but did not work too hard to get it published after an initial rejection slip. I was moving to California at that time and so went on with other things. I came across the manuscript the other day and in reading it over, I now see what it needs. Half of it is salvageable, I think. In fact it is not too bad and I have in mind tidying it up when I can get through with the endless technical writing I have gotten into since my retirement in 1969.

Chall: Oh, that's a book that you haven't published. I've read the one that you did have published--your engineering book.* It reads well.

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*P.H. McGauhey, Engineering Management of Water Quality, McGraw-Hill, N.Y. 1968.

McGauhey: I wrote that in one summer to meet my lecture schedule for an Institute on Water Resources at the Utah State University. However, it is more fun to write with less discipline about subjects that give freedom to the imagination. In that category I wrote a book of poems, which I had published privately. I shouldn't say poems--it is really verse dealing mostly with ranch life. People that understand what I am writing about better than they do poetry seem to enjoy it, and I am giving some thought to including it with other material I hope to publish professionally.* But that doesn't matter here.

The point is that being interested in writing all those years, and working at it, has been a great help to me because in the countless reports, technical papers, and research proposals I have had to turn out I have generally been able to produce final copies without first drafting them. That doesn't mean that I do not do a lot of erasing and foul up the desk around me, but nevertheless it has been easy and I have enjoyed it. I have no idea how many things I have written.

Chall: Reports and papers?

McGauhey: Reports and papers, chapters for various books, editorial comments, essays, and journal articles. I like to get up in the morning and dash off such good-natured cynicism as this one which I call "To Raise a Cat."*

Chall: May I take this and read it?

McGauhey: You may, indeed.

Chall: What about your stories? Were they all on your background?

McGauhey: Actually not, except that they dealt with people such as wandered through my background years. Principally I am concerned with situations, people caught in situations they don't understand. I prefer to write non-fiction, and my book is of that nature and intended to be humorous.

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*See Appendix.

Chall: Does it concern things that went on at VPI?

McGauhey: No, that would be a task for a novelist. It is rich in material. I am concerned at present with an earlier period. You may understand that on a cattle ranch there's a lot going on. Prospectors spent the winter with us feeding cattle, sheep herders were everywhere, and interesting characters came and went. There is a lot of material in my memories of the one-room schoolhouse. There you don't do the kind of things you do when sitting with your peer group today. In one of my little essays, I reflect on what it would have been like to have turned up as a boy in our school carrying his doll to show to other kids.

Chall: Oh, yes. Show and Tell.

McGauhey: In a school room with merciless characters ranging up to eighteen years of age, life was traumatic enough just having to wear knee pants--but carrying a doll. God forbid!

The kind of things that children do today as children would have required a stouter heart in my school days than is given to man. But these are some of the kinds of things I find interesting.

The McGauhey Family and the Homestead Ranch

Chall: Well, they're lost, you know, if you don't get them down. The kind of society you knew is not with us anymore, and these things are useful to have in our collective memories, I think.

What happened to your sister and brother along the line?

McGauhey: My sister studied home economics when we were in college together. Later she went back and got her Master's Degree in Spanish. She taught in high schools all over the West, beginning, as I recall, in Nevada; then in Arizona, Washington, and Oregon. She retired in 1968 from Willamette High in Eugene, McGauhey: Oregon, where she had been for some years. Her husband was a forester in the Oregon state department of forestry. He was injured in the woods and died some ten years ago. So she stayed on in the teaching in which she spent most of her active life. She also worked for a while for the federal government back in the Depression days, when they were doing a lot of rural rehabilitation.

My brother studied mechanical engineering but he was graduated in the Depression years. He was inclined to go into farming and ranching, and after some months working at whatever he could find to do he bought some land at Junction City, Oregon. His energy and enterprise impressed the owner of the land who let him have it without any down payment. There he operated a general farm mostly producing seed grain and hay. He also owned enough sheep and cows to make some profit from wool and milk sales.

When his daughter and son went away to college, married, and started teaching careers of their own, he leased most of his land and went to work as night superintendent of a large pre-stressed concrete plant. His area of interest while in college included heat engineering and his responsibility in the plant was the proper steam curing of large beams and structural members such as those used in bridges and modern buildings. There is enough money tied up in a few of these units to bankrupt a company if the curing operation fails. At this time my brother and his wife continue to live on their land, although the crop land is leased to others.

Chall: So he got back into engineering after all. And your family didn't keep any of that land they had acquired in eastern Oregon?

McGauhey: No. They sold it while I was in college. People could make a living on that land only when a pioneer-type of life prevailed. We depended upon horses for power, and pumped water and sawed wood by hand. The time came when people just couldn't make enough by hand labor to support a family. The work on a ranch such as ours was about 75 percent overhead, maintenance, and repairs; only about 25 percent was productive. As you know, in any kind of activity today, if you can't do it with machinery you are not

McGauhey: going to make any kind of a profit. The margin is just too small. So homesteaders acquired ownership to the land by living on it and improving it for five years. Then when they had a clear title, they sold it and moved away. This phenomenon was already apparent in the decline in pupils in our school districts while I was in elementary school.

Land ownership went into bigger and bigger units until now, in 2500 square miles of the area we knew, there are only six ranches. These six do not own the entire 2500 square miles. Most of the land belongs to the Georgia Pacific Company. Our old ranch belongs to a man and his wife who, incidentally, was the eldest daughter of our nearest neighbor. She was a schoolmate of mine when we were children. Her mother was trained as a nurse in the area near Blacksburg, Virginia where I later went. She served as midwife at my birth and was, I believe, pregnant with the daughter at that time. Today the daughter and her husband own her parent's land as well as ours and that of other settlers. They manage 8000 acres and a lot of stock.

Chall: So it's basically still cattle country?

McGauhey: It's still cattle and cattle feed. They do little gardening now because the highways have made the towns accessible. Rural electrification has reached the area which helps to increase productivity. U.S. Highway 395 crosses the Middle Fork twelve miles east of our ranch, and quite a good gravel road runs along the river to the ranches, so the area is not isolated although it has few people.

The old house that my father built when I was four years old is still in use. The owners have put siding on the outer walls but otherwise it is little changed. In 1968 when I last visited there they had the same old screen door frame on the kitchen that was there when we left in 1918, and it was old then. I think it was secondhand when we got it. An old woodshed that my grandfather built in about 1911 is still in use. The roof is made of shakes which he rived out of yellow pine at the time. These shakes are still in good sound condition, probably because of the dryness of the climate.

McGauhey: I have been overlong in answering the question concerning the road that led me to Berkeley and the background against which my activities at the University of California might be understood or rationalized. Fundamentally, my summation is that I have always been interested in everything that is going on and have tried to bring that same kind of interest into research. Whatever comes along intrigues me, and in my ignorance I become curious about how it works. As I will explain later, if anything seemed to me to be worth doing, of if our Laboratory ought to be concerned with it, or if anybody was interested enough to work on it, I was interested enough to try to generate a project in that area. That it might entail work, was no consideration.

II BACKGROUND OF SANITARY ENGINEERING EDUCATION AT THE UNIVERSITY OF CALIFORNIA, BERKELEY

Evolution of Sanitary Education Curriculum in the United States

Chall: In our previous conversations you said that a new era at the University was beginning, under the guidance of Professor Harold B. Gotaas, at the time you came to Berkeley.

McGauhey: I am sorry that I used the word "new," because it implies that what went before was "old." And to many people anything old is per se worthless, or at least is valuable only as a memento of antiquity. Nothing could be further from the truth about the sanitary engineering program at the University of California at Berkeley. What I should have said was that, in 1951, one of those periods when university programs experience rapid growth and expansion had set in and its eventual horizons were unknown. Thus from my viewpoint there was an opportunity to help build the future without the handicap of my own institutionalized commitment to the past.

Chall: Then the University of California has a long history of interest and education in sanitary engineering.

McGauhey: It dates back over nearly two-thirds of a century. But to do it justice and to show how its strength influenced the expansion that began immediately after World War II--and at the same time to get on with the story of the Sanitary Engineering Research Laboratory--requires me to tell three stories simultaneously.

Chall: Not an easy task. What are the three stories?

McGauhey: The first story is about the changes in engineering curricula which affected the emergence of sanitary engineering as a specialty area of civil engineering. It concerns the background against which to describe and evaluate the program at U.C., Berkeley.

The second story specifically concerns the U.C. program. And the third outlines the situation which I referred to as a "new era." It also described the development of the Laboratory as an organized research unit.

To avoid the utter chaos, which I am capable of generating as a story teller, I think I should tell these three stories sequentially. In so doing I may have to use the familiar "meanwhile, back at the ranch" technique.

Chall: I am sure you can organize the material.

McGauhey: I shall certainly try. First let me outline the evolution of engineering education as it relates to sanitary engineering. The interpretations will have to be my own and the detail sketchy because it is not our purpose here to develop a complete history of sanitation. This may leave me open to criticism for omitting many important events, but it will advance our story.

Chall: Undoubtedly there are some significant highlights which are worth recalling.

McGauhey: There are several. First, I would say, is the famous Broad Street well case in London in 1848 when Dr. John Snow proved conclusively that there was something in water which caused the great plagues that had swept Europe for decades. Next was the verification by Koch and Pasteur that the something was the microbe. This was only one hundred years ago; in the 1870s. In those same seventies, also, European engineers learned again what the Roman's once knew about the hydraulics of pipes and aqueducts. In the 1890s the famous Laurence Experiment Station in Massachusetts revived, codified, and expanded what the ancient Chinese and Egyptians knew about water clarification. And

McGauhey: in 1910, disinfection of water by chlorine was begun in the United States. These and related events made public water supply an early factor in civil engineering education.

By the time I entered college in the early 1920s every student in civil engineering was required to study some basic hydraulics. He then took a course in water supply engineering. This involved finding and developing a source of water, transporting water to the community, treating it to some degree and distributing it to the householder. The course also involved the design of necessary pipes and structures.

Initially there was no special course in what we now call wastewater engineering. Hydraulic courses included the information necessary to design pipes and channels for drainage, or sewerage. The problem was to collect sewage or storm water in pipes and escort it out of town. This job was relegated to the street department because there was a certain degree of holiness associated with the clean water engineers. They didn't want to get involved with the dirty water boys.

Chall: Is that why the same pipes are used for sewage and surface runoff in many older cities?

McGauhey: Yes. Sewage treatment is a relatively recent development. It began in earnest in the 1930s. In San Francisco, for example, the most capable engineers in the U.S. in the 1920s recommended combined sewers; and they were built. It is easy to forget that our concept of the ocean as the cradle of life rather than a sink hole is of quite recent origin.

Once a safe water supply was achieved there was a loss of public interest in water quality until sewage pollution of streams and beaches brought the health department back into the act. So late in the 1920s we had to introduce a course in sewerage into all civil engineering curricula. This word "sewerage," incidentally, means the whole science and act of collecting, transporting, treating, and discharging of wastewater. The first course dealt

McGauhey: mostly with collection and transport but it wasn't long before it also included some degree of treatment. Thereupon, water supply and sewerage, along with hydraulics, or fluid mechanics, became standard courses required of all civil engineers.

The civil engineering curriculum had other standard requirements also. The goal was to make all civil engineering graduates equally prepared to go into structures, highways, hydraulic engineering, or general practice. There were a few elective courses, but for the most part engineering had to go through the first of two traumatic experiences before they became especially significant in terms of sanitary engineering.

Chall: What was the nature of these "traumatic experiences"?

McGauhey: The first was what I call becoming holy in the sight of the humanists. The second was a rush to become scientists.

I had better consider these one at a time, beginning with our efforts to make engineers human. As engineering emerged from its more respectable ancestor--natural philosophy--the concept that engineers were an uncultured lot was echoed by various disciplines which considered themselves to be culturally superior. This routine, you know, is one way to put down those whom you cannot get at in any other fashion--the assumption of cultural superiority. As far back as I can remember, and until World War II, the French used this technique effectively on Americans. But that is another story. Engineering curricula were in need of a reexamination anyway. They were top heavy with "how-to-do-it" courses based on current technology which was no longer current by the time the graduate was responsible for the doing. There was a certain amount of loss of self-confidence and a rush to confess our scholastic sins. But I think we in engineering education generally agreed that we had to make room in the curriculum for enough of the so-called "humanities" and general subjects to give engineers a greater area of common knowledge shared with other humans. At least, that was the theory, and we proceeded to institutionalize it in our accreditation criteria.

Chall: About when did this occur?

McGauhey: Generally in the early 1930s, although it was advocated and accomplished in different universities at different dates. So we stripped out part of the required courses dear to the hearts of some professors in order to make room for the humanities.

Chall: What did you strip out?

McGauhey: Railroad engineering, is a good example. The railroads were all built before we abandoned our courses in how to build one. And we dropped about five courses in surveying. We used to teach lots of courses in surveying, not just control surveys and mapping. We had courses in land surveying, city surveying, railway and highway curves and earth work. And we had courses in precise surveying and in astronomical surveying. All these were required in civil engineering. Drafting and descriptive geometry were also required.

When I left college, back in what is now the Late Stone Age, every civil engineer was expected to do time on the drawing board and in driving some stakes and doing surveying work.

Chall: Doesn't he anymore?

McGauhey: No. But the reason is not that at one time men did senseless things which were abandoned later when they regained their senses. It is that as knowledge and technology advanced so did the spectrum of skills needed to do the work of society. In engineering education the choice was between lengthening the period of formal education to something like the life expectancy of man, or increasing the variety of specialists required to carry out an engineering project.

Chall: You followed the latter course.

McGauhey: Yes. Especially after the second trauma which I shall soon discuss, surveying and drafting became classified as sub-professional activities. By "sub-professional" I don't mean beneath the dignity of man, but specialty areas which can be mastered

McGauhey: short of education as a professional engineer. Surveying and drafting are important work that technology cannot do without, but there is no need to waste the time of people in preparing them for their careers. I once observed the supreme example of over-education--a chap with three degrees beyond the master's, who was peeling potatoes for his wife who cooked in a logging camp.

However, as I have implied, most of this shortening followed Trauma No. 2, but we did some of it in making room for the humanities. We eliminated design of wooden structures but we continued to make every student of civil engineering take courses in steel design and concrete design. Design by that time depended less on drafting than before, especially in skill of drawing rivet heads. In my college days they used rivets in steel structures; so we drew thousands of rivet heads in our design courses. And after you've drawn a few thousand little circles, there isn't much you can learn by drawing ten thousand more.

With the decline in drafting as a requirement we discontinued our course in descriptive geometry. If you can't express yourself in graphic language there isn't much use in being able to visualize the conjunction of physical forms in space. It is analogous to being a poet without being able to speak or to write. I might say, that as it turned out later, one man with the ability to visualize can arrange for the computer to draw the intersections of forms needed for constructing what engineers design.

But I am letting my interests lead me astray. The point here is that we eliminated from civil engineering requirements some courses in "how-to-do-it" and how to do sub-professional tasks. This made room for our beginning, however grudgingly it may have been, to get in at least some of the things that have since been called "humanities."

Chall: Those were what?

McGauhey: Courses which deal generally with information you can't possibly sell to anybody. My criterion for

McGauhey: identifying one of the humanities is simple; if the knowledge gained is of any use as far as peddling it off for sale, the course doesn't qualify. But if it stretches the human imagination, or broadens his concept of life and his understanding of people, or acquaints him with what philosophers have thought and said--and what good came of the saying; or if it introduces him to the accumulated wisdom of mankind, acquaints him with history, and makes him think about its lessons; it is, in my opinion a "humanity" at its best.

Chall: That's an interesting definition.

McGauhey: I trust that it reveals my respect for the humanities in engineering education. Unfortunately, the question of their true worth has not been asked by the engineering educator. Once room was provided in the engineering curriculum for the "humanities," nobody bothered to inqure whether a course was taught by a competent or incompetent individual. Too often, in my experience, the assumption of cultural superiority has generated the assumption that engineering students are unteachable and hence should be confined to special sections assigned to disinterested teaching assistants or to tenured deadheads who might dull the enthusiasm of majors in the humanities. The record here has been spotty--ranging from excellent courses to those which should not be tolerated by either the engineering or the humanities departments.

But quite aside from the merits of the package of humanities, is the effect on sanitary engineering education. This is what our discussion is concerned with this morning.

Accommodating the humanities had several fundamental effects. It caused us to start recognizing that we were not simply minting pennies--that all civil engineering graduates need not have exactly the same exposure to engineering subject matter. Obvious as this may seem on a rational basis, it was not accomplished without academic travail. Professors do not readily agree on anything, especially if it endangers their favorite courses. But we managed

McGauhey: to get more of our courses into the elective category. These courses we packaged into options; one of which was sanitary engineering. Thus during the 1920s and 1930s we moved in education in the direction of specialty areas at the undergraduate level. By offering courses beyond those normally required of civil engineering students we turned out graduates at the B.S. level who were pretty well specialized in the sanitary engineering area.

Chall: What were some of these courses?

McGauhey: First in the package were the traditional courses in water supply and sewerage. Relevant courses such as hydrology and hydraulic engineering were also available. To these we added courses in the principles of treatment processes, and in functional design of both water works and sewage treatment plants. We added a course in sanitary engineering laboratory. In this the student learned to perform the tests necessary to the operation of treatment works and to an evaluation of their performance. We also offered in civil engineering a course in public health engineering. It involved several kinds of information; rural water supply--wells and springs; devices for dealing with human wastes in the country--the septic tank and even the old pit privy. It included dairy sanitation, milk sanitation, restaurant sanitation, rodent and mosquito control. These things are done today largely through sanitarians and health inspectors. But there was a time when engineers in the health department were responsible for most of these rural and specialized problems as well as for the public water supply and wastewater systems. Some of us offered a course in something we called hydrobiology.

Chall: I don't know what that is.

McGauhey: It is a term we no longer use, but the course concerned what is going on in the way of life in waters; how it affects water quality; how an examination of it may be used to detect pollution; and the effects of wastes from human or other sources. In those days we were more concerned with sewage than with industrial wastes, but we were concerned with things the ecologist is excited about today. You see, some of us went to a great deal of effort to

McGauhey: prepare ourselves in this area a generation ago because few biologists of the day were interested.

Pioneers in the Profession

McGauhey: Here I think I ought to do a bit of explaining. I have talked of how we developed a whole profession of sanitary engineering by providing courses in our colleges and universities. But it is the role of the engineer to make use of the findings of many disciplines, including his own, in producing the systems, hardware, and structures needed or wanted by man. In engineering, educators cannot simply manufacture courses out of their own imaginations. There has to be some body of pertinent knowledge before there can be a profession. And that knowledge need not have been generated specifically for the purpose of engineered systems. In designing our courses we had a considerable body of knowledge upon which to draw.

I cannot possibly in the time available today give credit to all the pioneers who were responsible for this knowledge. I have already mentioned the Lawrence Experiment Station in Massachusetts as a major example. Allen Hazen had developed and demonstrated his theory of sedimentation. The U.S. Public Health Service assembled in its Cincinnati laboraties such men as H.W. Streeter, C.T. Butterfield, W.C. Purdy, and James B. Lackey. Earl B. Phelps of public health fame at Columbia University joined with the PHS group in pioneer studies of the Ohio and Illinois Rivers. The work of this group helped establish a basis for drinking water standards; clarified the interrelationships between organic wastes and aquatic life, as well as water quality; and generally evolved the objectives of engineered systems for pollution control and the principles which should go into designs intended to protect the public health.

Meanwhile at California, W.F. Langelier was developing the theory and process applications needed in water purification, and Charles Gilman Hyde

McGauhey: was teaching civil engineers how to utilize all this knowledge in engineered systems. We drew heavily upon the work of these men, and others who I shall be flayed for not naming, in designing our courses in sanitary engineering.

Simultaneously, for less direct engineering purposes men like E.A. Birge (Wisconsin), M.C. Whipple (Harvard), H.B. Ward (Illinois), J.G. Needham (California), R.K. Kudo (Illinois), G.M. Smith (Stanford), G.E. Hutchinson (Yale); and others who I shall again be flayed for not citing, were actively generating scientific data which we found applicable in sanitary engineering. Without identifying the scope of the interest of each of these individuals, I may say that sanitary engineering drew upon their discoveries in fields which we today call limnology, algology, protozoology, aquatic biology, ecology, and so on. It was from their work that we put together our initial courses in hydro-biology.

But I have left until last the two greatest deficiencies in courses required in any sanitary engineering specialty--sanitary chemistry and sanitary microbiology, called simply bacteriology in those days. Engineers generally took one year of inorganic chemistry in the areas of qualitative and quantitative analysis. What the sanitary engineer needed beyond that was a combination of organic and physical chemistry scaled down to his available time, tangential to his background in chemistry, and interpreted in terms of water quality. In microbiology, his need was even more desperate, because he had no elementary course in the area.

It is interesting and distressing to note that engineering has long defined science as chemistry, physics, and mathematics and persists even in 1972 in ignoring biology as a basic requisite course.

Solving this question of sanitary chemistry and microbiology course needs was not readily accomplished. There were seldom enough students to justify special courses within the chemistry

McGauhey: and biology departments; there were few professors who knew enough about water to develop one; and the engineer could not conceiveably follow the route of students majoring in chemistry and in bacteriology to achieve his goals. In many institutions this problem continues unsatisfactorily resolved.

Chall: What has been the situation at the University of California?

McGauhey: I purposely delayed mentioning chemistry and microbiology until the end of my first story in order to sharpen the contrast between the general situation and the situation at Berkeley. Here the story is gratifyingly different. Here the problem was solved at the very start by employing a competent chemist, Professor W.F. Langelier, directly in the engineering department. Thus the sanitary engineering program at the University of California began with a man who had both scientific knowledge and an understanding of how it related to sanitary engineering.

Evolution of Sanitary Engineering Curriculum at Berkeley, 1905-1945

McGauhey: The story of sanitary engineering as an identifiable area of civil engineering at the University of California began in 1905 when Professor Charles Gilman Hyde joined the U.C. staff. Hyde was an engineer's engineer--a designer, a builder, and an innovator. His interests were outstandingly broad. He was a highly organized individual and his files are a storehouse of knowledge on every aspect of what is now sanitary and public health engineering. His lecture notes on refuse management, for example, show that he was twenty-five years ahead of the rest of us in understanding of the problem and of its possible solutions. I do not know precisely what problems he encountered at Berkeley but I do know that the problem of chemistry and microbiology for engineers was solved in 1911 when Professor Wilfred F. Langelier joined the civil engineering staff also.

McGauhey: Professor Langelier was educated as a chemist but came to Berkeley by way of the Illinois Water Survey. I might note that the survey has for three-quarters of a century been an outstanding agency. It was a good place for a young man to start a career in water quality control. Professor Langelier brought to the University a rare combination of the pure scientist and the practical innovative engineer. At a time when most men dealt with isolated phenomena, he unlocked the secrets of the equilibria on which they depend. And he designed the processes by which to harness them in practical treatment plants. Consequently, his influence on both the science and the art of water quality control will not soon be forgotten. He is among the giants from which sanitary engineering drew its substance. And the program at California had the benefit of his guidance. Thus it was well established long before the years I described in my first story.

Both Hyde and Langelier were enthusiastic and dedicated teachers. They were also among the finest members of the human race. I can understand why they attracted top quality students.

During the period from 1911 to World War II the team of Hyde and Langelier turned out an outstanding group of sanitary engineers. Essentially all of the leading sanitary engineers in public service and in consulting engineering in California were students of Hyde and Langelier. Professor Harold Gray was also a member of the team who should not be overlooked. He taught the courses in public health. In those days there was no school of public health. Langelier taught the chemistry and microbiology. Hyde taught the engineering.

Related course available to the student concerned with the water supply and water quality aspects of sanitary engineering were available. You will recall from Professor Sidney T. Harding's memoirs that he and Professor Bernard A. Etcheverry had a very strong program in irrigation engineering.*

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*Sidney T. Harding, "A Life in Western Water Development," 1967; Regional Oral History Office, The Bancroft Library, University of California at Berkeley.

McGauhey: So the student who wanted to go beyond the required courses in water supply and sewerage then took courses in sanitary chemistry and microbiology, design, hydrology, irrigation, refuse disposal, public health, and similar subjects as he had time. Those who followed that route at California came out well prepared for advancing the level of sophistication of sanitary engineering systems of their time. Details of the program, I think, are best presented by Professor Langelier himself.*

This went on until World War II. During World War II, we ran out of students in most of our schools. We always enrolled a few, and we also had some Army personnel. The Army Specialized Training program sent men for short term training in the field of sanitation. But during the war years the program at Berkeley, as elsewhere, lagged for want of students.

Developments After World War II

McGauhey: In the interval just before the close of the war--in 1944--Professor Hyde retired. But when the war was over there came a big flood of young men back to college under the G.I. Bill. There was a demand for expansion of every institution; and scarcely a one that didn't tool up a great deal to do something about it.

Chall: And the University of California was no exception.

McGauhey: Indeed not. But to describe what occurred at Berkeley beyond expanding its staff to accommodate numbers, I will have to go back and introduce my third story; the one I have been calling "trauma number two." It parallels trauma number one; only this time it was science rather than humanities that shook up our program.

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*Langelier, Wilfred F. Oral history in process.

McGauhey: During the war the physicists worked under a protective cloak of secrecy in developing atomic weapons. There they closed very rapidly the time gap between discovery of a principle and its application in hardware. This was in contrast with the long lag period normally found in public works. Most everything we were doing in pipe lines in the twentieth century was known by the Romans. Basic scientists have generally prided themselves in pure discovery. Engineers have later--sometimes centuries later--put it to practical use.

Shortening the lag period meant that the discoverer and the user were often the same man, as in this case the physicist. This frightened the bejabbers out of the engineering profession. Scientists, particularly physicists, were now about to inherit the earth and there would no longer be used for engineers. So now we had to get holy with the scientists. But having traded in our how-to-do-it courses for humanities we were about out of trading stock in our undergraduate curricula. At least, until we could go through a lot more soul searching.

We began at once to re-examine the undergraduate courses but we guessed correctly that it would take several years, and the effect would be minimal. By that time it would be too late. We had to act quickly to become scientific enough to meet the threat on its own grounds. That meant graduate work, including a PhD program. Physicists have PhD degrees, you know, and to compete with them as scientists called for more than our customary undergraduate knowledge of physics and chemistry.

As it turned out the PhD was a good thing for engineering; not because it enabled engineers to protect their field from physicists, but because it enabled them to utilize science in the far more sophisticated systems needed to solve the engineering problems of today.

Chall: Was the PhD program in sanitary engineering something entirely new?

McGauhey: No but it was uncommon, and it had not been initiated

McGauhey: at Berkeley. If I recall correctly, the first PhD specifically in sanitary engineering was granted by Harvard University in 1925 in a program initiated and led by Professor Gordon M. Fair. In the years that followed, his graduates initiated programs in other universities. But for the most part these were the master's programs; the ones that offered in the fifth year most everything that constitutes a technical specialty. As I have said, curriculum changes growing out of the humanities trauma generally brought the student to the fifth year before he was free to take specialty courses. This enabled us to increase the degree of sophistication of the courses because the students were more mature. And we increased the variety of courses as well.

But I must not imply that Harvard was the only university that offered the PhD in the sanitary engineering field. Several did so with different areas of emphasis. Johns Hopkins, MIT, North Carolina, and Wisconsin were among the early group. I do not have in mind the entire list nor when they first entered their PhD programs. VPI joined the group after the war. I would say that there were perhaps twelve or fifteen such programs in the U.S. by 1946 when Professor Harold B. Gotaas came to Berkeley.

Chall: Dr. Gotaas took Professor Hyde's place?

McGauhey: No, you could hardly say that he took Professor Hyde's place. The world had so changed with the war that there was a whole new set of conditions to be met. The PhD program was only a part of it. We were at the threshhold of an era of expansion of programs, a proliferation of sanitary engineering curricula throughout the U.S., government sponsored research and training grants, and a new consciousness of environmental pollution which required attention.

So Professor Gotaas took over a part of the position formerly assigned to Professor Hyde in the College of Engineering. With that he became responsible for the engineering aspects of sanitary engineering. The other part of his position was vested in the newly created School of Public Health.

McGauhey: Principally he was to develop the area of environmental health sciences and to coordinate the program in sanitary engineering and the environmental health sciences so as to exploit the strength of each to the benefit of the University.

Chall: Was Professor Gotaas a public health engineer also?

McGauhey: In the United States it is difficult to distinguish between the sanitary and the public health engineer. For the most part the public health engineers in health departments have been educated in engineering in the sanitary engineering programs. Thus they work with people educated in other aspects of health for regulatory purposes but they are still sanitary engineers. In fact, the Bureau of Sanitary Engineering is a common section of a state health department.

In Professor Gotaas' case he was experienced with all aspects of the task before him. He got his doctorate at Harvard and was teaching at North Carolina when the war broke out. However he had prior experience in public health programs and in consulting engineering. He went on active duty during the war and worked on health problems of the Americas. When he came to Berkeley he had just been president of the Office of Inter-American Affairs. So he had plenty of public health experience as well as sanitary engineering experience, both in teaching and in design. He was well prepared to start the new program.

The least well known of the tasks ahead was that associated with the School of Public Health. Schools of public health were a relatively new phenomenon. Perhaps we had best talk first about that aspect of the situation before we get on with our story.

The School of Public Health

McGauhey: The School of Public Health is somewhat different than the College of Engineering from an academic viewpoint. A college, I am sure you understand, is an administrative unit led by a dean, and which has structured departments within it. Specifically, a college has undergraduate students; that is, lower division students in the several departments--civil engineering, mechanical engineering, etc. Such was the traditional structure of the College of Engineering.

The School of Public Health, on the other hand was a professional school. This resulted in the greatest assortment of academic dilemmas I have ever seen. To begin with it had some eighteen diverse specialty areas--administration, epidemiology biostatistics, public health engineering, health education, material and child care, sanitation, and so on--all representing appropriate activities of a large organized department of health. However, it had no departments. Each specialty area was a one-man department anxious to accept and further the education of students interested in that area.

But the degree structure of the school was the Master of Public Health, and the Doctor of Public Health. The objective of these professional degrees was to broaden the background of the specialist and so to prepare him for administering a public health unit or a department of health. To qualify for the program the individual was required to have at least two years of experience, and already hold a degree. Here dilemma piled upon dilemma. Each professor, and in fact each student, wanted to work in his own specialty area. Yet everyone from the M.D., with eight years of advanced study, to the sanitarian with a B.S. degree were to prepare themselves in the same courses to administer a health department. Everyone knew that no one but the M.D. will ever become director of a local department of health. And even in a large department the sanitarian will not be in a large enough section to require the MPH for his administrative duties. Public health engineering was an engineering college function, except for preparation for health administration.

McGauhey: The question then was how to advance students in eighteen specialty areas under a degree umbrella that had only a single purpose built around a set of required core subjects. To make chaos certain, the school began with the admission of a number of undergraduate students. And to make the dilemma complete--a dean is an academic anomaly unless he has departments. Therefore, it was necessary to appoint one individual as head of the Department of Public Health, than give him also the title of Dean so that he might supervise himself, yet have the appropriate hierarchical title to sit with deans when the affairs of the school were considered.

Chall: It sounds like an all but hopeless task.

McGauhey: Well not all of these incongruities had surfaced at the time Professor Gotaas came. And they were not all resolved when he left. It was known, however, that the student should become professionally oriented in his particular specialty area to some extent, but broadly oriented to the whole field of public health. This took a lot of doing and it wasn't easy to resolve. But nevertheless, creation of the School of Public Health at the very time they were ready to refurbish the program in sanitary engineering was part of the picture when they brought in Professor Gotaas.

Chall: How was the problem ever solved?

McGauhey: In the academic world one learns to live with problems, hence a total resolution is not always possible. But I may say now, and explain later, that we did three things to resolve the problem--after a few years of trying to identify the problem. First we discontinued the undergraduate program. Then we shrunk the required core course material to the extent that each student had some time to study in his professional specialty area. Finally we added the M.S. and PhD degrees to accommodate the student who wanted to apply his knowledge of any science or other field of learning to the area of public health. But much of that came along later.

To begin solving the problem, Professor Gotaas took stock of what we had left after the war.

McGauhey: Professor Langelier was still with us at the time and teaching the chemistry. In the PhD program to come it was recognized that chemistry would be one of its strongest areas in and beyond the M.S. level. Thus more of Professor Langelier's time would be needed in guiding research. Therefore it was decided that microbiology should be vested in a professional microbiologist. Since he might have a strange professional home in the School of Public Health, where there was other activity of a biological nature, Professor Gotaas proposed to place him there. The idea was that although his professional home and payroll status was in the school, he would in fact be the microbiologist for sanitary engineering.

Re-evaluation of the Curriculum

McGauhey: Engineering curricula are always under constant scrutiny. The humanities experience did not for long suppress the idea inside engineering that the engineer should become what I call a "specialist in generalities." From the outside, the blame for failure of the non-technical specialties to solve economic or social problems for which they were educated, is normally placed upon the engineer. This current pastime was abroad in 1946 as usual. Therefore, one of the early problems in establishing the graduate program was what changes should be made in engineering course context and requirements.

W.C. Pardy, in the Public Health Service, had a sign on his wall dealing with how to write a technical paper. It said, "Revise, rewrite, delete, deplete, de-gas, de-water, and de-bunk." Step one was to apply that criterion to existing courses. This began in 1946 and continues in 1972. Looking back I see that in sanitary engineering the principal task was to de-gas courses without depleting them too much, and to resist the perennial desire of structures-oriented civil engineers to de-water the curriculum entirely.

McGauhey: At the undergraduate level there was competition between the various areas of interest in civil engineering for curricular time. We were slow to recognize that the total of human knowledge had overrun our concepts of what a four-year curriculum should contain. The truth was that sanitary engineering as a field was by 1946 already more diverse than was the whole field of civil engineering prior to 1920. The same was true of the structural engineering area. It had long since forgotten about drawing rivet heads and was eager to get room for such engineering sciences as elasticity, plasticity, computer science and so on. Transportation was no longer a course in pavement design. Traffic, vehicle safety, freeway "spaghetti," and numerous other environmental aspects were important.

In 1946 professors were all eager to get a foundation established in the undergraduate years on which to build both their scientific and engineering graduate programs. But there were still several types of resistance. We were not ready to abandon the historic concept that every civil engineer should take a course in electrical engineering, and another in mechanical engineering for the good of his soul. We did recognize that these courses had been generally useless for at least a generation. But we still hoped this could be corrected by correcting the course content--one of the most persistent of all the futile notions I have experienced as an educator.

Within the department we also behaved in predictable fashion. It was a rare professor indeed who could entertain the possibility that society could survive a generation of civil engineers who had not taken his favorite course. This applied both to his existing course and to the scientific dream course he proposed to generate. I think civil engineering in 1946 had reached the situation of "three little bugs in a basket, with hardly room for two." The reasons were the rapid proliferation of knowledge and the glacier-like rate of change in educational viewpoints.

Chall: This was going on when Dr. Gotaas came in?

McGauhey: It was going on in the academic world, at least. And it was certainly waiting in the wings at California. At the time Dr. Gotaas came it was evident that we must go for higher degrees. But some of the most difficult problems confronting him were: What are we going to leave in the curriculum? Where, in the hierarchy of degrees is it to be located.

Chall: This was evident because the college had to provide more sophisticated scientific knowledge, or because it seemed that you had to do it in order to make yourself scientific, whether it was needed or not?

McGauhey: I think that the initial shock wave generated by the physicists in wartime hastened our inevitable re-evaluation of engineering by the profession. It did not take long for us to see that the engineer in the years ahead could not fulfill his role as a synthesizer of knowledge so as to provide the structures and hardware and the systems needed in environmental control unless he had enough education to understand the knowledge to be synthesized. It was obvious that civilization was going to demand technology and that education must produce somebody to fulfill the role long assigned to the engineer. As I look back, the problem was the ancient one of changing institutionalized concepts rather than of self preservation against the cannibalism of science.

Professor Gotaas was never impressed by the physicist as a bogeyman. His attitude on this point is best illustrated by his reaction to a report that another individual was invading his particular area of research interest. He said, "There's enough work in the world for everybody." I think that was his attitude toward the engineer versus physicist scare.

Chall: How was the problem of courses approached?

McGauhey: Action was begun on several fronts. One was the development of graduate courses. In sanitary engineering Professor Gotaas developed a central graduate course for sanitary engineering which ran through the academic year. It concentrated on the theory and principles of treatment of water and

McGauhey: wastewater. At first he shared with the rest of the profession the concept that functional design should be a part of this course. But it soon became evident that process design was all that could be expected. A separate course in the principles of functional design would have to fill that need for those who were interested.

At the undergraduate level in civil engineering the courses in mathematics, chemistry, and physics were expanded. The basic engineering sciences were identified. And the perennial "curriculum committee" of the department was directed to the task of recommending which courses should be made elective, which required, and which discontinued.

Chall: While these deletions, de-gassing, and other things were taking place, the humanities being brought in, and graduate studies set up, there must have been some professors with some specialties who couldn't have helped but be upset. Did they see themselves going out, being phased out, diminished in importance or what?

McGauhey: Well, I don't think that anyone was actually quarantined, but professors were upset at the prospect of students not electing their courses. I think just the normal rate of attrition took care of course elimination. For example, when we quit teaching railroad engineering the people who taught it were tired of teaching it and they were getting on toward retirement. And so it sort of went by the board. Nevertheless, as changes came on more rapidly in more recent years, there have been traumatic experiences of individuals. But, in general, the change was not too abrupt. The cultural change or the social change was not so abrupt that it suddenly just chopped off any need for doing some things at all. Irrigation engineering, for example, was a very highly respected department here at Berkeley. But when Professors Bernard A. Etcheverry and Sidney T. Harding retired, there wasn't anyone particularly competent to carry on their specific work at the same level. And so the department disappeared from the Berkeley scene.

Chall: Then it went to Davis.

McGauhey: The name and some aspects of the work were continued at Davis. But at Berkeley the emphasis shifted in new directions over a period of a few years. Irrigation engineering was discontinued as a separate department, but courses in this area were continued in the Department of Civil Engineering by Professors Russell Simpson and Fred Hotes. Professor Frank Clendenen came along with an interest in water resources management; and Professor David K. Todd began developing the area of surface and ground water hydrology. With the retirement and departure of Simpson, Hotes, and Clendenen, irrigation engineering entered a new phase.

So our interest turned to resource development. It was one of those situations where sometimes a job is finished and you get on to another job. Professors went on to other jobs or, having retired, it was not necessary for anyone else to start doing again the job they had already done. That part of the problem which dealt with how physically to get water on the land had been pretty well solved. Now the questions were: How much water do we put on? When do you put it on? What are the relationships between water, soil, and crop yield? And where in California are we to get the necessary water? And where do we keep it before we bring it out for use? The first three of these questions were left largely to our Davis campus. At Berkeley, attention was directed to the last two.

It isn't always that tidy, but a university can be great only in those areas where its young men lead it. We cannot simply achieve greatness in one area and then maintain that greatness by going out and hiring a great man to carry on in the same field. In engineering, especially--in environmental control--the task changes from time to time. Otherwise our greatness would gather dust and engineering would be a failure.

Challenges of Developing Problems of Air, Land, and Water Pollution

Chall: The war itself then was the break. Well, it was a cultural break in every way.

McGauhey: It brought on the discontinuity that made opportunity. But there was one other factor that the war brought into sharper focus--the matter of industrial wastes. That had to be considered in our educational package in 1946. In early years our concern in sanitary engineering had first been in water supply; getting safe water, and engineering the systems necessary to keep it safe and distribute it to people. Then we became concerned to re-collect it and to do whatever necessary, albeit the minimum necessary, to permit it release back into the environment.

But during the war industries sprung up in great profusion here on the Pacific Coast. This meant that we now had more concern for water quality than just what happens to water when it passes through the human being or through animals. This is pretty easily understood, although it is sometimes difficult to engineer a system to overcome its effects. But at least it was just part of the normal natural cycle of organic growth and decay that we knew how to cope with. We may have been reluctant to spend the money to treat sewage and counted on dilution where it wasn't necessarily urgent to build treatment works.

But as industries sprang up we were confronted with a whole new spectrum of wastes. And not all of that went into the water. I think 1948 was the first year that drastic action was taken in Los Angeles to control air pollution. At that time they thought it was sulfur dioxide. But in any event we recognized that we had a big air pollution problem. The war brought on atomic energy, and afterwards we wanted to see what we were going to be able to do with this technology. What were the dangers of continuing to test nuclear weapons; and the dangers of trying to use radioisotopes in peace time? So air pollution control and the whole area that we thought of as radiological health sprang up. Chemical pesticides and synthetic detergents were coming into widespread

McGauhey: use. They were being manufactured and used in California, along with numerous other chemicals of unknown environmental effects. Thus industrial wastes in California became more than a question of wastes from oil extraction and refineries.

The effect of some types of industrial wastes and vast amounts of agricultural return waters was to make it pretty clear to engineers--sanitary engineers at least--that public health was not the whole story of water quality anymore; that there were other beneficial uses, such as irrigation, industrial use, recreation and protection of aquatic life--all matters of concern that had little direct bearing on public health.

At that point in time, a study known as the Dickey Report on water pollution was made by the 1949 assembly.* Out of it grew California's Water Pollution Control Law which split the responsibility for water quality between the State Health Department and an agency initially called the State Water Pollution Control Board.

Chall: Are you familiar with the battle that went on over that?

McGauhey: Yes. I was at the University of Southern California when that went on. I was new here though and so probably missed some of the finer points.

Chall: Real political...

McGauhey: There were some who said (and I wouldn't want to have to document its accuracy) that the legislature never really intended to set up a Water Pollution Control Board. They just intended to scare the stuffing out of the State Health Department over some problems of Los Angeles discharging wastewater to the ocean. But whether this is true or not, I don't know.

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*"Report of the Interim Fact-Finding Committee on Water Pollution," published by the Assembly of the State of California, 1949.

McGauhey: In any event they did set up the board. Then they had to make a differentiation between contamination and pollution to decide whether a health problem exists. If it's contamination, it's a health problem, and the health department can move in, and was required to move in at once with a cease and desist order. If it's pollution, then the Water Pollution Control Board had authority. With pollution we could afford to temporize; not that anyone was encouraged to do so, but it wasn't critical. It wasn't immediately that anybody was going to die from it, it was just gradually going to get worse and worse. And how do we say when it is bad enough?

Chall: What did all this mean to the sanitary engineering program at Berkeley?

McGauhey: It meant that we now had to expand the scope of the sanitary engineering program to include courses and research in a whole new aspect of water quality--industrial waste pollution. It meant also that a further expansion in scope was necessary to cope with both the health and environmental problems of air pollution and radioactive wastes. And it meant, further, that we could not expect to educate any single specialty--sanitary engineer, chemical engineer, or anyone else--to deal with this whole spectrum of concern single handed. Instead, we should have to organize our program in such a fashion that people in a greater range of specialties can work as a team on environmental problems.

All of these added factors were recognized as the University of California set out to revitalize and reorganize its program in sanitary engineering.

Reorganizing the Curriculum: Advanced Degrees, Academic Flexibility

McGauhey: Reorganizing the curriculum to generate a strong M.S. and PhD program in sanitary engineering and in developing the strength of the School of Public Health was accomplished over a period of time. I will not

McGauhey: undertake a chronological listing of events. Instead I will try to outline the rationale and how it was implemented.

To serve the needs of engineers in the M.S. and PhD programs in the College of Engineering, and of the MPH and Dr. PH programs in the School of Public Health, courses were developed to avoid duplication. Their location in the system depended upon the location of the instructional competence and the general utility of the subject. Thus the School of Public Health was responsible for courses in administration, epidemiology, biostatistics, environmental sanitation, industrial hygiene, and our specialized courses in microbiology, and water biology, and also radiological health. Air pollution control was an engineering course taught in the school.

In the engineering college were located our courses in water supply, wastewater management, industrial wastes, engineering design, chemistry, and instrumentation, as well as various other specialty courses not strictly of a sanitary engineering context. This was so organized that a student without advanced degrees but interested in sanitary engineering could enter at the master's level. However he did not have to come from a background of civil engineering. He could be a chemical engineer or any other type of engineer having engineering, mathematics, and the fundamental engineering sciences. His program would include our hard core of water quality and water management, but it would be possible for him to specialize, to do some degree, in industrial wastes, air pollution, or radiological health. And I neglected to say that in subsequent years solid wastes was added as a research emphasis. Solid waste was a strong area at Berkeley from the beginning, Professor Hyde having offered a course in waste management.

In the revised situation, the engineer got his administration, his epidemiology, his biology, and his statistics in the School of Public Health.

Chall: These were required courses for the masters?

McGauhey: Generally, yes. However, if he had taken a course in statistics elsewhere it was not necessary to study biostatistics for the M.S. degree in sanitary engineering. The sanitary engineer might occasionally avoid the course in administration although normally the course served twin purposes--to acquaint the engineer with the principles of administration, and to bring him in contact with a totally different point of view than he experienced in technical subjects. Few students in the early years of the post-war program avoided the course in epidemiology. Not that they were inclined to resist it--it was well taught and logical. Dr. Gotaas' logic was that if you are preparing yourself to protect the public health by changing the quality of water, you should have some idea of the route by which the health is injured if you don't protect it--if your engineered system breaks down.

All this applies to students in sanitary engineering. If the MPH degree was the educational goal, then statistics, administration, and epidemiology were among the required courses.

I neglected to note that in those years the Public Health Service made grants for study in sanitary engineering and included epidemiology as one bit of evidence that the student had some orientation to the health field. In any event, the student had to know something about epidemiology if the purpose of his work was to protect the public health. However, at the master's level the engineer could emphasize the field of water, air, or radiological health.

Chall: As a specialty?

McGauhey: As a specialty--or more accurately, as his special area of interest in his sanitary engineering program.

Chall: Was the sanitary engineering program limited strictly to engineers, once the field was open to others than engineers?

McGauhey: It was not limited solely to engineers but the problem was not fully resolved until we developed the Environmental Health Sciences with M.S. and PhD degrees in the School of Public Health.

McGauhey: Our degree designation was in engineering. Therefore we had to stay holy with our own profession. This meant that the M.S. or PhD student in sanitary engineering had to have the basic mathematics, fluid mechanics, and mechanics of materials minimals for engineers. He also had to have some design. This was not too much of a problem for the graduate chemist who wanted to enter the program. Chemists generally have the same mathematics background as engineers. Chemistry also is one of the strong areas of study for sanitary engineers. Thus the chemist has some trading stock--some courses he can trade off against graduate requirements. So with some judicious auditing and makeup course work, the chemist was not too much delayed.

But suppose a biologist came along saying, "I want to put my knowledge of biology to work in environmental control." The biologist normally takes very little mathematics, hence he doesn't generally know enough mathematics to get into engineering. Therefore he has less to trade off against engineering courses because engineering curricula generally are devoid of biology requirements. What route is open to this chap? Lord knows we need his talents in environmental control. Yet he cannot generally get all he needs from the biology department. If a man studies biology in the biology department he generally wants to do those things which will enhance his stature among biologists, just as engineers might wish to do in engineering.

So here we have a student whose educational objectives make him somewhat of a hybrid. His educational goals are not quite holy enough for the biology department. He is definitely unholy from the engineering department's viewpoint because of weakness in mathematics. And yet he has something to offer that mankind badly needs. For this student the Environmental Health Sciences of the School of Public Health is a natural home.

Chall: Was all this arranged for by Dr. Gotaas?

McGauhey: The degree structure that made this possible was arranged after Dr. Gotaas left the University of California, but nevertheless, he laid the groundwork

McGauhey: for it and it was a natural outgrowth of what he had organized.

Chall: Were the M.S. and PhD programs in Environmental Health Sciences developed especially for biologists and other scientists who were in some way unqualified to undertake an engineering degree?

McGauhey: No. The opportunity these degrees afforded the scientist was a valuable spin-off. The degree structure of the School of Public Health was initiated to solve some problems within the school and two years of experience in a health department was prerequisite to enrollment. We did get quite a few such people in engineering in the late 1940s. They enrolled in the school and took courses in both the school and the College of Engineering. They could emphasize water, air, radiological health, or other specialty area just as could the student enrolled in sanitary engineering. His degree, however, had to be the MPH.

Chall: Was the MPH an academically unacceptable degree?

McGauhey: Not at all. It was unsatisfactory to some students because its experience requirements were constrictive and its intent was to accomplish a different goal than the M.S. It was unsatisfactory to the faculty who guided students desiring a depth of study in their specialty areas rather than broad study in public health. However, we did not let this prevent us from meeting the needs of students in the environmental field. We simply used the degree somewhat as an M.S. for some students and as an MPH for others. The dichotomy was more of a strain on the faculty than on the student. Until the M.S. and PhD degrees were approved for the School of Public Health specialties, it was beyond the resolving power of the faculty mind to understand how the school was to give the same administrative orientation to all students while simultaneously pursuing in fact the M.S. objectives in eighteen or more specialty areas. Before the worst of this dilemma was resolved by the introduction of the M.S. and PhD degrees, a vast amount of faculty energy was futilely directed to the question. In retrospect I liken our efforts to that of trying to convert the family auto into a Cadillac by adjusting the carburetor.

Chall: The problem was solved, though.

McGauhey: Yes; certainly as far as the student is concerned. Once we got the matter of degrees straightened out we had at Berkeley a program quite unique in the annals of environmental control. The student having an engineering background and an engineering objective could take advanced degrees in sanitary engineering, with emphasis in any of a wide spectrum of subjects; or he could obtain the degrees in environmental health sciences, with emphasis on any branch of science; or he could go the MPH/DrPH route for an administrative degree in public health. Similarly, the scientist from any of a great variety of backgrounds could enroll in the School of Public Health, taking his degrees in environmental health sciences, with emphasis on any of a variety of fields (including engineering); or prepare himself to be an administrator in health departments. Moreover, in this arrangement, engineering, public health, and science departments had no need to generate overlapping courses--or, at least, to proliferate courses.

Chall: It sounds like an ideal arrangement.

McGauhey: It made academic sense, but I am not certain of its life expectancy. In recent years, as the University has approached physical maturity and competition for positions has become a feature of departmental woes, an unhealthy situation has arisen.

Chall: What is its nature?

McGauhey: Well, to accomplish the ideal arrangement required a split appointment arrangement between engineering and public health, and the locating of courses in whichever division of the two was appropriate in terms of staff competence. Thus some courses required of engineering graduate students were under Public Health numbers and some required of public health students were listed under engineering or science. Administrative evaluation of staff needs based on student loads puts a premium on courses taught by an individual department. The tendency therefore must certainly be to keep all students enrolled in a department in courses taught by that department.

McGauhey: It is easier to violate the non-proliferation of courses policy (via elective courses which obscure the proliferation) than it is to disguise the fact that X number of students were taught by Y number of professors in a given quarter. The alternative is to become, in some cases, second rate by requiring two or three professors to teach all about everything, because everything multiplied by the number of students equals only the prescribed load for two or three professors. But this is a whole area of discussion in itself. The point here is that the impetus for some very important developments involving the Sanitary Engineering Research Laboratory came from Dr. Gotaas' serving half time in the School of Public Health and half time in Engineering, and from his adding more people (some of these with split appointments) as the program progressed.

Chall: Why was Dr. Gotaas given this latitude? How was it that he was responsible for so much hiring, and structuring of the program?

McGauhey: Part of what I have described developed over the years. In fact, I, myself, played a major role in getting the degree structure for the School of Public Health. But the route was charted and the program initiated by Professor Gotaas. I should not imply that he was responsible for the hiring in the sense that authority to hire and fire was delegated to him. He made recommendations and they were approved. But Gotaas is a man with lots of imagination, and lots of ability to organize things and get tuned up to do a job. There was a job to be done and he was employed to evaluate it and to take action.

Chall: But he was really just one of the faculty members in the Department of Civil Engineering.

McGauhey: True, but he was responsible for the area of sanitary engineering. Soon after his arrival in Berkeley he became Chairman of the Department of Civil Engineering and, later, Chairman of the Division of Hydraulic and Sanitary Engineering. And although the School of Public Health was not structured to have chairmen, Dr. Gotaas was the leader of the group responsible for public health engineering.

McGauhey: In the role of chairman of C.E. it was his responsibility to build up the department in line with the wishes of the faculty and the objectives of the college. I do not mean to imply that Dr. Gotaas came in and held back the ocean single-handed, but the climate was right for a major development in engineering education. He came with the imagination to set the system in motion, and he had the support of Dean M.P. O'Brien and Dean Charles E. Smith in getting things done.

In the immediate postwar period a major expansion was needed to accommodate the student population. I don't think Dr. Gotaas or anyone else had a preconceived plan which he set out to implement. Positions were available for expansion of the department of C.E. These were filled only after the faculty has undergone its traditional travail and soul searching; its internal political maneuvering; and its Gilbert & Sullivan routines. Dr. Gotaas had ideas and he tried them out and evaluated them in discussions with other faculty members and administrators. They were by no means all accepted by faculty or administration.

Chall: Why did he have these ideas?

McGauhey: He was born on a South Dakota Farm and quite as poor as the rest of us. He learned early to scuffle hard to accomplish things. The war had delayed many of the things that ought to be done in the fields of health and sanitation. Moreover, Dr. Gotaas had been operating in a system where you get things done.

Chall: And had money.

McGauhey: Yes, the State Department and the Rockefeller Foundation had money and they were getting important things done with it in the programs Dr. Gotaas had been associated with. He was aware of what needed to be done. He was also aware of the sources of funds that were becoming available for research and study in the sanitary and public health field, and in civil engineering in general.

Chall: So Dr. Gotaas set out to get money to do the things which needed to be done in the sanitary engineering field.

McGauhey: Yes; both inside the University and outside of it money was becoming available. Many of the faculty who had been working for years with an annual budget of some $600 to buy glassware were somewhat shocked at the amounts of funds Dr. Gotaas began to bring in.

Chall: They didn't know the money was out there?

McGauhey: Many didn't know it was out there because there had been an interruption of departmental activities during the war and most university people did not yet realize in 1945 what the war and technology had done to the costs of operating a department. What had happened was that the war had changed both the necessity for getting at things and the ways of getting at things. Electronic equipment had replaced glassware. Research as a fountain of information for instruction had come to the forefront. And the need for higher degrees, which I have discussed, further compounded costs. All this was ready for discovery.

But academic arrangements were not there for simple discovery. They required imagination. In any event, what came out of the situation was the organization of something new and unique in the field of sanitary engineering education.

Chall: And it was new right here in Berkeley. It hadn't been tried before?

McGauhey: It had been invented right here. And we became the envy of a good many institutions because we had the School of Public Health. At that time there were only eleven schools of public health. This was not a thing that each institution could decide by simply saying "Now I'm going to have a school of public health." There was the American Public Health Association and, of course, the medical profession and limits set by federal legislation involved in setting up schools of public health and in preventing their proliferation so that available

McGauhey: funds might become too dispersed to be effective.

By organizing and by keeping the number of eligible participants small a few schools of public health got the Congress, under the Rhodes-Hill Act, to establish a formula grant under which each would receive money each year for operation. This formula, incidentally, had a basic minimum amount which could be parlayed upward if you knew how and had the energy to work hard at research. The significant fact was that the schools of public health had a source of funds that others could not get at. It was not these funds, however, that put Berkeley in a good position. It was the spectrum of competence, the combination that the College and the School could offer, and the range of student background it could accept in environmental and health oriented programs that made Berkeley unique. It remained for the Sanitary Engineering Research Laboratory to round out the facilities needed to complete the program.

III THE SANITARY ENGINEERING RESEARCH LABORATORY, 1950-1970

Chall: What factors led to the creation of the Laboratory?

McGauhey: In addition to the research needed to support the graudate programs I have been describing there are two factors of especial importance. The first was the rise of environmental problems to the crisis status required to generate research support. The other was the establishment of the Richmond Field Station by the University. One crisis led to the establishment of the Laboratory, although various others nurtured its growth. Several needs, as I shall summarize, led to the purchase of the Richmond facility.

Crisis in Solid Waste Management

McGauhey: The wartime growth of urban California is responsible for the crisis that led directly to the emergence of the Laboratory. It caused the whole string of discrete and separate towns that ran from San Francisco to San Jose to expand until they impinged upon each other. This created a crisis in solid wastes.

The crisis was an interesting development in two ways. First, the towns and cities had been small prior to the war--some in the three thousand population class. I am sure you know, as I do, something of the mentality of people who habitually or traditionally live in a town of three thousand people. I have used the wrong word here. It is the reaction rather than the mentality to which I refer. The mayor and the

McGauhey: council are attuned to the tiny budget and the quiet streets. So, when, as happened in wartime, the population booms to say 25,000 overnight, life in the town is disrupted. The majority of people then are newcomers--people who can't vote in the community. The political power, therefore, remains in the hands of the small town politician. People can't vote but they are there physically. They are driving in the streets. They are doing things which result in generation of tax monies. But it is awfully hard for a public official mentally scaled to the small community to realize what it means suddenly to have 30,000 people about. Even if the tax base is expanded the old-timers continue to think small and to maintain their political hold upon the community.

One difficulty that arose when this situation developed in California was the result of the way the towns had traditionally handled solid wastes. The procedure was to transport refuse beyond the edge of town and dump it along the working face of a fill, starting at one end of the site in the morning and spreading waste along the face as the day progressed. Pigs were allowed to come in and salvage whatever they desired. Then after the pigs had gone to rest for the night, men would set fire to the dump and burn off such things as were burnable. This facilitated the salvage of metal. In the morning the metal was cool and salvagers came along. Then the residue was pushed over the edge of the fill, the pigs arose, and the trucks arrived with another day's contribution of refuse. Having been burned, the residue did not need much cover and the cost of waste disposal was low.

But as the towns grew and impinged on one another there was no place to dump the garbage except in the other chap's city. This meant that there was no place for hog farms anymore; so the hog farm had to go.

And about that same time vesicular exanthema--which is a disease of swine that causes blisters in their mouths so they can't eat very well--suddenly blossomed out in epidemic proportions across the United States. The disease had been endemic in

McGauhey: California for years and years but was never eradicated. It is spread by meat scraps, and meat scraps in garbage from the Union Pacific Railway began to infect hogs in the big hog-growing states like Nebraska and Kansas. This, of course, created a crisis and meant that men had to cook garbage before feeding it to swine. So most states passed laws against feeding raw garbage to swine. Cooking just added another cost so swine growers, who had been feeding with garbage, went out of business.

Impinged jurisdictions, plus the decline in hog farms using municipal garbage, generated a crisis in refuse disposal which reached the California Legislature in 1949. Assembly Bill 2033, statutes of 1949, appropriated special funds to the University of California for research relating to technical problems of disposal of sewage, garbage, refuse and industrial wastes, and for disseminating such information to people.

The appropriation was $100,000 but the Governor cut this in half when the bill reached his desk. Of course, $50,000 sounded like a lot when measured against the pre-war academic department yardsticks that I mentioned previously.

Chall: To get $50,000 to begin a new type of research at the University must have taken quite a bit of lobbying and pressure within the University itself and in Sacramento.

McGauhey: I do not know much of the politics of it. I do know that at that time the University had a strong president. And it had a strong lobbyist in Sacramento. I know that Professor Gotaas was articulate and that he was called to explain the problem to legislative committees at the time. I know also that the League of California Cities was deeply concerned with the question of how its members were going to solve the solid waste problem and was anxious to get support of how the crisis could be dealt with.

As to internal pressure within the University, I can only guess that it was not much debated on the campus. Those who dwell in ivory towers do not

McGauhey: concern themselves much with the rubbish at the base of the tower. I expect that it was not until the refuse research became institutionalized in an organized unit that the question of academic integrity came up. Let us come back to that aspect in the broader context of the entire program, after we get the Richmond Field Station and the SERL on stage.

The Richmond Field Station

McGauhey: No amount of money makes research on "sewage, garbage, and refuse" an activity suited to ivied halls or marble towers. But there were other developments in the making.

Dean O'Brien, among others, was getting badly crowded for space on the campus. Our hydraulic engineering group for one, in which the dean was active, had an old wooden structure where hydraulic engineering studies were conducted. They called it the "towing tank" because of the facility it housed. We had some top flight men like Professor Joe W. Johnson who was interested in hydraulic engineering and heavy ocean engineering, Hans Einstein who was a world expert in sediment transport, and Professor R.L. Wiegel who is one of the men who developed methods of anchoring ships and drilling rigs off shore. You know, during the war we sent ships into places that had no docking facilities, and there were some considerable problems of anchoring.

At any rate we had assembled at Berkeley a number of people that were of outstanding competence, but whose research was ill-suited to desk top experiments. Besides, the old towing tank was getting in the way of other progress.

Chall: Towing tank?

McGauhey: A towing tank is a tank of still water in which you calibrate flow measuring instruments. There is a little car that runs on a track over the tank at a controlled velocity. You can hang a meter from the car and sail along to relate its rotation to the

McGauhey: car's velocity. Or you can use ship models or various shapes of this sort to study friction, etc. There are a lot of things you can do with a towing tank, but ours wasn't much of a structure and space on the campus was becoming too valuable for this one to survive.

Acquiring the Station

Chall: You certainly need something else for solid waste research anyway.

McGauhey: Yes, and there were several other activities of the engineering college that needed space--aerospace research, highway lighting, wind tunnel investigations, beach erosion models--to name but a few. These were unsuited to teaching laboratories. Most needed space, some made noise, some required sewage or sea water. So in 1950 the University bought, with the encouragement and certainly the enthusiasm of Dean O'Brien, these grounds here at the Richmond Field Station for use as a research station by the whole College of Engineering. This was an old blasting cap works which had furnished explosives for the mining industry and, I guess, later for the Civil War. It managed to carry on through World War II. By that time the facilities were obsolete, so the Richmond Cap Works, as it was called, was going out of business and the property was for sale.

This area is zoned for heavy industry. Therefore, it was felt that we could do things here on a scale that you couldn't do in a teaching laboratory. I used to say we could bore holes in the walls and put up pipes and pilot plants without cracking any marble or tearing down any ivy. Presumably, we could make noise and odors and generally carry on activities that couldn't very well be done on the campus.

Heavy industry in the area was a little fearful of this development, lest the University move in right next door and plant a big lawn and make it another campus, and they say, "You fellows are creating a nuisance. We'll have to get rid of you."

McGauhey: I don't blame them too much for their fears but we ourselves needed something different than a campus environment.

There were a lot of old wooden buildings on the property which we overhauled a little and used. Sanitary engineering was one of the first tenants on the Field Station. We got the old building 102 which had been a laboratory building for the Richmond Cap Works, and previously a grain warehouse for the Vallejo Ranch before the University was in Berkeley. There was presumably plenty of fulminate of mercury in the ground. Workmen were afraid to strike the ground too violently for fear the whole thing would explode. We simply covered over some old concrete footings instead of trying to knock them out--I don't know that they would have exploded, but since explosives had been handled there, people proceeded pretty gingerly when breaking any concrete with a jackhammer around that old laboratory building.

Utilizing the Station

McGauhey: Several problems attended the utilization of the RFS facility. Refurbishing the old buildings to meet the research facility needs of academic departments was necessary and, of course, expensive. To meet the needs of projects for services it was necessary to establish shops on the Station grounds--a computer shop, a machine shop, a photographic and duplicating shop were among the services set up in refurbished buildings. Small stores, a receiving facility, and mail service were provided to expedite the research work. Then too, transportation had to be arranged to transfer faculty and students the seven miles between the campus and the field station. Reluctance of some faculty members to undertake such a long journey was one of the problems of utilizing the facility. I once explained this phenomenon on the rationale that the RFS was located on the wrong side of the campus. Thus it was not on the way to Europe and hence geographically inconvenient. But this may have been an exaggeration. More likely the situation simply varied too far from the ideal.

Chall: What would be the ideal situation?

McGauhey: I think it includes a reserved parking space on one side of one's office and one's laboratory and a library on the other.

Chall: How utopian.

McGauhey: We never quite achieved the ideal, but the College of Engineering did provide free hourly bus service and it worked out rather well for some professors. The route along the bay shore was always interesting and the traveler might reflect upon the flocks of shore birds or the phenomena which placed so many old auto tires upright in the mud flats north of the "Albany Hill." Besides, the atmosphere of the RFS was more conducive to thinking about research than was the bedlam in a campus office.

Chall: I am interested in the phenomenon of the old tires. I have seen them standing there by the dozens when the tide is out.

McGauhey: They floated in from an old refuse dump off the point at Golden Gate Fields race track. Air trapped in the old tire as it is lifted by tidal waters cause it to tilt. Sand is deposited in the water-filled side and after a few cycles the tire is standing erect, firmly anchored in the mud.

Chall: Now I understand.

McGauhey: To provide the services needed by RFS-based research projects, and to assign space, and oversee and maintain the facility required some administrative structure. For this the College of Engineering set up what is now the Office of Research Services. It was something else then--the IER, or Institute of Engineering Research. That was the arm of the College responsible for physically managing the grounds. But IER had also a more difficult task--that of dealing with the proposals for research funds that professors in the College might develop; and of maintaining liaison between the University's Accounting Department and the faculty investigator during the life of a project.

McGauhey: In the first of these two functions the IER insured that the proposal met the requirements of University policy, both fiscal and educational. In setting up the RFS neither Dean O'Brien nor the University administration wanted it to develop into a research institute that didn't educate anybody. IER was the first in a series of filters intended to make certain that projects served some educational purpose. Specifically, that it enhanced the teaching competence of the faculty investigator and provided opportunity for graduate students in research.

The second function of IER--financial accountability--was a must. Professors are notoriously "drunken sailor" economists when it comes to operating a budget. So the IER played a watch dog role, not only to oversee the physical facilities but to insure the educational objective as well. It served as a go-between the professor and the administration, looking after personnel policy when staff was employed and taking the load of paper work off the professor.

Chall: This was the IER?

McGauhey: The Institute, yes, in the first years of RFS. Its duties were later split so that physical management of the RFS is separate from the Office of Research Services which handles the other functions of IER. Both are assigned to an assistant dean in the College of Engineering.

With the developments in the academic program and the establishment of the Richmond Field Station, the stage is set for a discussion of the Sanitary Engineering Research Laboratory (SERL). As I previously noted, SERL was the first tenant of the RSF. Some 6.6 acres of the station, plus several of the old buildings were somewhat informally dedicated to sanitary engineering activities, subject to approval of the manager of the RFS facility.

Organizing the Sanitary Engineering Research Laboratory (SERL)

McGauhey: SERL was not conceived in its final form in any single spasm of planning. Neither was the concept nor the administrative structure of organized research units into which it fits within the University. Instead it evolved over a period of time with a considerable--probably a normal--amount of faculty turbulence. As a matter of fact, the initial $50,000 project was called the Sanitary Engineering Research Project. So we carried on under the banner of SERP until we had so many projects in being that the word "Project" no longer described us.

Chall: What was the nature of this turbulence?

McGauhey: To answer that question challenges my ability as a story teller. Some of the turbulence was generated within the University structure; and some of it related to the participants in the program. You will recall that Dr. Gotaas held a joint appointment in the College of Engineering and the School of Public Health and that it was his task to integrate the two so that the School could maintain its proper interest in public health engineering without being devoured by sanitary engineering. This posed a considerable task because, as I previously noted, the public health engineers in health departments were traditionally graduates of colleges of engineering; yet there had to be room for public health engineering in the MPH program of the School. It did, however, lay the cornerstone for a subsequent research unit to serve as the graduate research arm of both sanitary engineering and the environmental health sciences, as I shall later explain.

Chall: Concerning the University itself, how did it go with the hierarchy--setting up the School of Public Health and the new laboratory? Were they, at the administrative level willing to accept these kinds of changes and innovations? Was that a problem?

McGauhey: I don't think the administration was any problem. But there is nothing quite as conservative as a

McGauhey: professor per se. I couldn't document this, but judging from all of the years I've gone to faculty meetings, I'm quite certain that had the entire faculty been aware of what was developing it would have viewed it with considerable alarm as the close of one of the greater ages of culture. This would be my guess. But people were busy with their own aspirations and, besides, there is a great deal of insulation between sectors of a university as a result of both poor inter-disciplinary communications and mutual disrespect between disciplines.

Some of the older professors of engineering shook their heads and wondered what all this might come to. Universitywise there was a good deal of discussion as to whether a School of Public Health belongs in a university or not. That went on for several years and hasn't died out yet. But, at least, it is, shall we say, no longer topical.

Concerning emerging organized research units, one of the questions was "Where does this type of activity fit in?" Another was "How are we going to make sure that this does not become an empire-building research operation?"

Chall: Or a trade school.

McGauhey: Trade school, yes. But what they were really afraid of was an empire. This happened at another university, not in California, where it hired a lot of good researchers on soft money. It gave them professorial titles, but didn't promise to pay them when they ran out of money. These fellows were energetic and concerned for their jobs. They put all their time on research and publishing papers. They hustled up funds and paid themselves better salaries than the tenured professors who had to teach and research at the same time. Pretty soon they had built up a monster that it took the university a long time to overcome.

Insuring Academic Integrity

Chall: Was the University of California aware of this danger? How did it insure academic integrity?

McGauhey: Yes, the University was well aware of the pitfalls of research units unresponsive to the faculty. It, like other universities, had solved the question in relation to the Agricultural Experiment Station by giving academic positions for part-time service to the scientists involved. It was also pondering how to deal with the Radiation Laboratory which had numbers of good scientists eager to acquire academic status. It was uneasy about the number of lecturers engaged in the School of Public Health on a part-time basis through the Hill-Rhodes monies.

These problems, however, were peripheral to that of the SERL and similar units, but they must certainly have been considered in establishing the policy which made SERL a healthy facility.

Chall: What is the nature of that policy?

McGauhey: Its over all feature is that all authorized faculty positions must be backed by hard honey--i.e. money in the state budget. Next, that every research project must be headed by a member of the faculty. More precisely, that anyone to be a faculty investigator on a research project must be a member of the faculty senate. His project will have to be approved by the department head, dean, and Research Office for relevance to its educational value, and by the budget and policy authorities of the University for conformance to fiscal policy. If a project is just a matter of testing it is not acceptable. We would not, for example, be permitted to break ten thousand concrete cylinders just because we can hire four students to do it.

So a project must be the responsibility of a professor and it must be passed upon by the administration. If the grant is approved by the University it is accepted in the name of the professor and he is expected to justify such confidence in him. He is expected not to go off

McGauhey: half-cocked and publish trash that won't stand up under scientific review. Of course, it is to the professor's advantage not to do so.

By avoiding soft money professorships, by requiring that the chap who runs the project must be a faculty member, the University has held the line. This prevents the use of research money as a device to magnify the number of professors without authorization from the administration. That, I think, is the key to success of research units. It is a good policy.

Chall: How did the faculty of the sanitary engineering and environmental health programs react to the concept of the laboratory?

McGauhey: This brings me finally to the point in our discussion where I should leave off setting the stage and get on with the subject of SERL, which I set out to explain some two hours ago. Besides, I want to get on to the turbulence which surrounded the birth of SERL and which "enriched" my later experience as its director.

At the time the Richmond Field Station site was acquired in 1950, research on solid waste disposal initiated by the $50,000 appropriation was already under way in campus laboratories and in the field. Professor Gotaas was faculty investigator of this project and he had several studies under way. Professor Erman A. Pearson, who joined the sanitary engineering faculty in 1949, was in charge of a very significant study of the economics and technology of refuse collection and landfill disposal. Professor Harvey F. Ludwig, who came to Berkeley at about the same time, was leading a group concerned with incineration of refuse. Gotaas himself was interested in composting and had made a tour of Europe to learn of the production and use of compost there. The question had arisen within the University of whether the $50,000 appropriation was exclusively intended for Berkeley or whether it was a statewide fund which UCLA should share in. That is, should the emerging research unit be statewide in its organization or confined to the Berkeley campus. Some funds had been sent to UCLA for field studies of incinerator performance, and a project there was in progress.

McGauhey: Several staff members had been recruited to carry on the solid waste work. Dr. Jerome F. Thomas was employed in February 1950 to serve as sanitary chemist of the laboratory. Vinton W. Bacon was employed to serve as assistant director of the laboratory. But he stayed only a few months; then went on to become the executive officer of the newly organized State Water Pollution Control Board. His place was taken by Mr. Raymond V. Stone who had previous experience with health department employment and had just got his M.S. degree from Harvard. Ray B. Krone who had just finished his first degree in soil science joined the staff, as did Gerhard Klein.

Up to this point there was only one project, and it was under the leadership of Professor Gotaas. But by March 1950 a new study was begun with money from the State Department of Health. This project was intended to determine to what extent bacteria and other pollutants travel through soil with infiltering and percolating water. You see it had long been said that sewage, or wastewater, or polluted water must not be discharged upon the land lest bacteria travel through the soil and get into the public water supply.

As an aside, I must say that this fear, which had been codified in state laws is one of the least intelligent pieces of man's reasoning. Rain had been falling on a biologically active soil mantle since the beginning of time. Both song and story attested to the clarity and purity of spring water, so that one might have concluded that bacteria will not travel at all. Instead, the conclusion was that they might move freely and the State of California led the way in testing this hypothesis. The project was conducted in a field study at Lodi, California. It, too, was the responsibility of Professor Gotaas and so raised the question as to the limitations which might accrue to other faculty members under a laboratory led by a director.

Soon thereafter, Professor Ludwig got funds from the Public Health Service to study the role of algae in wastewater treatment, and brought William J. Oswald on to the staff to pursue his PhD research.

McGauhey: This, then, further raised the question of the relationship of the individual faculty member to the director of emerging Laboratory. "He's my boss academically as chairman of the department, but is he also my research boss?" was the question that was asked and not yet answered. Before it was answered, the State Water Pollution Control Board provided funds to study the underground movement of pollution when reclaimed wastewater is used for ground water recharge. This further brought the question into focus because the funds were assigned to the Laboratory under Professor Gotaas. It also raised the question of the appropriateness of the title Sanitary Engineering Research Project to describe the activities of the Laboratory.

Well this situation went on for a few months without anybody swallowing anybody else. In early 1951 the activities began to coalesce into one major enterprise as these research projects were centered at the Richmond Field Station.

With all of the organizational activity I have described, plus academic courses to develop and research to direct, Professor Gotaas became a very busy man. He was persuaded, partly by his recognition of the need and partly by Professor Ludwig, that he needed someone with experience to serve in the capacity of assistant director at the field station. I presume Professor Pearson was also in the act which went on to further persuade Professor Gotaas that McGauhey was the man he ought to get.

P. H. McGauhey Joins an Enlarging Staff, 1951

Chall: Did Mr. Ludwig know you?

McGauhey: Yes. I knew him from 1948 onward. He was a consulting engineer in Southern California during the two years I was at USC before he came to Berkeley. I had met Pearson only once, I think, before I came to UC.

Chall: You didn't know Professor Gotaas?

McGauhey: I had met him a time or two. But I didn't know him personally. He had established a reputation of which I was aware. The sanitary engineering fraternity was not a large one. But I can't say that I really knew Dr. Gotaas at the time.

Chall: So it was really Mr. Ludwig that...

McGauhey: Ludwig, I think, was the salesman there. But anyway, after some negotiating and a personal interview, I agreed to join the staff as a full-time research engineer. I had been teaching for a long time and was chairman of a division, so I decided that I did not have to be a professor--at least the lower grade academic title didn't bother me.

I neglected to say that by that time the emerging Laboratory was fairly well structured in the University budget and provided four hard money positions in what was to be SERL: Two sanitary engineers, a chief chemist, and a chief biologist. I was one of the engineers. As it turned out, the program at Berkeley was expanding faster than personnel could be recuited, so immediately I was put to teaching as a lecturer because I had been in the business a long time and had, I trust, established a modest talent for that sort of thing.

Chall: This was what year?

McGauhey: 1951. I was on the payroll as of July 1, 1951. When I arrived at Berkeley I was confronted by the situation I have described briefly. That is, a Laboratory being established at the RFS, ongoing projects of major importance and plenty of challenge, some unanswered questions, and the program growing at an exciting pace. I also found the operation running on a real "drunken sailor" economy. There were thirty thousand dollars more in people employed than they had money in the budget. Of course, part of the work had to be done by an intensive summer study of land fill as well as in the field--at Lodi, you recall, where we were measuring the movement of bacteria in the ground. The refuse incineration work going on down at UCLA was asking for more funds. We just didn't have the money. Fortunately, the budget year for some of our funds was just beginning.

McGauhey: Being a natural born Scotsman, I had to begin to consider how we were going to keep anybody alive till the end of the year with these kinds of expenses. So I wrecked two or three gravy trains along the way, but the anguish was temporary and no permanent hard feelings were generated.

We got the budget back on a more hopeful course. Then, that fall Professor Ludwig went back to the Public Health Service. Professor Gotaas then inherited the algae project by default and transferred much of his interest to that study, trusting the other of his projects to my care in their day-to-day operation.

That first fall, in September of '51, he brought in Dr. W.J. Kaufman to head a radiological health research unit with some AEC money. Within a very brief period Dr. Kaufman was appointed to a teaching post in both the School of Public Health and in engineering. But he first came as a full-time researcher. Meantime, Dr. J.F. Thomas was made chief chemist in one of the hard money positions. W.J. Oswald was the project engineer on the algae project. Ray Stone had a similar post on the ground-water recharge project, and the Lodi study, assisted by Ray Krane. Gerhard Klein served as project engineer for Dr. Kaufman's AEC Study.

The boys that were working on composting were just getting started with experimental work. At that time the subject of composting, I must say, was veiled in a shroud of mysticism throughout the world. The most vocal of its advocates were peddlers of one or another brand of witchcraft upon which the process was alleged to depend. We needed a sound biologist to sort out the fundamentals of the process and to lay to rest much that was reported concerning its parameters. Therefore Dr. Clarence G. Golueke, who was just finishing his doctorate after a good many years of experience elsewhere, was employed to be our chief biologist and to lead the composting study. Dr. Golueke and I went ahead on composting and Professor Gotaas and W.J. Oswald carried on the algae experiments.

McGauhey: At this point in time, the concern over the relationship between the professor's freedom to carry on research in his own right and the role of the director of Laboratory reached its greatest intensity. By circumstance much of the research in sanitary engineering was in the Laboratory and under the faculty investigatorship of Professor Gotaas. Professor Langelier was going about his usual profound experiments in the campus laboratories and elsewhere in the community. But younger men on the faculty had not yet got started on research in their own right and were somewhat fearful lest the road by which each faculty member must prove his own merit might be blocked. Happily, this situation began quickly to clear up in the fall of 1951. Dr. Kaufman, having acquired faculty status, became the faculty investigator of the AEC project. Professor B.D. Tebbens got some funds to begin research in air pollution. Professor Tebbens, by the way, had known Dr. Gotaas in South America and had been recruited by him to join the academic staff of the School of Public Health and the College of Enginering. Dr. Thomas, the chief chemist of the Laboratory, then divided his time between the duties of the Laboratory and research as a teammate of Dr. Tebbens. To look after office affairs Dr. Gotaas sent Mrs. Raab from the campus...I don't know if you've ever met Jeanette Raab?

Chall: No, but I noticed in your reports that she worked up from secretary to administrative assistant in her years of service to SERL.

McGauhey: True. She began as secretary the first fall I came. There were one or two periods when she was away, but she stayed until the end of my tenure in 1969.

This is very much the way SERL began: First the renewed vigor of the program in sanitary engineering program following World War II as education at higher degree levels became necessary and expansion of the engineering program and development of the School of Public Health afforded a unique opportunity; second, the critical problems of environmental control came to transcend water resources and to include air and land resources as well; third, funds for research made it possible to

McGauhey: seek solutions to critical environmental problems and acquiring of the Richmond Field Station provided a place for appropriate research to be conducted; and fourth, the individual faculty member learned that the Laboratory offered him opportunity rather than threatening to devour him.

I should like to come back to this matter of organization of the Laboratory after I introduce some more of a historical nature and bring a few more characters on stage.

In 1956 Professor Gotaas decided to accept the post of dean of the Technological Institute at Northwestern University. The challenge appealed to him. I think Professor Gotaas enjoys building an organization more than he does the hammer, hammer, hammer of production. And I don't blame him. Having got the SERL going the next thing to do was to wait around for someone to grind out results. Dr. Gotaas got various unsolicited offers but the Northwestern one was too attractive to refuse. Nevertheless he took it only after a good deal of soul-searching. He was happy here and wasn't looking around for any place to go. He asked me one time, "Mack, what do we want anyway?" I said, "We want really to be left alone. We don't want anybody coming around offering us jobs; just leave us alone when we're happy." He said, "I think you're right."

But in the end he decided to move on. That meant that now we were in a situation where we were headless. Whoever was director of the Laboratory had to be on the faculty. And I was not on the faculty. So, decisions were made which transferred the challenge of SERL to me. I had come with no promise of being on the faculty, with no expectations of being on it, and with no intent to shed any tears if I didn't get on it.

P.H. McGauhey Appointed Director, 1956

Chall: No particular desire either.

McGauhey: Obviously I didn't want to get off into an eddy current. But I had attended enough faculty-senate meetings for one life time, but not, as it turned out, all that I was destined to attend. By 1956 Dr. Gotaas and I had been working closely together for five years and knew each other well in an atmosphere of mutual respect. I may say that although I have called him Dr. Gotaas or Professor Gotaas throughout our discussions here, he was "Ben" to everyone who knew him just as I have been "Mack." At any rate, when we faced the problem of management of SERL upon his departure he had sufficient confidence in my ability to work as a member of a team that he went down the line for me.

Wisely or unwisely I was appointed half-time to the academic faculty of engineering and public health. The other half remained in SERL in the role of Research Engineer and Director. My academic duties involved 40 percent service in the College of Engineering and 10 percent in the School of Public Health. So I got split into several pieces. I was appointed chairman of the Hydraulic and Sanitary Division, director of the SERL, and general leader of the environmental health sciences of the School of Public Health with the duty of keeping that part of our program energized. I have neglected to say that by 1956 SERL had been formally recognized as an interdisciplinary organized research unit in the University serving as the graduate research arm of both the sanitary engineering program and the environmental health sciences.

As a member of the faculty I could now serve as faculty investigator of projects so I began to go after funds to support our graduate program as well as to satisfy my own intellectual curiosity.

Reorganizing Staffing Patterns and Administration

Chall: You also had to teach.

McGauhey: Yes. The first year I taught, as Professor Gotaas had done, the three major courses in sanitary engineering. By this time, of course, we had around us a strong group of young men. We had Professor Pearson, Professor Kaufman, Professor Orlab, who was a good sanitary engineer with a lot of research and water resource interests similar to some of my own. Those three were all full-time faculty in the College of Engineering. Professor Tebbens was part-time engineering, with 90 percent of his time in the School of Public Health; Professor R.C. Cooper was our micro-biologist in the School of Public Health; and as Professor Langelier had retired, we had put Thomas half-time teaching in the college and half-time in the professional staff of the Laboratory. W.J. Oswald, having reached his doctorate, was put in a half-time teaching position and half-time here at the field station. We had Ray Krone full-time in one of our SERL staff jobs. Dr. Golueke continued full-time in the other SERL staff position.

For the young men I don't think this was too good a deal. I was accustomed to working seven days a week--had been doing it for most of my life, so I didn't feel a strain. But the young men who had to make their way up the ladder, having to teach half-time, having to work on committees, it was almost impossible for them to really do research on a half-time basis. I felt that they weren't getting much more research done than they'd do if they were nine months professors. This weakness was not any fault of the men. It is just the scrambling is too hard that way. The part-time faculty are called upon to serve on committees and do academic chores without regard to their percentage appointment.

So as it became possible I changed my mind about whether they ought to be half and half, and ultimately got Professor Thomas full-time on the

McGauhey: campus nine months. And we got another young man out here in a professional capacity to serve as chief chemist in the Laboratory. Pretty soon I got Oswald switched over, too. So for several years I was the only one with an appointment divided between SERL and the faculty. However, Kaufman and Tebbens, and Oswald and I continued with joint appointments in engineering and public health.

I think this worked out rather well. By this time these people were maturing and they were beginning to quit asking the question: "How is it that we have a director? What can he tell me that I can't tell him?"

It became amply evident that it was unnecessary to ask this question because I was not trying, as director, to make any encroachment on the prerogatives of professors. They did not have to work in SERL at the RFS if they elected not to do so. Their project could be elsewhere.

However, they all found it to their advantage to work in SERL because of the facilities that we had put together and the housekeeping funds that the University funneled through the engineering college took part of the load off professors. The research energy of the chief chemist and biologist, and of the assistant director was an asset to the faculty and its graduate students, so they found it to their advantage mostly to work in the SERL facilities. And pretty soon they quit trying to solve this "angels on the point of a needle" type of question.

One of the things though that caused this question to be asked was that the director of the Laboratory was responsible directly to the deans, of engineering and public health for research, and responsible to the chairman of the academic division for academic work. However, the duties imposed by the deans and by the system--and properly so--was to keep the SERL operation educationally oriented, and to see that what it did was educational in purpose rather than for any other personal objectives. I think the question died because there seemed no

McGauhey: longer any reason to keep asking it. To help alleviate the situation the University itself began to get a little more highly structured. The administration decided that all organized laboratories should have an advisory committee and so appointed one. I began immediately to request that they put on this committee all members of our participating faculty because there were only ten or eleven of us.

Chall: Just ten or twelve. I thought there might have been thirty.

McGauhey: If it were thirty, the board would certainly have had to be selective. But since there were only a few it didn't seem to me to make much sense to have six on the board and four or five that were not. After one year the Chancellor agreed with me.

Chall: I noticed from your early reports that you met approximately once a week with this board. And I couldn't imagine what you would be doing once a week.

McGauhey: The principal thing that happened was that the work of the board was combined with that of a faculty meeting. The entire participating faculty from sanitary engineering and environmental health sciences was on the board. This same group had the task of dealing with course content, academic program planning, and the adherence of SERL to policies which furthered this educational program. As Director, of course, I was not the chairman of the board; however, as chairman of the Hydraulic and Sanitary Engineering Division I could introduce matters which did not concern the hydraulic engineering staff into these meetings. I would say that three or four times per year we were concerned strictly with the Laboratory. So it was mostly academic business, and mostly a waste of time. It did serve to keep us all informed and so keep at a minimum the academic doubts that always attend ignorance of what the other fellow is doing.

Some Philosophy About Administration

Chall: I noticed, too, that you as director had the authority to act or overrule the recommendations of the faculty board on any or all matters. So that gave you quite a bit of authority.

McGauhey: As a matter of fact the authority was more apparent than real. The truth is that the faculty board was advisory to the Chancellor and its task was to report to the Chancellor each year on the activities of the SERL. That is, on its adherence to University educational policy and purpose. The board's function in advising the director was largely of our own agreement and the board itself wrote the stipulation regarding the director itself. Therefore the authority was probably meaningless. If it was not I would certainly have moved with caution. When one has the authority to do this kind of thing it must be used sparingly. You can wreck an organization pretty quick by over use of authority.

But for example, suppose I had in the approved SERL budget a small sum of money for maintaining equipment and to keep it running. The board might say to me, "We have decided that you should take that money and buy a special piece of equipment that we agree professor X should have." In such a situation I would probably have recommended that they forget it because I would myself have to get permission for the dean to spend money for a purpose other than that for which I had requested and defended it. And so, nothing of that sort ever came up. I did get occasional suggestions from faculty members that the entire SERL budget should be divided among the faculty members participating in the Laboratory, but no such recommendation was ever made by the board.

I might say in passing that the existence of a board can be an insulator as well as an isolator of the administrator. Both of these phemomena arise from the same penchant of professors to disagree. Sometimes I have said in various degrees of facetiousness that if two professors ever agree on anything, each would entertain the possibility that his judgment had erred. Professors will combine against

McGauhey: the common enemy, leaving off their disagreements until the enemy disappears. These disagreements, incidentally, are not often personal matters. They may go on for years between the fastest of friends and are based on lofty principles rather than bad feeling. As for me, I never had much talent for appearing as the common enemy, hence whatever my associates may have thought of the idea of having SERL at all, they gave me support when it was needed.

But some of my group were quite literal minded; they wanted things all spelled out in great detail. I, in turn, contended many times that no matter in what detail you have it spelled out, if people don't do it, you're out of luck. If it's as slap happy as a hoot owl and yet works, why worry about its administrative structural weaknesses. [Laughter]

But younger men are quite often that way. They want everything all spelled out. And they quite often want things spelled out that you don't dare spell out. As an example, the University says wisely, I think, that if the engineer doesn't take some part in engineering practice or have some contact with it, his teaching is going to be pretty sterile. The next obvious question then is, how much contact? Well, you can't put on paper how much. Some people have a greater capacity than others to do their job. One might be capable of putting one day a week into outside work where one day a month might strain another.

Imagine what would happen to the University budget if it decided that professors could work one day a week in professional development, and put this decision into a rigid policy statement. Imagine further that our enemy of the University went to the Legislature with the story that professors get paid fifteen or twenty thousand a year, only work nine months, and only four days a week at that. We'd be down the tube quick. And it wouldn't be true, but once you write a lot of stuff on paper, then you're not given the chance to put in all the and's, but's, and if's, and so on. This was the kind of thing I'd run up against in the Laboratory; a desire to have everything in great detail; and yet there are certain kinds of things that you can't detail.

McGauhey: One of the things that the faculty would often say to me, "We ought to have a budget right at the beginning of the year stating just how we're going to spend every dollar. Then we'll all adopt this budget and we'll spend the money that way." All I could give them by way of such a budget was what it cost us the year before. For example, if I were to decide, and to write into the budget that we'd spend only $1000 for maintenance of equipment even though five or six faculty projects depended upon the pumping station working continuously, the next week the whole thing collapsed, what good would be the budget if it cost me $3000 to get the pump going. So the best we could do was to put some funds into various categories and take precautions to stay within the overall budget, even if categorical changes had to be requested.

For the most part, the professors got their own grants and they didn't bother too much with the central SERL fund. It furnished supporting services and assistance which was of obvious service to the faculty and students. Of course they took such advantage of the central fund as was feasible under the elasticity of its director.

In my first years, I had plenty to do in the School of Public Health to help keep our program there alive. To this end I put my energies in getting the degree structure approved for the M.S. and PhD degrees in the Environmental Health Sciences. Thus we overcame the problem there.

I stayed on five years as the chairman of Hydraulic and Sanitary. I was then carrying about five to seven research projects in my own name. This kept me moderately active.

Chall: To say the least.

McGauhey: Then there came a time when we were preparing to change chairmen. Now the question arose again about the Laboratory. "What is the relationship between the director of the Laboratory and the chairman of the department, when he's no longer the same person?" This contingency had never arisen as both Gotaas and I served in the dual role of director and chairman.

Chall: Why were you not going to be the chairman of the department any more?

McGauhey: Because chairmen are appointed on a three-years-minimum, five-years-and-out schedule. This is a good thing, because there's only so much that you can do, in five years, if you're not good, to destroy something that's already rolling. And there's only so much good you can do to accelerate it if you're a good chairman. A bad chairman can't ruin anything completely in three to five years. Whereas, if he were there for life he might drag down the whole thing.

Once relieved of the duties of chairman of the Hydraulic and Sanitary Division, and largely as an act of self defense because I felt it was to the interest of our group, I took the post of chairman of civil engineering. At the end of two years, I asked to be relieved of being chairman and to confine my task to that of director. The dean agreed that the two were just too much load on one man. Nevertheless, it was an interesting and challenging experience and quite an active one.

Directing Research

McGauhey: In my research I operated on a little different base than some other people. As director of the Laboratory I was under pressure to be faculty investigator on projects that no one else wanted but were of importance to students and faculty. Happily I was interested in anything that came along. I don't mean in terms of just dollars. I mean there was hardly any subject you can think of that I wasn't interested in. This didn't mean that I knew much about some of the things I undertook. But if I could get the outside funds to support students on studies related to environmental control, I did not hesitate to take responsibility for a project outside my field of major competence.

As we discussed on a previous occasion, there are problems involved in environmental management which require teamwork between engineers and numerous

McGauhey: other professionals from a variety of disciplines. My rationale was that it was important that SERL take part in preparing such students even though their degree work was outside sanitary engineering and environmental health sciences. On one project, I once had students in twelve different disciplines working on various aspects of solid waste management.

The key to success, or even survival, in such an enterprise was, of course, the willingness of professors in appropriate disciplines to guide the thesis work of their own students. I generally served on the thesis committee to evaluate their performance as researchers, while their major professor made certain that they did not violate the principles of their special discipline. So the professors worked with me; the student was on my payroll and I knew what I wanted to get out of the project; and all concerned met from time to time to keep the activity coordinated. I am happy to say this boldness in research responsibility never let me down, although there were occasions when time might have been spent more efficiently had I possessed the depth of knowledge in the student's field that his major professor brought to the study. Obviously, such a situation has not been possible since Leonardo Da Vinci.

This undertaking of projects without the competence to critically evaluate every aspect of the student's work is all right for the professor who is already mature. For the young man who has to develop his own depth of knowledge in a specialty area and to work his way up the academic ladder, it is unsuitable. He cannot get anywhere by continually working at things he doesn't know how to do. But later, when he has established himself in his profession, he can begin to grow laterally instead of vertically.

In my opinion this branching out on an informal basis provided an opportunity for the Laboratory to make a great deal of contribution to education in more ways than just teaching our own students.

Financing Research

Chall: Now over the years various little changes seemed to come about in the way this Lab was, not necessarily organized, but watched by the University.

McGauhey: The principal reason for this is that when the post-war years began nobody knew exactly which way we were headed. Neither the University administration nor the faculty knew what the future was to be. We didn't draw a blueprint for the future and then try to follow it. And I doubt very seriously that Dr. Gotaas himself knew exactly what he was going to make of this Laboratory thing. Although I will say that I had not been there very long before he was able to tell me the visions that he had for the future--what he had in mind, the kind of thing he was thinking about. Thus, while nothing was completely planned the direction the Laboratory was eventually to follow and the purposes it was to serve were not accidental.

At that time, the University itself had no policy about organized research units, and as far as I know, no good experience with organized laboratories. There'd been one situation in which an institute had been set up on the campus by outside money. The donor specified the well-known scientist who was to head it. Thus he became its director for life. He was a strong and able man, so the institute grew in reputation and stature until an academic program in this particular field was needed. By this time the director was a permanent giant who owned the tower and the transient state of academic chairmen made them unwelcome little men. Their presence in the tower was scarcely tolerated and they never could get enough strength at the academic level to overcome the top heavy organization of this particular institute.

Having suffered with this problem the University didn't want this kind of thing to happen again. And I don't blame it.

How do we prevent it happening? This question is still being debated, although, I think, it is now clearly understood what an organized laboratory should

McGauhey: be like. I believe that part of this understanding came from just watching the way in which SERL and one or two other organized units developed. To a gratifying degree the University's description of an organized research laboratory came to read like the early reports on the nature and organization of SERL.

Another thing that worried the University was that anything the legislature sets up, as it did some money for SERL, or as it did in a bigger way for the Institute of Traffic and Transportation, comes with certain problems attached. The legislature says, "Here's something that ought to be done. The University ought to do it. We'll give the University some money to do it." Thus a one-time special appropriation creates a continuing program. However, when the second year comes round and money is needed to continue the program, the legislature says, "We got you started, don't fool around with any more special appropriation bills. Just include the funds in your regular budget." Well, the regular budget is never approved at this expanded level and so, if the University is not careful more and more of its budget is tied up in things that the legislature passed on as institutes, centers, and laboratories.

This impoverishes the instructional aspect of the University which, after all, is its primary function. The problem therefore becomes one of preventing legislature-generated services to the state, however important they may be, from establishing a prior lien that petrifies an increasing fraction of the University's budget.

Chall: Does the legislature now simply give money to specific research projects?

McGauhey: Not always. You see the state-established institute like ITTE appears as a line item in the state budget. But this laboratory is only one sector of the state-supported research included in the University's budget.

That is to say that if the University is asked "What did you do with the money we approved for research?" the answer would be that part of it went to support SERL via an allocation to the College of

McGauhey: Engineering at Berkeley, which administers the SERL funds. There is no line item in the state budget for SERL.

Chall: That clarifies that situation.

McGauhey: Yes, except that as budgets became more lean research is increasingly unidentified as an instructional element of the program, hence is downgraded at the state level.

The Value of SERL in Research and Training

Chall: I have a quote here from your 1961 report that I'm sure you wrote.

McGauhey: Yes, I wrote the report.

Chall: "Whether by design or by historic accident, the program of the SERL as envisioned by Dr. Gotaas and Dean O'Brien established a thoroughly new and unique pattern of sanitary engineering research." Do you think that it was by design as much as by historic accident that this came about as it did?

McGauhey: That is a fascinating question--the type one answers by talking all around it until the questioner is sorry the subject was ever brought up. I would say that the conditions which brought us to the end of World War II with a whole new concept of matter and energy was a result of the design made necessary by the accidents of history. Perhaps it should be said that the needs confronting the University, and the opportunities confronting it, were generated by history.

Considering your question in terms of our responses to those needs, I would say that in setting up the Laboratory, the idea of an area such as the RFS, where you can carry on activities on a scale greater than that feasible in a teaching laboratory--that was definitely by design. Whether it was historic accident that brought together the School of Public Health and the College of Engineering and the staff and the stuff from which SERL was made--and

McGauhey: the program in which it serves--depends upon one's point of view. I would presume that the faculty decisions which divided Dr. Gotaas' time between the two schools was historic accident. What alternatives there were to the employment of Dr. Gotaas at the time I do not know. My guess would be that had someone else been chosen the whole story would have been different. That makes it historic accident. But after these accidents had occurred, some of the elements of design are detectable. Perhaps I should avoid the question and say that we were just lucky.

Chall: But then Dr. Gotaas told you some years later what he had in mind.

McGauhey: It was evolving in his mind as we talked it over. That is, how it came out is the way, very much the way, it was developing in his mind. Of course, there was a lot of feedback from the many people concerned. Because of what I have previously labeled the penchant of professors to disagree--often as a reflex action--much of the feedback was negative. It served, however, to refine the concept of SERL. I might say that in this refining process, and at the time the name Sanitary Engineering Research Project became incongrous, there was considerable debate as to whether the word "research" should be left in the title. I think at the time the designation of a unit as a "laboratory" seemed a little more holy, although to those of us who opposed the change it sounded a bit more pharmaceutical without the research designation. I judge now that the logic on both sides stemmed from the "penchant" I have noted.

Regardless of the threads that went into the fabric of SERL, the refining process resulted in a situation in which we have a place where people can work in a work atmosphere--where we can put up pilot plants and build things of different size or scale than you can have on a teaching laboratory.

I say a "work atmosphere" because one of the problems with graduate students around a professor's office is that if they were to chart what they think the professor does, they would say he arrives one minute before class and promptly goes off to coffee as soon as it's over. So he never sees the professor

McGauhey: doing anything but talking. Students fall into that same habit pattern. They don't realize how much oil the professor is burning when the student isn't there to take his time; or that some freedom to rearrange your time is important to a professor; or that he ends up breaking his own neck if he doesn't hit the ball and do what's necessary for promotion. It is easy for the graduate student to fall into the habits he thinks characterize the professor; i.e. endless talking and coffee breaks for even more talking. This is not the way research work progresses.

When I first joined the SERL staff one of my difficult tasks was to deal with graduate students in the Laboratory who were working under individual scholarships in relation to those who were employed half-time on a project. The difference here is that one was not paid by SERL or any project. His source of support was really none of our business. We simply provided him with the space and the facilities to do his dissertation research and if he didn't do it he never attained the degree. In contrast, the doctoral student supported by us was paid half-time for full time attention to his thesis. In this fashion he supported himself and his thesis could go beyond the objectives of the research for which the project was funded.

One example will illustrate. We once had a self-supported graduate student that arrived at the Laboratory when it suited his convenience and thereafter sat reading the morning newspaper. Not appreciating his situation the employed students took the attitude that if this bird doesn't work on the job why should I have to. I had repeatedly to explain that nobody is paying him. If he wants to lie there, as long as he doesn't get in your way, forget it.

Chall: But you do have to show a little for the money that's gone into the project at the end of a period of time, don't you?

McGauhey: Indeed yes. But graduate students are good producers. The particular case I noted was unique, but it does underscore the value of separating a work atmosphere from the campus routines. As an interesting aside, McGauhey: I may say that in the particular case I cited, when the student finally laid his paper down and thought for two minutes, he accomplished more than most people do in a half a day. He was one of the sheerly brilliant people. He appeared to be doing nothing, and all at once he'd have more done than the rest of them get done in the entire day.

So at the field station there is more of a work atmosphere than in an academic building, with people running in and out, and people going across the street to coffee and the "why don't you come along with us" type of thing. There's less time lost by inertia of the system than there is on campus. It has some disadvantage being a little further away. And yet it has some advantage, too. The distance never bothered me. I didn't mind. I'd go to the campus early in the morning and stay until noon; then go to the RFS. It wasn't hard to arrange the situation.

Chall: Well, you're a disciplined person. And, I suppose, not all people are as self-disciplined as you are.

McGauhey: One has to be either disciplined or fairly highly organized, as you have to organize each day pretty well in order to expand your capacity to do things. At least, as time goes on one's capacity to accomplish things does increase. You work just as hard. No harder than you did before. You just get a little more done.

Chall: You must have done a good job or you wouldn't have been here all these years.

McGauhey: Well, it's been really sheer fun. But it would have been an awful haul, if a person didn't enjoy it.

Chall: Mrs. Langelier said that she was a laboratory widow. Is that what your wife says about herself?

McGauhey: Well, she often says that she's long since learned to live alone. We never had any children, but since the RFS is only two miles away, I go home for lunch. We go out to eat at night a good deal. And she has gone with me all over the world.

McGauhey: Through the years we had what I called the McGauhey Foundation, an unlikely and impecunious organization and a figment of the imagination in which I put the money that I made consulting, which wasn't much. But any that I got, I put in the foundation. The purpose of this was to pay for my wife's travel when we went overseas. And my rationale, which she laughs about, is that it's far simpler to take her there to see for herself than it is to try to tell her about it.

IV RESEARCH AT THE SANITARY ENGINEERING RESEARCH LABORATORY

Obtaining the Research Grant

Chall: I suppose that we ought to talk about financing the research and this Laboratory before we get into the projects themselves.

McGauhey: As far as the budget's concerned, it hasn't grown any.

Chall: Your own budget at the Lab.

McGauhey: The University's budget, yes. In dollar amounts it went up for several years as salary increases occurred; then it went down as people left and positions reverted to lower grades, and as funds for equipment were cut. Finally it decreased significantly as vacant positions or authorized positions were taken away.

Chall: So how do you manage?

McGauhey: The principal thing is by fast thinking and horse-trading where you can, and by getting assistance from more projects--getting more of the budget load onto research projects. I don't mean transferring the load that normally is the responsibility of the University in the way of housekeeping activities. But we furnish fewer services in the answering of phones and xeroxing and kinds of things that clerical help might do. There is no choice but to reduce that part of the staff and let the people from the projects use the equipment themselves and pay for the cost of doing it.

Chall: How do you apply for a grant that includes that kind of overhead?

McGauhey: Well, this is really not overhead. This is direct cost, and we get at it this way: We ask for a certain amount of clerical and stenographic assistance, for which we can demonstrate a need. But it isn't at all impossible for the granting agency to understand that if you have four or five men working in the Laboratory, half-time of a secretary or half-time of someone of the clerical and stenographic level is necessary, just to keep the letters answered, the literature in order, and the files usable.

In addition we include, generally, a separate item for preparation of the report. This doesn't necessarily mean only the typing of it. There's a lot to be done in the way of drafting and in xeroxing and in general legwork that goes into preparing and, ultimately, in publishing, the report itself. This is included in the budget and is clearly identified. SERL is in no position to ask for any overhead, but on the other hand, it isn't necessary or required that the University furnish a great deal of the staff assistance and financial assistance beyond that which is written into the proposal itself.

The proposal itself shows that the University is making contributions in terms of time of people and that is part of what is reviewed for approval. But on the other hand, if someone on the SERL payroll isn't busy, we'd rather have them doing productive work than sitting around just because there is no project work to be done at that moment.

Chall: I see. But you do assign to the project everything that has to do with getting it organized, accomplished, and then actually published, which is the end result of a project anyway.

McGauhey: That is true. However, we have an editor who is paid half-time by the University, and it's always difficult to say that 50 percent of one's effort went into doing those things which the Laboratory would be doing if it didn't have any projects. It wouldn't be doing much if it didn't have any projects. Therefore we wouldn't need all the SERL personnel.

McGauhey: So the editor does a good deal of work for the projects--advice and counsel, all of which takes time. But this, by the way, is also listed as part of the University's contribution, because it has to make some contribution in order to get these projects. There are hardly any granting agencies that simply say, "Here's the money, do something with it, do what you said you were going to with it." You have to show that you have something invested in it. The percentage of project costs required of the applicant differs from one agency to another. At least 5 percent is required by the Environmental Protection Agency, for example.

Chall: Doesn't the University take a certain amount off the top of the grants that come in?

McGauhey: The University's overhead has to go over and above the amount of funds that are asked for operating the project. It is generally determined by the University, but in some cases negotiated with the agency itself. It is largely applied to manpower, and not to other costs. The percentage at the time of my retirement was 44 or 45 percent. This applied to that part of the budget which is manpower and general assistance, and not to the equipment and laboratory supplies and that sort of thing. So it actually isn't 45 percent, or whatever the figure may be, on top of the whole budget request.

Chall: You have to figure what it is that you basically need and then add a certain percentage that you know the University's going to take.

McGauhey: Yes, but the University, the Office of Research Services, is maintained for the purpose of developing that part of the budget for us. We take to the ORS the amount of money that we are asking for. They verify it--go over it carefully to see that, at the classifications of people we are asking for, the money is in line with the University scale for that classification. The faculty investigator can't simply put in "full-time assistant, $5,000," you know; you have to identify what sort of assistance this is, and that $5,000 would be the normal pay scale.

McGauhey: Of course, the Office of Research Services itself supplies a considerable service to the projects, such as getting the proposal itself prepared, or at least typed, and through the mills of the University, and making a monthly accounting to the faculty investigator, or his designated project leader, on the status of the budget. Accounting sends this to the ORS, for transmittal in summary form to the projects; otherwise the University would be in an impossible situation. Professors being what they are--with other things on their minds, and what I have called a drunken sailor sense of economics--would spend all of the money and the University would be the loser if it didn't watch finances pretty carefully. In all fairness to the faculty investigator I should say that the strange ways of accounting, and the funds that are in the pipeline of expenditure at the time the accounting is made, insures that the professor can not find out the status of his budget unless he keeps books himself. Only bills paid are charged against the budget. Fringe benefits are set aside at the outset. And other obscure factors are introduced into the accounting process. Thus the project may be in the red as a result of careless expenditures not yet in the paid category; or it may be well in the black as a result of employment of personnel not eligible for fringe benefits.

Nevertheless, it is a part of the terms of the grant that the University's accounting will look after this money in appropriate fashion. If accounting sent out this material to each faculty man, it would get lost. We need an organization to look after all of this sort of thing. That is what ORS does, and we put in our budgets some money to cover such service. Charges by ORS are therefore based on actual service performed. It is not an overhead cost.

It was one of my perennial tasks through all the years to try to make faculty investigators understand that they're not paying an overhead to ORS. They said, "Why can't we do that ourselves?" My answer was that we could hire somebody for a few thousand dollars, but why pay a few thousand when we can get it done by ORS for $200. It doesn't make

McGauhey: any sense to try to handle all of this through the faculty investigator.

Although University accounting and ORS services may serve to protect the University from faculty economics, it does nothing to make the life of the director of SERL less complicated. Funds included in the budget for clerical and stenographic assistance, and for preparation of the report, were almost always grudgingly spent--if at all--for the purpose cited in the proposal. It is a rare faculty investigator who ever reads the objectives and methodology proposed originally, once his project is financed. Generally he immediately sets out to do something else at twice the cost. Or he becomes intrigued by the research paths that open up as the project progresses and attempts to follow them all. The result, in my experience, was that with but few exceptions the project came to the hour of report preparation with no funds left in the project. At that point the investigator is caught between the University, which may not get its money if the report is not submitted, and the alternative of trying to find some way to unload the cost on the basic SERL budget. For me it was easier to find a way to bail them out than it was to change the ways of professors, so I considered it a part of the game and managed always to meet the challenge.

I believe I have already noted that ORS serves as the first filter to see that the proposals themselves are in line with University policy, and that they serve an educational purpose; that graduate students are involved, and education is a goal of the activity; it isn't just a trivial repetition of routine things for the purpose of getting a few dollars to support a student.

Some Criteria for Determining Grants

Chall: Are they at all interested in kinds of research, or is that left up to you--to determine what kind of research is needed, and where you take your proposal?

McGauhey: That's pretty much left up to the professor. Generally the way a proposal is developed is through the professor's own contacts with agencies that are authorized to provide funds for certain kinds of activities. That is, if one is in the field of sanitary engineering, he knows pretty well that the Public Health Service, and the federal water quality administration (now the EPA) and various other agencies, are funded for certain kinds of purposes. If those purposes happen to be something that the professor is interested in pursuing in research, he then makes unofficial inquiry from his own friends in the agency. "Here's what I have in mind. Is this anything you might be interested in supporting?"

Such contacts are all strictly informal and are not binding on anyone, nor are they part of any formal negotiations. So this is done largely by the faculty member himself, although the University does have an office in Washington which keeps track of the availability of funds, and periodically inquires into the status of project proposals when requested to do so by ORS or the faculty investigator. So generally, before anyone from ORS goes to Washington, as they do every month or so, they inquire of the various professors whether they have any projects in Washington which ought to be looked into. From time to time, upon return of this individual, usually an assistant dean, we get a summary from ORS of the status of various projects at any moment.

But what kind of problem is to be worked upon is pretty much determined by the chap who wants to do it. The University's interest then is to see that this serves an educational purpose and that it is something a university ought to be doing.

There are some things that one might propose to do which are in direct competition with our own graduates that are in the business of consulting engineering. And these are things that are not really as appropriate to a university as they would be to some private research agency. An example of that is something that requires a considerable installation at a long distance from the campus, and the hiring and firing of people.

McGauhey: Suppose for example that I were to get a demonstration grant to work with a city 150 miles away, and it involves the employment of people to do certain kinds of tasks. Suppose it involves laborers who are here today and absent tomorrow, and stay drunk for two weeks. In private business you could fire them. In a university, however, we hire everybody as though they were going to be permanent staff members, and we just don't have the flexibility for dealing with the labor situation I have cited. Moreover, just maintaining supervision of the distant project is extremely difficult, and wasteful of the professor's time in running back and forth. So this is one of the kinds of things that the University is not really set up to do well without interfering with its normal function. Then I suppose there are other kinds of things that are politically sensitive or involve discussion between two groups of taxpayers.

One other kind of thing that is not considered, and should not be considered appropriate for the professor to be involved in is something that is so secret that it doesn't become public knowledge. Everything we do as a public institution must be public information, except in cases where the University itself has entered into contracts with agencies like AEC, where restriction of information is part of the agreement. But the University is not going to let me, and I say it shouldn't let me, take money to do a development task or a research task from which the findings go into the file of a business that doesn't want to reveal them.

The reason behind this limitation is certainly a valid one. That is, that the advancement of the professor is based partly upon his scholastic attainment; and scholastic attainment is partly measured by publications in referred journals. It doesn't do much good to say, "I wrote a really good report, but I can't possibly show it to you." This would not help a committee judge the fitness of the researcher for promotion, so the University just should not allow a man to paint himself into that kind of a corner.

Chall: It would happen that sometimes these kinds of proposals are made, and ORS would catch it?

McGauhey: I don't think the faculty would ever make that kind of a proposal.

Chall: They know better?

McGauhey: Yes. They know it is not in their own best interest. They are more likely to do that sort of work on a consulting basis, where it's only a small undertaking. If it involves a large project they would recommend a consulting engineer. The consulting engineer might retain them, if they're particularly expert, for an occasional consulting day. But we don't get much of that--certainly not out of SERL because most of its interests and activities lead to public works. In fact, nearly all of the applications of sanitary engineering, and of any environmental control engineering, is public works. So we're really in the field that the public finances, rather than the field that is financed by private industry.

Chall: Yes. I've noticed that almost all of your grants are public agency grants. And the ones that are private are so important to the public--like the soap industry--that it is in the public interest to get the work done.

McGauhey: Yes. That such research support comes from an association of manufacturers rather than from an individual manufacturer. That is, the Soap and Detergent Association has, as its members, most everybody of any important size that makes anything--raw materials or detergent products--for cleansing. Therefore, what the association does is public information as far as its own membership is concerned.

Chall: In your little story here, "To Raise a Cat," you indicate at one point that the limit of most granting agencies is elastic--that's the word you use, "the elastic limit of most granting agencies."

McGauhey: There isn't much use to ask for more money than the federal government has appropriated to an agency, nor to ask for all of it from one agency. [Laughter] So you have to get some kind of a feel for whether your proposal makes economic sense or not, in terms of the available funds. It has been

McGauhey: estimated that we need to put in about two billion dollars a year for the next five years into research on solid wastes. Well the EPA may get fourteen million or eighteen million, or something of this sort for solid waste. It has to be spread around. For political reasons, they can't put it all in one region of the country. For reasons of productivity, it is unlikely that it will all be invested in one or two chaps' ideas, because in the academic world there are a lot of people with ideas, and some of them may turn out to be good ones. And so as a researcher you have to get some kind of a feel for whether you are working within the constraints of any feasible funding. This is what I think of as "the elastic limit" beyond which you can't go. [Laughter]

Chall: However at any given time there is apparently a certain political or social climate--and it changes rapidly--that determines what you can do.

McGauhey: It changes quite rapidly. It changed rapidly in the last five years. I believe I mentioned this in one of our previous discussions. The interpretation placed by the HEW on what it meant by environment was the effect of environment on man, matters of crime and housing and things of this sort, as opposed to what man himself is doing to the eco-system, or to his own chances of survival in the long-run. Not that these are things of total unconcern, but at the moment they say the time has come to build things, and to come up with systems, and to move things around. So they are de-emphasizing research, in terms of dollars.

The time may change again when the emphasis will shift back to very basic research.

Chall: What happens to an organization like SERL, then, when research is cut. Or is it cut, really, this much, in your field?

McGauhey: It's cut. It means that we just come up with fewer projects and this means that we can support fewer graduate students. However, this is one of the good things about a policy that says don't load up a research laboratory with too many professionals.

McGauhey: We have to have some professionals around for assistance, particularly on long-term grants, but the elasticity comes without having to discharge any employees. When a graduate student ultimately gets his degree--most people do live long enough to get their PhD in the United States, though it's getting near the life-expectancy of man--by that time the project is over. The graduate departs and if there isn't any other project, we have retrenched without dismissing any employee.

What we have lost is the ability to support another graduate student. And of course the number of graduate students that can be maintained in a university is partly dependent upon support that if can offer them. The amount of support is about the same everywhere, so it isn't that we can offer more at the University than they can offer some other place. If the other place is not out of money, the student may say, "Well, I would like to go there," and it doesn't give us the choice that we like to have in selecting students for our own program.

If we get down to where we have more professors than we have students, then we're below some kind of a critical mass. If a low graduate student to faculty ratio is a result of obsolescence of our whole program, then we ought to begin thinking about phasing it out and bringing into the University some other viable program. But if it is the result of over support of universities in a particular field that has diluted down the number of people that field can attract, then it becomes a somewhat critical thing.

This occurred in sanitary engineering during the early years after the war. The federal government, for good reason, supported the development of sanitary engineering programs in many universities. The number of programs then was sixty-three or more, whereas there were previously maybe fifteen that were doing most of the teaching.

Now the support enables the people there to pay graduate students, and some of them had policies permitting them to hire a professor on soft money, McGauhey: as we call it. Having nobody in a program, they would hire one of our PhDs as an associate professor, where we would consider him as a Step I or maybe Step II Assistant Professor, and give him a chance to develop a program.

Pretty soon we just had more programs in the United States than we had students that we could attract to the field. Even though the need is there, the competition for the human mind is pretty great these days, and this is reflected back in the problem of getting research contracts.

But to further answer the question, once the money gets tight, the number of projects that a faculty or laboratory can obtain shrinks. Then it becomes a little difficult to develop programs for support of graduate students.

Chall: And is SERL feeling this kind of a money pinch now? Everything today is pointed toward water pollution control and environmental pollution control because of chemical or industrial pollution. All of the aspects of your Laboratory's work would seem to be very important today.

McGauhey: We are definitely feeling a pinch, although we are beginning to get out of it. The pinch came here in two different ways. One is, as I've said previously, is that what a professor does, is largely his own area of interest. Now to maintain a varied faculty, we don't want seven chaps with all exactly the same interest. We have a lot of areas to cover. So when any one of them retires, as I did, part of the program that he was supporting goes with him.

Some of the areas that I was working in, notably the economics of water, we didn't have anyone to carry on, because everyone else had his time committed to his own areas of interest. Although another person might have had an interest, he could generate just so much financial support at one time and so stayed in his own area.

Some projects, a large number of which I carried, died, or came to an end, anyway, and we didn't renew them. As the new director came on it took him a little while to begin to generate a greater load of

McGauhey: projects than he was carrying as a professor before, and he is doing that quite successfully. He got some work on the pollution of San Francisco Bay from the state, and it will build up again, but more people have to scuffle a little harder.

Another thing that happens is that, as a faculty member grows older, he gets more administrative duties and you can't get him to put the same hustle into research as he did when he was an assistant professor and trying to make a reputation. It isn't that he's grown particularly lazy, but it's that the onset of responsibilities take part of his time, and public service takes more of it, and University committees take more, and he leads more graduate students at levels of research that cause him to have to put time into keeping his lecture notes current. And so you get the energy die-away curve appearing in research just as it does with aging of people.

Our group expanded rather quickly after World War II as I mentioned on a previous occasion. That meant that we had quite a number of people that were nearly the same age. The tendency of all university professors, I think, whenever a vacancy occurs, is to think we must hire someone now who's already got a big reputation in this field. And this has to be resisted by the administration on two grounds: The most important one is if we have everybody retire at once, and get a big flame-out, we have lost all our stature in the field at one blast. So when a position opens we'd better get another young man who has potential and let him begin to demonstrate that potential and support his research. It's a little harder for the young man to get money that it is for the well-known one.

We have dealt with this sometimes by joint investigatorships, in which a more seasoned individual appears as a joint investigator. He assists the younger one in developing and pretty soon drops out and lets the other man write the papers. When you get old enough, it doesn't matter whether you write any more papers or not.

Chall: Just as soon not, too? [Laughter]

McGauhey: Even though most of us keep doing it, it's not as critical a factor in our career as it is with the younger men. [Laughter]

Chall: I see. It's just a momentum you've built up.

McGauhey: Yes.

Chall: Is it also true that these changes might be forced upon you by other institutions competing? I mean, you're talking about your work on the economics of water, coming to an end, and I noticed that Resources for the Future has funded studies of water economics in other institutions.

McGauhey: They funded us here at the very start. In fact, I think our first project in economics of water was funded by RFF.

Chall: So they could be funding other institutions who could be also carrying on similar research.

McGauhey: Yes. And they funded one of our graduate students, Dr. Richard Frankel, currently over in Bangkok, who has gone on to a considerable reputation in the field of water economics. His initial funding was from the Resources for the Future, although they do some of it themselves.

Chall: Is there a great deal of competition among institutions, so that there is a duplication of effort? Or are granting agencies careful about duplicating effort?

McGauhey: They're pretty careful about duplicating effort in this fashion: They're not unwilling to have people in different institutions working on the same subject. The reason is that one man has a different idea than the other, and his approach is different, and you can't tell which one is going to pay off. But they are very careful not to fund an organization for doing the same thing that has already been done.

Some of our early research here is a good example--the algal systems started by Ludwig and taken over by Professor Gotaas, from which Professor Oswald has made a world-wide reputation.

Chall: What systems? Algal?

McGauhey: Yes. The use of algae in systems for wastewater treatment and in life-support systems. As soon as these pioneers had published something that looked good, the agency began to get proposals to do the same thing. The attitude of the agency then was: "Well, look, somebody's already published that. What new idea do you have here?" If they can't show some new idea, they are filtered out, at least until a new generation takes over the agency and has not heard of the past.

But as to the competition, it is healthy rather than awkward as far as our Laboratory's concerned, because it makes us scuffle to stay in the front rank, and this is what we expect the University of California to do--to stay out front. There are only a few competitors for the front rank. There's lots of competitors for money, and I don't mean that these are inconsequential programs; but it's easy to understand that a university which has only a sanitary engineer, a chemist, and a biologist teamed together, and not much other support in the university structure, can't do the kind of thing that we can.

When I say, "other support in the university structure" I am referring to the people we can go to on soil systems, in soil sciences, in metallurgy, and epidemiology, and entomology--anything you can name you can find in our system somebody who has a pretty considerable reputation in that field. There's never been any problem getting them to sit with us and put us on the right track. But if one gets into an institution where these are limited in number, then he can move only so fast because he just doesn't have the support, either in human resources that might assist him or, perhaps, in facilities as well.

The competition never seemed to be a critical factor, although we have lost some graduate students that we'd like to have to other institutions for, probably, reasons of the length of time that it took to get through our admissions mill. They got frightened that they were not going to be accepted, and when somebody elsewhere said, "We need you here right now," they went. But that is part of the game, McGauhey: and it's not anything that one can deplore in very tear-jerking terms, anyway. [Laughter]

Chall: You manage to get over it. What if somebody says, "I have some money to have you do some research on a project," might you decide that it isn't worth taking or going into that facet of research?

McGauhey: Well, after you recover from fainting...

Chall: I guess nobody really ever comes to you with money. [Laughter]

McGauhey: In one case they did; and I turned it down.

Chall: Oh, you have done this?

McGauhey: Yes. It was some money--of course we didn't get as far as discussing how much, but it wouldn't have been a lot--from the construction industry that wanted to resolve the problem of disposal of demolition debris. I told them I couldn't take the money because I didn't have any idea of what to do. Unless I have some hopeful research ideas, just having money isn't going to solve the problem. There may be other people with ideas, I said, but I don't know a confounded thing to spend your money on that would make any sense.

You see one of the troubles with getting into research or accepting research money is, you are committed to producing some results. At least you've got to make some progress along the road toward solving a problem; so just money without an idea doesn't help you any. That does not mean that there are not people in the world with ideas, but it means if you don't have it you're a poor one for them to invest their money in.

Chall: Yes. But there must be some projects on which you don't really have ideas, but you feel that somebody else in your general area here might have an idea, or it might at least be worth exploring.

McGauhey: The Laboratory has never said no to any suggested study which was appropriate to our educational purpose and our commitment to public service. We

McGauhey: always check to see if there's anyone around either in the Laboratory or elsewhere in the University that is interested. This is not an arbitrary decision by the director of the Laboratory. If there's any money around we find out whether anyone has an interest or an idea.

Chall: I see. Or any desire to take it on.

McGauhey: Desire--particularly if it's money that leads to the support of graduate students and our educational purpose.

Techniques of Writing Grant Proposals

Chall: Some people, I think at your level, have criticized granting agencies because it takes so long to write a proposal properly. Apparently there are certain rigid systems to follow, every granting agency has its own forms, and so much money seems to be taken off of the top for whatever reasons there are, that it's hardly worth the effort. There must be some other way to finance the programs that we want.

McGauhey: Well, people have talked of doing that by getting a big institutional grant. This is somewhat the way NSF [National Science Foundation] is worked. Get an institutional grant and then the institution itself, by internal scuffling, decides who's going to be supported in what research effort. After a few years this becomes a comfortable sort of a vested interest, you know, and doesn't, in my opinion, fire up the imagination of the professor to the extent comparable to that of the project he has to go after for himself.

But to the point that you made, one has to learn how to write proposals; that is, if he's going to get money.

Chall: Do you charge the time that goes into writing that proposal against the cost of the proposal when you finally get the money?

McGauhey: No, you cannot. No agency will permit you to put in any cost of going after the money. This comes out of your own energies. If you want support, then it's up to you to get busy and put together a proposal.

Chall: But it must come out, not only of your own energy, it has to come out of your pocket, someplace. Is that a personal pocket?

McGauhey: No. Getting the thing ready and sending it off is part of the service of the University through our Office of Research Services. It sends away many proposals and a good percentage of them come back without any olive branch, you know. [Laughter]

Chall: Then what about all the time it takes you and a half-a-dozen other professors, let's say, to work out a proposal first, before you get it to the Office of Research Services? The secretary has to type it up.

McGauhey: Typing is only a minor aspect. The main task is getting something worth typing in a form that the secretary can read. That comes out of the seven-day-week that we put in on it. That's part of our responsibility, I think, to the University. The University, while it doesn't actually say, "X number of hours you should spend in teaching," generally implies that if you are not doing research your teaching load ought to be bigger than if you are. Some fraction of our effort is supposed to be dedicated to research. And while no one has ever codified that, and pity the one who tries it, it is rationally a sound approach.

If we have people with energy and curiosity and interest, they'll generate the proposals. I have written proposals that turned out to be a waste of time, except as they may have educated me. But not too many, not too many. The plain fact with proposal writing is that if you can't tell the granting agency what it is that you want to do, why it makes any difference to anybody in the world whether it's done or not, and what kind of an idea you have about how you're going to do it, then you shouldn't expect and can't expect it to get any

McGauhey: serious attention. As in my "To Raise a Cat," there must be presented some idea of how the professor is going to do this, how he's going to get started, and what wonders will accrue if it works out.

This is the difficult part with many people and their proposals--I've read lots of them and have been on countless review committees--they just either can't tell you what it is they want to do, or really don't know what it is they want to do. Or why anyone cares.

Chall: Or should care.

McGauhey: Yes. Once you can tell what it is you want to do and show that you have an idea of how to go about it--an idea that has not already been mined out and reported in the literature--then you can get a proposal seriously considered.

The ORS helps, of course, with the budget considerations, but writing the proposal is just part of the chance you take. It's part of the cross you bear if you want to get research support for your students.

Chall: Isn't there some way that you can obtain, in advance of writing a proposal, whether the granting agency might be interested in supporting your research?

McGauhey: Theoretically there is, but it doesn't work out in practice. Of course, the granting agency lets it be known what areas of research it is interested in supporting. Thus if we are interested in study of air pollution control, water quality, solid waste management, or other subjects we can decide who to approach with a proposal. In many cases the agency also suggests that a brief letter be sent in advance of any formal proposal in order to determine the agency's interest in the project the researcher has in mind. "Don't bother writing a complete proposal," they say. "Just tell us in a brief summary what you want to do. Write us a letter saying 'This is the area in which I would develop a proposal if you have an interest.'" To follow this course is to be assured of disaster.

McGauhey: Let me cite an example.

Recently I was called in to consult with a water resources center in another university to assist in preparing some new proposals. My role was that of an expert in grantsmanship rather than in the particular subject of the proposed research. The institution had employed two people (who were getting ready to leave) when I arrived, but they weren't getting any research money the way their program and manpower justified. I found out at once that they were following the rules, or following the suggestions, of granting agencies; and they were exciting no interest.

Chall: How do you explain that?

McGauhey: To answer the question one must inquire: who gets such letters as the agency suggests? No one knows. In a large agency, somebody presumably reads it; it isn't in enough detail to tell anybody what the professor is going to do and the message just doesn't come through. So the reader advises his agency to say "We are not interested."

My advice was, "Write a proposal as though you meant it, even though this takes a lot of effort. Send this proposal informally to your contact in the agency, and make it clear that the document is unofficial and subject to refinement to fit the objectives of the agency as long as they are compatible with the university's policy."

Then somebody will read it. Quite commonly the judgment will be either, "This is good, but the budget's far too big," or "This aspect of it we are already supporting elsewhere," or "We don't want to support some phase of it." After this initial evaluation you can rewrite the proposal on the agency's standard form--it doesn't have to go out on the forms to begin with--and submit it through proper university channels. From my experience the flow in university channels is like cold molasses. Therefore, I advise that the university be badgered into sending out an advance copy which is official except for some signatures required by the university process. Most agencies

McGauhey: will let the applicant meet deadlines with this kind of proposal.

But you simply can't get money by just skeletonizing what it is you want to do. Because the chap who reads it will say, "There's not enough detail here to tell how he's going to do it." Even though the policy of the agency may be that the skeleton proposal is adequate, it won't work. Not with me, anyway.

Chall: Did it help when you changed their methods?

McGauhey: Yes. They quickly got two more projects supported, and have continued to be successful in obtaining research grants.

Chall: There's a system then that you should be following.

McGauhey: You have to follow a system, such as I have noted. But first you must have an idea, preferably, an idea about new subjects that are emerging, and be able to state clearly what it is you want to do about that idea. We at the University of California normally search for the new idea. We expect to attack these impossible problems that are coming on fast, or that we can foresee. It is possible sometimes to see so far down the road that there isn't enough interest yet on the part of the granting agency. I believe I mentioned on another occasion that this is one of the pitfalls of research, that you have to shout that the sky is falling in order to get anybody excited enough to take an interest in financing a project. Only if you can make the world believe that the sky is falling can you get enough lead time in research to come up with the measures needed when the falling begins. [Laughter]

If it is, indeed, already falling, as in the case of air pollution in urban centers, something has to be done, and will be done politically, before research can possibly produce results. Then we hear again the familiar refrain: What good did research ever do? They research, and research, and nothing ever comes of it. This is the major cross the researcher must bear; that in order to obtain research funds the problem has to be so immediate

McGauhey: that it is difficult to get lead time enough to come up with results that can be put into hardware.

Along with that is the danger that the researcher will become so intrigued by what he finds, that he thinks it necessary to attack smaller and smaller pieces of the problem he set out to work on before any conclusion can be reached. This is what I call receding into the background, instead of moving along in the direction of the horizon. Fragmentation of a problem is unavoidable because as you crack it you see that it wasn't one problem at all. It was ten thousand problems locked up in one nutshell. Following his instincts, the researcher feels he must get at each of the ten thousand little problems before he reaches a conclusion befitting a scientist. Thus cracking the big problem may never have any effect in the real world as the reseacher follows the intrique of interesting pathways and forgets his original purpose.

Determining Contemporary Environmental Research Goals

Chall: That has to be watched, then, I suppose, by somebody who's giving the money.

McGauhey: It isn't so much that the granting agency serves as a watchdog to insure that its money is well spent. The phenomenon that leads to research support only when crisis is upon us has yet another facet. This is that the granting agency itself, particularly the federal agency, gets its funds from the Congress only when the Congress believes that the sky is falling. In the matter of environmental control most of the research funds come from federal agencies. Five or six years is about the length of the attention span of people to any particular crisis. After that the excitement is gone and we need a new crisis to make life exciting--or to keep up our accustomed level of sensitivity to impending doom. So interest shifts periodically to some new threat. This doesn't mean that the old crisis is resolved. Water pollution, for example, goes on and on but a new buzzword replaces the one of the moment in an endless sequence.

McGauhey: Thus every five or six years the granting agency will say "Look, we've been supporting your project for X years and are now shifting our research emphasis to another subject." In such a changing world the professor should not expect a single research idea to last him all his lifetime. He ought to have another occasionally.

The trick in good grantsmanship, beyond writing a proposal that does not boggle the human mind, is to foresee the crises ahead with enough clarity to judge when the lead time is down to about five years. At that time his cry that the sky is falling seems plausible to some granting agencies. With good luck, the researcher may get funds and be in a position to provide some of the answers when the critical questions are finally asked. In that case he becomes the established authority on the subject and the reputation of the university for leadership in the overall field is enhanced. If the coming crisis is too far down the road, the researcher will merely become a jackass braying in the wilderness, and will have to compete for support with a host of unimaginative researchers for funding when the crisis is finally upon us.

In one of the many forgotten papers I have written I call attention to the reasons why research of a very subtle and multi-disciplinary nature is required in today's environmental climate. Of course, we in SERL have made it our business to look for the coming problem and to be prepared to attack it at the earliest moment we can excite some support. The overall situation, as I see it, is that we are now entering an era when reconquering the environment is our major problem. Incidentally, I did not invent this particular idea. I got it from some long forgotten writer who failed to elaborate upon it. Nevertheless, in pioneer days the first task of the engineer and nearly everyone else was that of conquering the wilderness--just overcoming gross environmental problems. Much of this was done with well known hardware--the plow, the pick and shovel, the mule drawn scraper, and a little dynamite.

Then came the second era in our national development. This is the one in which most of us have spent our lives. Now, having conquered the wilderness to

McGauhey: a vast degree, we set about exploiting the resources that we found in the wilderness developing technology and science and all manner of industrial enterprise--chemical and metallurgical, and so on. That we did this with considerable abandon as far as residues and environmental impacts were concerned gave birth to the third era--the era of reconquering the environment. Only this time, instead of having gross wilderness or obvious environmental problems to deal with, we have subtle ones and long-term ones. When conquering the wilderness was a matter of chopping down trees, we could eventually see the sky and the ashes and know that we had them chopped. The immediate objective of creating a field for our crops was achieved by relatively simple, if strenuous, means. But what we did not know, or care much about, was the long-term effects of our gaining a field. These effects have now become our environmental concern. So it's this area of "don't know" in which we need research far more than we need hardware, because we don't know what kind of hardware to make.

Chall: And a whole new attack on values, too.

McGauhey: Yes. A whole new attack with a different kind of a team, too, because there's no individual discipline so uniquely prepared that it can attack a major environmental problem with all its implications and come up with a solution. What happens is what has happened often in the past: we may come up with a simplistic solution, and all that solution does--or at least one of the things it does--is to create unforeseen dislocations in equilibria in the environment.

As a result we are now confronted with a situation where multi-discipline research is far more important than it was in the past. I use this term multi-discipline, rather than inter-disciplinary.

Chall: Oh, that's something else?

McGauhey: Yes. Because the way the system works. If it's multi-disciplinary it means you have assembled together a group of appropriate disciplines that understand the problem and are working together on it;

McGauhey: but when you get into interdisciplinary ones, this means--or has meant, at least--that each discipline will take what money it can get and go off and do what it pleases with it, and in the end, as I have said on another occasion, you never can put all of this product together and get any observable gain toward the original objective. [Laughter]

Chall: Really? So if you start out with the phrase, "It's going to be multi-disciplinary," then they know what you mean, and what your final objective is.

McGauhey: The definition, or distinction, is not well established yet, so one had best explain what he means. On my multi-disciplinary team I propose to assemble a proper crew of carpenters, and plumbers and electricians to do a job on this site, rather than to encourage each to go off and do what he thinks is a good idea and send me a bill at the end of the month.

Chall: Each in his own lights.

McGauhey: There's plenty of room for the individual to pursue his own area of interests. But let him do that when he goes for his own grant. [Laughter]

Some Noteworthy Research at SERL

Chall: Tell me, now that you have somehow managed to get the money, with all the painstaking effort that it requires, from the foundations and the funding agencies, what kinds of research projects have you done here which you think are most important.

McGauhey: In listing the ones where this Laboratory has led the field, particularly those that have made a considerable impact, I will not try to put them in any order of importance. In the field of solid waste management, for which the Laboratory was initially created, we have made a major and continuing impact. I will say a bit more about this later, as it concerns multi-disciplinary research as well as technological and scientific discovery. One area that has attracted world-wide attention is our work in algal systems for waste management and life

McGauhey: support. Another is the area of kinetics of waste treatment processes.

I might explain briefly what this is all about. When we are disposing of organic matter such as human wastes or dead vegetation, or any natural organic matter, by biological means, the rate at which bacteria will break the material down and carry out their biochemical processes is not particularly different from one city to another, or from one situation to another, at the temperatures that prevail outdoors. So we have been able to get along pretty well in designing treatment plants with a rather home-grown, roughly determined, value of what we call "rate constant" for the way the thing progresses. But as soon as treatment of organic industrial wastes is the problem and the rate constant is unknown, then the whole set of parameters we have used for designing a system are inapplicable. Sometimes, the practice has been to just go on and use the same old rate constant that applies to something else. The results have not been spectacularly successful. So at SERL we have done a lot of work in the field of reaction kinetics which has been quite significant.

We also did significant work in detergents. The fate of detergents in waste treatment systems, and out in the environment--we did very significant work on that and then followed it through with checking out the new detergents in the same kind of systems.

On groundwater recharge, and with it the movement of travel of pollution in soil systems--we've done pioneer work, and have stayed pretty well at the forefront of that field, although the field has expanded, and of course we're no longer the only ones in it. But we led in it.

And in the whole matter of things as presumably simple as septic tanks, we clarified the situation of percolation system failure for the Federal Housing Administration--the result of our work pretty well leading the FHA to abandon septic tanks in urban situations. Most significantly we revealed the misconceptions on which septic systems were predicated and generated a new concept of systems design.

McGauhey: Presently (1972) as revived interest in land disposal of wastes has come to be the buzz word, a considerable amount of research is emerging from our findings, often rediscovering what we have long had in the literature.

We also did significant early work in the area of radioactive wastes in the environment, particularly in the wastewater system.

Recently and currently, I would say, we are doing pioneering work on the processes for wastewater treatment. Professor W.J. Kaufman is particularly at the forefront in that area, and I think the system that he now has in the pilot-plant stage and which the University has patented, is very likely to be the direction that wastewater treatment takes in the immediate future.

Chall: You mean it's different from what we have had for the last fifty or sixty years?

McGauhey: Yes. Of course, it uses biological and chemical systems, but in a different combination, on a different rationale, and in producing better results.

Chall: I see. Are you getting at the chemicals in the water now--is that part of it?

McGauhey: We're using chemical treatment, but the University's big contribution in the matter of removal of minerals has been through its saline water laboratory, the seawater conversion laboratory here under Professor Everett D. Howe, now under Professor Alan Laird.

One other area where we have gained an appreciable reputation is the principles and engineering, including design, of ocean outfalls--dispersion of waste waters into receiving waters. In this area, Professor Erman Pearson and Professor Robert Sellek have been most active. Professor Pearson is Mr. Kinetics as far as our shop is concerned, too. [Laughter]

We did some exceptionally significant work in the economic evaluation of water during the 1960s. The detergents, the solid wastes, the septic tanks, the economic evaluation, and the soil systems, and

McGauhey: water reclamation were all areas in which I personally participated in research, and with some very able men. Dr. Krone, who now heads civil engineering at Davis, and Dr. Golueke, who is our chief biologist at SERL, were among the ones who did much of the work here.

Solid Waste Management

McGauhey: We've done enough work in the field of solid wastes that I think we are, if I may say it modestly, probably the leaders in that particular field. You see those big red volumes on the bookshelf; the Public Health Service has just published two of our major reports. The Bureau of Solid Waste Management--it used to be the Public Health Service--has published them. Of them they said to us, "Well, this establishes you chaps as the center for solid waste for the whole United States!"

Chall: You've been working on it for fifteen years.

McGauhey: Yes. The first significant thing that has been accomplished here was Dr. Golueke's work on composting. At the time when people thought it involved witchcraft and specially-trained bacteria and all other kinds of mystical rituals, the University and this Laboratory sorted out what was the truth of the situation and established the criteria and the parameters for composting. They have stood up through the years.

So in the area of solid waste management we have been running in the lead position for a long time, and were pointing out the problems and some of the solutions long before the public got much excited about wastes.

Chall: I believe you referred to solid waste management as a field where you have utilized multi-disciplinary research.

McGauhey: Yes. Through the years I gave a great deal of thought to how a multi-discipline research project

McGauhey: could be successfully organized. I am sure you have been around the University and professors long enough to know that, as I mentioned the other day, they have to swim by their own energy if they wish to advance. Moreover they are inclined to work only on things in which they have an individual interest. How could you bring such a group of individualistic people to direct their combined fire power on any one individual field?

With the rise of concern for the total environment, social sciences discovering the earth, and a whole new spectrum of saviors concerned with the environment, there arose a great deal of interest in the federal government and other agencies in products which involved interdisciplinary or multi-discipline research. The concept also had a good deal of appeal to universities on the rationale that you can't do anything with resources without involving administration, and economics, and sociology, as well as engineering, public health, science, etc.; in fact you can hardly find any field that doesn't have some relevance to environment. There ought, therefore, to be some way the University can bring all this to bear on the overall problem.

The formula that Dr. Golueke and I ultimately came up with in solid waste management was one in which, on the basis of our presumed competence, or at least our stature in the field, we would seek to get support for a project which would be multi-disciplinary. In it we would bring interested individuals from other disciplines as participating faculty people. We would support graduate students in the particular areas of the cooperating or participating professors; we would have this group of professors constitute a project control committee that met every week, or at least every month, to review the progress and the relevance of our work and to fit together what we were finding in the various activities of the project. We would manage the budget in SERL, but the fraction to be allocated to each activity would be determined by the group in developing the project. Money would be allocated for the several purposes, but the funds remained in SERL. Thus, if the participating faculty member failed to work on his agreed area, I could shut off

McGauhey: the money. This is the secret of multi-disciplinary research: central responsibility for budget. In my opinion you cannot invest money in a whole series of projects fitted together with any hope of holding them together. They just go off in any direction and the result is choas.

We started our multi-disciplinary project by going in the field the first summer and learning what the problem was all about; the entire group of participating professors taking part at once.

Chall: What were the disciplines involved here?

McGauhey: There was sanitary engineering, agricultural engineering (Davis); chemical engineering, mechanical engineering, forestry, planning and economics, and operations research, and public health. Thus in the waste disposal group we had a good spectrum of technology in agricultural waste, disposal, landfilling, incineration, and composting. The economics and planning group worked closely with operations research to set up first a waste-generating model, and then an overall management model. Then we carved out for research teams the areas where we needed information to fit into these models; and it worked well. I think ours is about the only way that you can get multi-discipline effectively to attack a problem.

In each of the several disciplines where graduate students were working they were guided in their thesis activities by an expert in their own field, and this made it possible for us to get quite a variety of points of view developed and quite a variety of technology analyzed, and interrelated.

After about three years some of the technology became more advanced than others. That is, some aspects of the project were ready for pilot plant experiments. Some were obviously of a long-term basis nature. Some were brought to a satisfactory conclusion. Thus when I retired in 1969 the time had come for some aspects of the project to go on as separate projects. You can carry multi-disciplinary research only so far. By and by you get into the niceties of the technology, or the details of a

McGauhey: technology and we must then expose that aspect to the granting agency to see whether they want to support it or not. At that point the multi-disciplinary phase will concern largely the economics, planning, overall engineering, and operations research aspects in one package, the various technologies and long-term scientific studies being packaged otherwise.

Solid Waste Defined

Chall: What is solid waste as you study it?

McGauhey: Most of the attention has been directed to those wastes that are generated in a city and are handled as solids. Of course, air pollutants are largely particulate matter which are solids. So are the things that go into water and pollute it. These are solids which are dissolved or floating. Thus, in general, most of the pollutants which give us concern are solids.

But what we are talking about in solid waste management are those resource residues that we have to handle as solids anywhere in the community. Solids which if not removed by man are going to stay right there and impoverish our environment.

Most of the attention has been directed to what we would call municipal refuse. This is more than garbage. Garbage per se is just vegetable scraps, from food and the preparation of food, and is increasingly handled by grinding into the sewer. Thus, more and more in our domestic refuse is paper, plastic containers of all kinds, metal containers, non-returnable bottles--lots of glass, and paper, and combinations of plastic and paper, such as they use in milk cartons. This is an ever increasing load. In the Bay Area it's between six and eight pounds per person per day.

Besides municipal refuse there's a lot of other things that we haven't paid much attention to on a utility basis. For example, there is the debris from

McGauhey: demolition, redevelopment of housing, and building of freeways. We didn't give that a lot of attention because we left disposal to the people who were generating it. They commonly have hauled it off to a private dump. Then there are agricultural wastes generated in the vicinities of cities, and the debris that comes from the commerce and industry. A lot of that the producer used to haul away to a dump.

As we begin to occupy more and more the land with people, and begin to say we must manage the land in some fashion by zoning, we tend to zone out the dump. Eventually there is no place where the individual can discard wastes himself, because the public is governing land use. Thus eventually the demolition debris and other solid wastes once hauled by individual arrangements becomes a public problem. In California, this total of wastes generated in the community approaches nineteen pounds per person per day. All of this then becomes a problem of the community.

Historically the way a city got rid of its solid waste was to export it. But now it can't find any place to export it to. At the same time it can't burn it inside its own jurisdiction because of air pollution, and it can't bury it inside because of lack of land.

Chall: It can't dump it in the Bay because nobody is allowed to fill it anymore. What do you do with it?

McGauhey: Certainly it won't go away. If you burn it, you still have 50 percent of the mass that's left. It has to go on the land someplace, whether people like it or not. The appropriate rationale for land disposal depends upon how one looks upon the material. First, is it a resource material, or is it a waste? And second, what is it feasible to do with it?

If we consider unwanted materials as residues of resource use, and resource exploitation, rather than wastes that we don't know what to do with, then the question is, if they're resources, what are we going to do with them? How are we going to reclaim these resources?

McGauhey: There are two things we could do. One, we could take the attitude that this is a mixture of bits and pieces of all kinds of resource materials, and because it's extremely expensive to sort them all out we will look upon it as cheap fill material. Then if we could find a place where we could make a fill, the resource that we could reclaim would be a land resource. This is what is going on in Mountain View and in the Los Angeles area. Thus we are salvaging a land resource rather than trying to reclaim individual resource values that are in the mixture.

Chall: How did you test out that theory?

McGauhey: It evolved in my own thinking of what indeed are we doing in the Los Angeles area, where we are putting it on the land. My questions were: on what rationale do you say let us put this material in a landfill where it is lost to us forever, if it's a resource? What is the rationale for not reclaiming it as a resource? The obvious answer is that the resource we are gaining is land.

On the other hand if we say we don't really want land resource, or we have no place that we can generate a land resource with refuse, then we may consider it as resource material. Either one of two things can be done with resource material. Part of--say 50 percent--can be destroyed by burning. All of it might be destroyed as a resource by making a deep water ocean fill somewhere. But if we are not inclined to destroy it, then the rationale would have to be that either we must stockpile it, and keep it till we need it, or we have to recycle it immediately.

Problems of Disposal

McGauhey: Historically and traditionally when people speak of recycle they have been impatient and want to recycle the whole works at once. This is the attitude of the present cult of environmentalists. Realistically, however, we know full well that we don't know what to

McGauhey: do with some of it. Paper, and aluminum cans, and certain other major components, such as the non-ferrous metals and, in a few cases, rags could be salvaged now.

But it certainly wouldn't make any sense, either economically or logistically, to take all the solid wastes and make one pile of cans, and a pile of aluminum, a pile of plastic, and a pile of this, and a pile of that, and a pile of brick, and a pile of broken concrete, and then find out you can only use two of the piles--you just wasted your time and money and still don't know what to do with them. So under this kind of a concept, storage on the land, as a resource that we don't know what to do with yet, is the answer.

Personally I think this is the answer, in California at least. Transport it over as long a distance as necessary, to land that is not in competition for subdivisions and other things--desert land that is government-owned or state-owned, which we don't have to buy in competition with subdivisions, and make a proper landfill. And by proper landfill I mean one that permits nothing to blow about, where things are properly covered, and properly drained so it doesn't endanger any ground water. Such a fill would serve the needs of communities in every direction which may find it a feasible solution to their local problem of disposal. Under this rationale, the landfill becomes a big stockpile of resources that we don't know what to do with at the present time. Maybe we'll never need them. But if we ever need the organic matter that's in there it will be partly composted. We can go in with industrial machinery, because by that time the pile will be a whopping big one which can be worked over economically. We can sort out resource values when we need them.

An example of this concept can be drawn from the mining industry. When we first mined iron, no one knew what to do with vanadium and tungsten; they just threw it in the tailings. And so by inadvertence rather than by intent we came up with a big stockpile of vanadium and tungsten when, forty years later, we knew what to do with it. When

McGauhey: we wanted it, we went and took out more wealth than they ever did in the form of iron.

To say in regard to solid wastes that if we're going to reclaim it we've got to reclaim everything now, would be equivalent to saying in the age of iron, you've got to figure out what to do with tungsten and vanadium or you can't mine any iron. We'd have never gotten out of the stone age, if we'd had to take that attitude.

So you see what I'm saying is that in solid wastes we're going to have to put some of it on the land. If we put it in one big, well-managed pile we'll have sequestered there resources values that someday we'll want, and some that we know we never will want. We're never going to go and get old, broken concrete in competition with other earth materials for making cement. And there're more brickbats than people can throw through windows. Stockpiling of wastes as resource materials is one emerging rationale.

Some cities, of course, do not have the prospect of long distance transport to some stockpile. It has been noted that on Manhatten Island it would be impossible to park enough railroad cars to haul away the day's wastes even if every inch not occupied by buildings could be covered with cars. Obviously, the alternative here is to destroy as much of it as possible on the site, although there is no reason why heat should not be salvaged as a byproduct of waste destruction.

But as I have noted, incineration gets rid of only about half the total of solid wastes of a municipality. The remainder must go into the sea or onto the land. The choice here is a matter of local geography and land availability. The choice may lie between hauling the residue a long distance for deposit on cheaper land; reclaiming land as a resource; or dedicating land as a matter of public policy and public necessity to waste disposal.

Chall: So a general conclusion of the economists is that it would pay to haul this stuff away let's say even a thousand or two thousand miles to a desert, if possible, or necessary?

McGauhey: Well, I think that we could calculate quite simply how far you should go. Here in the Bay Area we could probably talk in terms of 100 or 150 miles, before we came to land that is not in competition. But if we go to the heartland of the U.S., say Iowa, or of Illinois, or other Midwestern states, there isn't any land beyond the immediate vicinity that isn't just as good as the land right there. So they either have to dedicate, as a matter of public policy, some land, somewhere, as a receiver for wastes, or they would have to go to very long distance haul which wouldn't be too feasible.

It wouldn't be too feasible because in hauling refuse we're not going to clean it up so there isn't some degradable organic matter in it. Therefore it has to be transported from the point of origin to the discharge point in a relatively short period of time. We can't have a railroad car sitting for a week on a siding while somebody wonders where it is. Local residents will find it quickly enough by their sense of smell.

Where refuse is to be exported the community must accomplish export in an acceptable fashion from the standpoint of sanitation, and it will have to go fairly rapidly. So there are going to be places where land will be valuable as a waste receptacle or else we'll have to produce a smaller amount of solid wastes. Most likely we shall have to do both.

The fill can be used to develop a recreational resource. One example is Mt. Trashmore at Virginia Beach. It has 700,000 cubic yards of refuse in it already mixed with dirt obtained from an old fill made by the Corps of Engineers. As a result they have a mountain sixty-five feet high where the highest elevation above sea level is about twelve feet. This makes quite an impressive mound. They are building on it a soapbox derby run. Also it overlooks a pond where people can fish, and an adjacent picnic area. I think it would be a good place to fly a kite because rising up as high as it does the wind comes up the face of it and makes your hair stand on end. Michigan, and Oregon, and Illinois are also building recreational mounds from refuse.

McGauhey: A few moments ago I spoke of one concept of solid waste as that of resource materials which might be recycled. Although the true believer often applies this concept to the entire waste mass, recycling is one method of reducing the total amount which must go upon the land, while at the same time conserving certain non-renewable resources. In the household waste stream packaging wastes and paper are the predominant components.

Packaging and Recycling

McGauhey: What some of us are advocating as a result of our research and our thinking about the solid waste problem is that industry, particularly the packaging industry, should embrace the notion that one of the objectives of design of a package or of any kind of packaging material is its degradability. At least one of the things that a designer will have to bear in mind is where is this thing going to come to rest in the environment after people no longer want it.

It isn't realistic simply to say, "Let's don't exploit the resources," because our whole economy depends on exploitation of resources. Nevertheless in the case of a good many materials, we can't keep throwing away the residues and not end up with most of our resources in the junk heap.

I have what I call the tidal theory of resources. We have resources here in a stockpile, and we exploit them and throw them over there in a refuse pile. Eventually we have to take the refuse pile apart and move resources back the other way. There is some loss in the process, so we have a pendulum action in which our resources get smaller and smaller. [Laughter]

Chall: Do you think that it's possible to halt in some way--this is all a matter of public policy however--the use of the basic original resource first? That is, what if you didn't have bottles that were non-returnable?

Chall: If a law were passed to make this impossible, or impracticable, then you would probably be reusing your bottles.

McGauhey: I think if you passed a law saying that bottles have to be returnable, you would see some new faces in the law-making bodies pretty soon, and they'd pass another law. [Laughter] That is, even the legislators can't run against the tide of a civilization or a culture, if you want to call it that. And you couldn't get one of them right now to talk about making the householder separate refuse into its components.

There are problems with the returnable bottle. If you say let's make people return them, some things become evident. First, there's always a tremendous stockpile of them in the system. Take Coca-Cola, for example, with returnables right in this area. I think they have to have more than ten thousand bottles before they get one back, just in this one little distribution area. Until everybody's garage is full of Coca-Cola bottles they don't start coming back. And then they're heavy. Going from non-returnable to returnable bottles involves passing back to the retailer the costly task of dealing with them. The entire system seeks to pass the buck to the retailer for handling these things, and he doesn't want to fool with them. And, at the present state of affluence, a lot of people just won't take bottles back, at any price.

And there's another factor. Some bottles--especially those used for alcoholic beverages--are not coming back even if they were returnable because the law against having an open bottle of spirits in your car is a great deal more ferocious than the law against littering. So whether one would rather take the risk of having a bottle of wine in his car or pour it all down and throw the bottle out real quick--you know what's going to happen. No matter what the reward for return is. So you've got a lot of bottles that end up as litter. This is not perhaps the biggest concern. If the law permitted re-use of liquor bottles I shudder to think of the material that would be purveyed as I.W. Harper.

McGauhey: By the way, we are talking about twenty-nine billion glass containers in the U.S. this year, and forty billion other containers--other than glass. So we are talking of a vast amount of waste which comes from earth materials that are by no means in short supply. Thus the rationale for the returnable bottle is based on reducing the volume of refuse rather than on any resource conservation need.

What I think we need to do is to say maybe it isn't necessary to make the container of glass; make it of some other material. Or if you make it of glass, make it of glass that can be recycled as a resource material, not as a bottle. Instead of saying let us take it back and we'll use it again as a bottle, let's be a little more sophisticated and break it all up into sand and use it for ballast on the highways or aggregate of concrete or making glass wallboard. You can't make glass wallboard out of colored glass readily because of a problem of lubricating the dyes, but if one designed the glass--if it's just for ordinary purposes--so that it could be used for some of these other things, then I think recycle through re-processing rather than recycling directly is where we will go.

And it might be well to say that you can't make certain kinds of containers. It isn't necessary, really, to have so many--seventy, eighty, ninety--alloys of aluminum in order to use aluminum. And it isn't necessary to have so-called tin cans--the iron cans--made by four different alloys just because it's made by a different manufacturer.

So one thing society could do, or that the whole technology could do, is to give some thought to what is to be the end of this particular item. Simply to require that we just use an item over again, until it's worn out, is a naive and simplistic remedy for a dimly understood problem.

Chall: I see--which is what the recycling people are now advocating?

McGauhey: That's the simplistic one. I don't think we'll go back to it on bottles. We're not going back to bottles on milk; I don't think we ever will. In fact

McGauhey: I doubt that man ever goes back to anything effectively. He does go forward though, and I think we are going to have to go forward in solid waste management. Containers now are often a combination of paper and plastic that's laminated, and you can't reclaim the paper because of the plastic laminates. It isn't physically impossible, but it would be economically catastrophic to try to go to that--waste that much of our wealth on trying to unravel some of those little bits of residues.

Chall: A milk carton can be burned.

McGauhey: Yes, you can burn a milk carton. You can burn them in a high-temperature furnace. You can't burn them in your fireplaces anymore, because they're made of plastic. They used to be parafin and were good for starting a fire. Now they won't burn readily because they've got plastic on the outside. They're laminated plastic, you see. You can burn them in an incinerator--that kind of plastic will burn. There are some plastics, the ones with chlorine in them--the polyvinyl chorides, like the pvc pipe and those things, which burn only at a high temperature. The chlorine then comes out as hydrochloric acid. Then we have a problem of keeping the chimney from falling down as well as the gas attacking the neighbors, and so forth. So there's not a very simple answer there, but we might make a plastic that could be burned. All this is part of the design, I think, so that more material is going around the cycle, albeit only maybe two or three times.

Newspaper, for example. If we pulp newspaper, about the third to tenth time you pulp it, the fibers begin to get broken up, and by and by we have just a soup, like a slurry of clay, so finely divided that it won't hold together as paper anymore. Part of this can be used in a new stock, but it isn't that we can just take it round and round forever. Eventually it wears out. But three or four passes before it wears out would reduce the solid waste load to be managed.

What they have made from all the wonderful paper generated in the Pentagon is these paper egg crates.

McGauhey: You don't get to read all the secrets that the Russians already know, unless you can see through those egg crates.

Chall: Is it just in the East they make the egg crates from Pentagon paper?

McGauhey: No, they're doing it a good many places, but you can take the egg crate and pulp it up and make another egg crate from it. But by and by it becomes difficult to do much with it because it's such a soup. That's not true of this brown paper, Kraft paper. You can keep recycling these old cardboard boxes with a little more Kraft material.

Of course everybody is excited about recycling and as many of these environmental ideas come along they get carried away with simplistic and naive concepts, either for forbidding somebody to use something, or to pick it up and use it in too simple a manner. What I am saying is that recycling of solid wastes will have to be done and will be done eventually as an industrial-type undertaking and will probably have to be subsidized, partly by the public because there isn't enough material in there--the value of the material isn't enough to pay for its reclamation. But it will be cheaper than doing what we are doing with it and in the long run, a better use of resources.

Chall: The recycling that was begun by volunteer groups who agreed to take the tin cans and all of that--has this pushed industry in any way to reuse material that they wouldn't have done otherwise?

McGauhey: Oh, no, it has done this: It has given people who were extremely interested in environment something to do that gave them a sense of achievement. It is not particularly different than the World War I routine, which I perhaps told you about, where they had a barrel of buttons which they took to the basement of the church and they had the ladies gather and they persuaded them that success in sorting out all these sizes and shapes and cards of buttons was what the war depended upon. So the ladies would gather at tables and sort out the buttons. At the end of the week the army would mix them all back together again and they'd start over the next week!

Chall: [Laughing] Are you saying that all the work I do in flattening out my cat's and dog's tin cans every day is a useless effort?

McGauhey: Not necessarily. It gives you some sense of participation.

Chall: But it isn't helping?

McGauhey: It helps in the fact that it reduces the volume in your garbage can, but that's about all.

To get back to your original question, the first thing that happened was that it was possible to get quite a lot of publicity and good public relations out of accepting cans. It also meant you had children and housewives and everybody working for nothing. This is a good enough deal as long as you can get work done for nothing. But the attention span being what it is, it is not going to continue forever or at least they'll get smart enough to say, "We're not going to do this job for you for nothing!" By that time the company will have achieved, through its advertising, enough publicity and good will for being good Joes that things cool off. You don't pay too much attention to it.

But what happened to those who really knocked themselves out to try to do it? Well, they set up bins for collecting cans and within a very few weeks they just become receptacles for the swinish part of the community who just throw anything in them. They throw garbage and old newspapers or any kind of thing in it--grass clippings, rubbish, all sorts of things. So the poor ecology groups had to go out of business when they couldn't sort out this stuff. The same things happened on the big boxes that they put in the supermarkets. They said, "Well, we'll put a box here and you can throw bottles and cans in." Very soon it was just a receptacle for all kinds of debris.

Chall: That's interesting, because in South County area where we live it was very well organized and nothing goes into the barrels in the wrong way and volunteers are there full-time. I don't think they've had this kind of thing happen.

McGauhey: Well, the Boys Scouts in Kensington collected newspapers for years, till all this came along, and they began to catch the same kind of rubbish. Now the newspaper drive ended up by filling all the warehouses from Los Angeles to San Francisco with paper. Well, they've got no place to store it any more. It starts out with a simplistic approach and it takes quite a long time for industry, for the whole equilibrium, to readjust.

Chall: But will paper be recycled by industry?

McGauhey: Yes, but that isn't the motivating factor. Twenty-one percent of it has been recycled right along. The motivating factor is economics. If we went up to 45 percent recovery of newsprint, this would be the equivalent of ninety million acres of forestland.

Now this sounds like something very urgent and would save a lot of forest if we were to do this. Well, much of this land is trees that are planted and grown just like cornfields and it is quite as easy to keep cropping that indefinitely as it is to sort out paper. So you are not really saving a resource, as a matter of fact you might be destroying a resource because if the big paper companies quit planting the land, who takes charge of it and maintains it, and for what purpose and for whom? The ramifications of the thing are complex. The packaging people will tell you--have told me--"Don't get too excited about building a big, expensive system for reclaiming metal cans or aluminum cans because probably within a year we will be able to put beer in aluminum headed cans with a combination of plastic and paper like we put frozen orange juice in. So the technology of packaging is not frozen either.

In an article in Waste Age which I have written which will come out soon, I postulate that it is absurd to think that the ingenuity of American industry is so lacking that it can't use a bottle with an aluminum ring around its neck. Before this was ready for publication, before it is published, one of the companies, Schweppes, has come out with a aluminum twist top that cracks the ring and it comes off in one piece. I brought a sample of it

McGauhey: with me, I have it out at the house. You see, we can't reclaim them because of the aluminum in the middle of the glass. Well I have faith enough in American industry to think they can lick that one. If you can make a bottle you can take that off. Already it has been done without having the ring stay on the bottle.

So that to avoid getting involved in simplistic things and naive approaches is something that all of us want to do. We don't want to be suckers--nobody does. But on the other hand, the fact of participation, if a lot of people are doing it, may inspire a whole lot of changes to come along a little faster. We've got a society in which a great number of people have no sense of participation. This is one of the problems of youth. There is nothing to do that seems to have any meaning. Stay off the labor market, stay on the streets, stay out of the way, stay out of trouble and stay out of everything, you know? They get, understandably, restless and with energy to burn; if you can pick up cans and feel that you are doing something useful, that you are doing something that society wants done, then good!

I have an article coming in Waste Age also on--since I have to write for it every month under pressure, under duress [chuckles]--in which I postulate that the way to solve the problem of collection is to applaud people for being refuse collectors. If we have them doing things society doesn't think worth doing and, if we associate human worth on the same scale that we measure the value of refuse, we are not going to get many people volunteering to take that kind of job.

Furthermore, I predict that in the short run at least, we are not going to be able to solve this aspect of the solid waste problem by any sophisticated equipment. Equipment may take part of the physical load off people but in refuse collection we may be up against something we have not accepted previously in our society. This is that we may have to pay a man a living wage, whatever that means, for the amount of production he can do with his hands. You see, in industry, his pay is justified on the

McGauhey: production he can achieve with all kinds of equipment. But when it comes to collecting refuse there is no mechanical system that as yet they have found which is going to work. We may just socially have to accept the fact that if this man does all he can by hand--produce all he can do by hand--he may well have to be paid for that, even though it represents a high cost per unit of product.

Chall: That's the ordinary garbage man you are talking about?

McGauhey: Yes, what they call the tipper. The one who picks up the can. In the trade they call him the tipper. Generally, the pay scale--traditionally--in labor are related in some fashion to the productivity of the individual and productivity is increased by reducing the number of people and putting in machinery, the number of horsepower each man is manipulating. But when you are collecting a whole lot of miscellaneous things at an infinite number of points in the community, I don't foresee any great monster that will come down the street and seize a can without a man who sets it out there and runs to get out of the way! [Laughs]

But back to the question, I don't think that we are going to sort out refuse by hand in any home--with but few exceptions--possibly newspapers and maybe glass bottles. Generally it is going to have to be picked up mixed because it is going to have to be hauled as a mixture. I think we will set up an industrial-type operation to take refuse apart again, remove whatever we want and recycle it. What we don't want to remove at any point in time will be the material we don't know what to do with at that point in time. Therefore in many communities this residue will very likely have to go into a landfill.

Chall: Then the waste disposal activity could very well be another municipal activity or community activity like waste water or the reclamation of sewage?

McGauhey: I don't think it will be. When we go to reclamation I think then is when private industry comes in. The city will do the collecting, undoubtedly, and the transferring and delivering it to industry. It will probably have to pay industry for some appreciable

McGauhey: time to take refuse, and it may well have to be the one to pick up the residue again and haul it to the fill. The municipality will have to decide where in this community can we put a fill, and very likely operate the fill. But the stripping off or pulling out of the stream that material which is to be recycled, I think is most certainly to be a private industrial operation, albeit under contract with the city and under appropriate terms so that it can be done at a profit just like any other utility. You see, our waste water treatment utility--some of them are private, some of them are public. The East Bay Municipal Utility District is a private utility but of course it can only do what the utilities commission will let it do in terms of rates and activities.

Chall: Oh, I thought it was a public utility.

McGauhey: It is a private utility under public control just as the telephone company is really a private utility but its rates are established by public control.

Chall: So you think that is the way it will go.

McGauhey: I think so because no city charter permits a city to go into a commercial business or mercantile business. It can't manufacture products for sale. That doesn't mean the charters can't be changed if this is the way society wants to go. But it means changing them is a stumbling block and marketing is pretty hard to set up in a community. The companies who know paper markets and glass markets, the markets for metals and this kind of thing--it used to be called the junk business now it is the reclamation business--these people know markets and are sharp traders and are the kind of people who could do it. I think they are the ones who properly should do it because it would be pretty hard to have a civil service alert enough to market, to figure out when and how to sell waste paper, aluminum and all those kinds of things.

A Look at the Future

Chall: Does your positive attitude toward life give you a feeling that some of these problems will be solved before it's too late?

McGauhey: I have no fear that solid wastes are going to overwhelm man. He may impoverish his life by piling them in the wrong place. He may get so many people that it's inconvenient to get around, and therefore there's less room for the results of his activities. But I don't think he's going to make the environment so unlivable that either by a catastrophic event on himself or by inadvertently disrupting all of the eco-system he's going to disappear.

I would expect that eventually the part of the earth that we are populating now will be populated by people that are considerably less affluent than we are. The next civilization that occupies this part of the earth, may be living farther back toward the beginning than we are, but I think this environmental problem is a problem of cities rather than of the whole environment. And of course cities is where people are and their problems can't be totally resolved inside the limit of cities. Just overload the environment with people and you're going to overload it with the results of their activities too.

But I think it's something we've got to be about, because cities are filling up with people that have nothing to do in the city, and filling up with so many layers of people that there isn't standing room, so life is further impoverished, and the problem of hauling the residues--just logistically moving them around in the community--is an unsatisfactorily solved one.

Chall: There's such a time-lag. At the time you began to study solid waste it was an obvious problem, or you wouldn't have been granted the money, but it's more obvious today, and still the cities are struggling to come up with some--not answers, there are probably none but...

McGauhey: Resolution.

Chall: Yes, a certain resolution to get something done.

McGauhey: And a realization of what it's going to cost to do it. And a real attack by technology. In solid wastes we have never really asked technology to do more than three simple things: pick it up, haul it--that is, transport it somewhere and unload it.

Chall: And that's not hard.

McGauhey: That's all we've asked technology to do, although we invented more sophisticated equipment for picking it up, but we've never said to technology, "Our objective is to have this material recycled as a resource material and we're going to insist that this be done to the extent that it is at all feasible. Find out what we can do."

And yet in other cases we have said to technology, "Find out a way that you can make a motor with X number of horsepower per pound so that we can get it off the ground and fly a plane." You see, we're just really in a very primitive condition in solid waste. We've always picked it up and we've hauled it somewhere, and unloaded it. Now we've decided that nowhere in our environment are we willing for it to be unloaded. We don't like all the traffic of hauling it.

But, given enough pressure from the citizenry, and from our own aesthetic sense, we can come up with money and men. With money we can hire men and can also buy trucks. We can load refuse onto a truck. We can find some time of the day when we can work our way through the streets and haul it somewhere, even though it's awkward, and generally unsatisfactory. But now, where do we unload it? Nowhere in the community will they let you unload it. It used to be we went outside the community to unload it. But now out there is another community and it won't let us unload our trucks in its jurisdiction. So we are only just at the point where we are going to have to ask technology to make some relatively sophisticated solutions.

Chall: Who asks these questions of technology today? Or does it just suddenly occur that it's got to be done?

McGauhey: I would say that our Laboratory has asked it as many times as anybody in the world, in literature at least. We have posed these questions. But the people that are asking it largely today are, I think, the Bureau of Solid Waste Management in the government. They're beginning to say, and I've been saying, "Let us put up some money for demonstration grants to try to solve the waste management and recycling problem."

Unfortunately it hasn't been working very well, not because of any fault of the government, but because the demonstration grant is looked upon largely by the city as a way to get some money from the government to build something conventional. So if we get the money to do here something that's unsatisfactory everywhere else, we just end up with another unsatisfactory solution.

I have long been saying to the Bureau of Solid Waste Management, "What you should do is to set up a demonstration plant in some real situation in which the endpoint is not a piece of hardware that some individual city can use to deal with waste, but is, instead, designed to establish engineering parameters and economic parameters. With such parameters engineers can then design with confidence a waste management suited to the needs of any particular city. In addition, you should work with industry that produces the hardware so that they can say, with confidence, what the necessary hardware will cost."

Chall: And where would something like this be built? Could you do it on a small scale?

McGauhey: No, it would have to be done on a full-scale, I would think probably at least 100 ton per day capacity plant; possibly 50 tons, but a big scale unit. To get at the economics, we're probably going to need 100 or 200 tons per day plant. But when they have found out all those things the demonstration plant is capable of revealing, the installation doesn't

McGauhey: become a unit that the city takes over and operates. It becomes a facility, just like any other research facility, which is redeveloped and put to work on some other experiment.

Chall: So something like that could even be built out here?

McGauhey: That is true. It would be a demonstration facility rather than a production unit. It would, however, be more likely built in a big city where it could be adjacent to a sewage treatment plant, or in an industrial section, or something of that sort, and where the city itself would participate in the study. But what the city would get out of it through participation would be know-how on the part of its engineers, plus proper financial compensation for its participation in the demonstration.

Chall: We haven't much experimentation like that yet?

McGauhey: Not on any big scale. There have been efforts to get at this with recycling, but the plant operators have just got poorer and poorer and are finally closing down for lack of economic feasibility of the project. They don't come up with any great resolution of the problem.

Stating the Assumptions

Chall: It seems that what you do first--those of you who've made this experimentation on solid wastes--it's mainly a thinking operation to begin with, and then you get a place where you need to go out and test.

McGauhey: One has to get some kind of a rationale that opens up possibilities for research or for study. As long as one believes that the earth is flat, and he's going to fall off the edge of it, there isn't much use going out there and taking a chance of falling off the edge. Before men could circumnavigate the world, they first had to develop a rationale that the thing is round. The first step in launching a successful experiment is that of getting the mind open and the possibility open.

McGauhey: Question the assumptions. If we start with the assumption that there's no place in the world where we can put solid wastes--we can't put it in the land, we can't put it in the Bay, we can't burn it in the air--if we start with that assumption, it isn't a very big problem to figure out what lies ahead. But if we start with the assumption that we're going to keep exploiting resources, we have to maintain our standard of living, we have to look to the future of these resources--then in a little longer time, are we going to have to become imperialistic and go and take resources away from somebody else when ours are short, or are we going to begin to recycle our own resource materials.

Chall: I should think that with this multi-discipline approach you might find that you don't all agree on some of the assumptions.

McGauhey: The first point where the disagreement comes quickly is between those who deal with people and those who deal with mathematics, as I mentioned the other day. You can set up a system where you should most advantageously put X number of transfer stations and route your collection trucks. This you can do without questioning anybody, other than about the physical geography of the area. But, when you come up against the hard-nosed fact that people won't let you put a facility there--you want five transfer stations and you can only find one place people will let you build, then is where one researcher's knowledge of people keeps another member of the research team from building up a big network of dreams that can't possibly come true.

Chall: This is a good reason for your approach because he could really be way off on the wrong track.

McGauhey: Yes. I have a saying--reversing an old adage, maybe I mentioned it the other day--that anything not worth doing is not worth doing well. [Laughter] Some research gets us into that situation. If it's infeasible in this century or in this particular cultural climate, then maybe it isn't the thing that we ought really to be putting our energy into first. It may not be the critical point in environmental management. There are probably better ways to spend X

McGauhey: number of dollars and X number of man-years of energy in attempts to resolve these environmental problems.

Economic Evaluation of Water

McGauhey: Another field in which we built up a reputation so big we couldn't keep it, because we couldn't get enough money to support us, was this matter of water economics, and particularly the application of the input-output methodology. [Laughter] That project area produced four PhDs, two of them in water resources, two in economics, and a master's degree in public administration. We got a lot of mileage out of that project, and we generated a national reputation in it. The research participants are now out working elsewhere, but at least, it is an area in which this Laboratory pioneered in the application.

Chall: What were you indicating in this study?

McGauhey: An approach to an evaluation of both water quality and of the water resource management. That is, management of quality and of quantity on a regional basis.

Chall: Did you come out with results in terms of how much water can be taken from one end of California to the other, and from the Colorado River and where it can best be used?

McGauhey: We came out with a model that could show the economic effect, in a whole region, of dedicating any given amount of a scarce water supply to any of the major areas that are used in calculating our gross national product. It can tell you when you begin putting in more money than you're getting out, and what would be the economic effect of dedicating any given amount of water to any set of uses. We constructed a model for the eleven western states, although it still needs some refinement.

We also made one study in which we determined, by setting up a mathematical model using the Bay here

McGauhey: as an example, what would be the minimum cost of achieving any particular water quality that might be specified in the Bay. What would be the distribution of the cost? It turned out that, if least cost to the whole system was the objective, one little industry shouldn't have to treat its waste at all, and another one might have to treat it to a much higher degree, but the combination of the total cost--the overall cost of doing it--is quite different than making everybody do the same thing--the popular national way of pollution control. For example, if reducing phenol discharge by 99 percent is the objective of control of phenol pollution, requiring everyone who discharges phenol to make a 99 percent reduction isn't the cheapest way to do it. It would take a different political organization of course to get the cost properly adjudicated but these are the kinds of things that our models lead to. There's still obviously work to be done in those areas.

Chall: Who's taking over?

McGauhey: In the area of the systems, our Operations Research Center, Dr. [Charles Roger] Glassey, I think very likely. He is the man in the Operations Research Center who is most interested in it. He worked on the multi-disciplinary solid wastes study as the systems man, and he is very interested in continuing in applying systems engineering to water quality. But as to the economic end of the thing, there are various other agencies and universities working on it now, and we are not.

Chall: What becomes of this kind of study, which points out--even though you say it may be primitive in some stages--a problem that's got political implications? What happens to a report of this kind?

McGauhey: The reports are fairly widely distributed. We see that they get into the hands of the legislators that are interested. But the effect will be felt only in the long term, and I think the long-term effect will be a much more sophisticated basis for making decisions. That is, in the end, decisions about what to do with resources are political. But with the kind of tools which research can provide

McGauhey: we can test very quickly on a computer the probable consequences of any one of a number of different political decisions, and so come up with a better basis for political decision than existed before. And also, with a basis for new legislation that makes management possible.

Chall: The output depends so much on who's setting up the input. Does this have to become, in a multi-discipline approach, something that you can all agree on?

McGauhey: No. We have to agree on the objectives that our program is going to try to achieve, and, when reports are made, review the progress of the whole group of disciplines toward those objectives. We have to do some interpretation. We may find that one discipline hasn't gained much, because the kind of problems that it has to deal with are long-term in nature. Another may have produced a whole lot. But nevertheless, we can still interpret the best information we have at the time of decision. We can then suggest: "Here's what you ought to do."

Value Judgments Other than Dollars

Chall: In terms of the use of water: you mentioned that the input had dealt with all the aspects that go into the gross national product. Does recreation, as such, and open space, go into the gross national product?

McGauhey: No, but it goes into our model in two fashions: One way that it can go in is by an arbitrary evaluation, but the other is by a system of evaluation better than dollars. This one is as yet quite primitive. So we need an evaluation system for the environment that isn't strictly cost-benefit in terms of dollars of investment versus dollars of profit resulting from that investment.

This is one of the areas of research that has been opened up, and we've attempted to put it in the model as qualitative factors, and this is what sends the mathematicians reeling. In this field of sanitary

McGauhey: engineering, and in agricultural economics, particularly, we have both quantitative inputs and qualitative inputs.

And when you start linear programming mathematically on non-linear systems to begin with, and have to put in some qualitative value judgments, then the hard-core mathematicians who like to deal with quantitive material don't want much to do with it. But nevertheless, a good deal of progress is being made, particularly in agricultural economics, with this kind of thing, where a value judgment is made and put into the model--albeit recorded, so that the next chap who thinks he has better value judgment can put in his value judgment and run it out on the machine, too.

There is no way, unfortunately, yet, to say what is the value, compared to dollars, of having a man be able to see a long distance instead of a short distance, or of being able to contemplate the forests or the ocean--how many more dollars we'd have to spend keeping him in a nut-house if we didn't have these things is just unknown.

But I don't think we have to get at it that way. I think we can get at it the other way around, by saying that here is the kind of environment we want. Technology, we ask of you to provide that, or at least to show us that it's going to cost so much that we're unwilling to provide it. Bring the findings back to us for a decision whether we can afford it or not.

We have never asked technology to do that in years past. We've asked them to do simple things: figure out ways to separate this ore from that one, and do it economically; or a cheaper way to do it, and so on. But we haven't asked them to figure out a way to do that, and at the same time maintain certain environmental objectives. This is what we're beginning to ask now. And if we start from that point of view, then technology and research can continuously feed back either the systems to do it with or, at this point in time, an estimate of the money that it's going to take to do it. Then if the public says, "We're just not going to put that

McGauhey: much money in it, because we have other things more urgent," at least the decision is back on the public, rather than letting him become the victim of his own request of technology.

This is where the whole picture has to change in our research as related to environment, and why we need a value scale other than dollars. But even putting it in dollars, we can set the values that we want first and cut them into slices according to level of environmental quality achieved.

By the way, Frank Stead and I did this once, and published an article that got us quite a lot of mileage.* It was our first attempt to establish different levels of environmental quality for land, and for water, and for air pollution, and to say what the effects are on man of having this or that level of reaction--whether an aesthetic effect, total enjoyment, or general feeling of depression, or the actuality of disease. We arbitrarily established the various levels and then estimated what it would cost to achieve that level. We got a pretty good response from that article and it has generated, I think, a considerable interest around the United States. At least it caused people to think about reasons why we might be naive and thereby we caused them to think about the problem a littler harder! [Laughter]

Chall: It's certainly one of the great problems facing us today.

McGauhey: This, I think, is the real challenge, and where I think this Laboratory will head in its research projects. It's already doing that in its new work on toxicity of wastes in water.

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*F.M. Stead and P.H. McGauhey, "Air, Water, Land, and People," Journal of Water Pollution Control Federation, 40-2, February, 1968, pp. 233-240.

Chall: There is a question about whether placing agriculture on the west side of the San Joaquin valley is a wise idea. It seems to be loaded with economic, political, and water quality problems. Could this--the economic evaluation model--be used to determine whether or not it's a good idea to put agriculture there? Is there some system for determining this?

McGauhey: There's no system for doing it. The University's Water Resources Center has a very considerable project aimed at trying to answer some of those kinds of questions for that west side. But one has to assume a static future. It might well be that when we get the west side planted it will change the whole crop situation.

I recall when they were building Bonneville Dam the opponents of it said, "Here we're going to produce a whole lot of power. The Northwest is a land of sheepherders, and they don't need all this kind of power. What in the world are we ever going to do with it? It's just a big boondoggle and a waste of money." Well, perhaps by good fortune, or blundering along, the war came and here a whole aluminum industry was invented and saved by the power that we had available. Now we're short of power.

The same thing might be true of agriculture. Maybe we don't have to grow the things that are now profitable to agriculture. Maybe we don't have to grow cotton for the Surplus Commodities Corporation. Maybe that isn't what we should be doing with our water.

So, while it may be strictly true, and I have no way of knowing, that this kind of sheer eventuality would occur, I'm quite certain that a new equilibrium would build up in which something different prevails. In the long run we're probably not going to have more cropland than we need. If we're going to take what we have and put it in cities, we're going to have to develop some more somewhere, maybe the west side is the place to do it. [Laughter]

Chall: Those are important questions in terms of what we're going to do with our water and our land, and

Chall: whether or not, at some time, we'll have to look at these farmers who are making so much at the public expense, and consider whether they have to pay a little more for this subsidized water that they're getting.

McGauhey: I think that that has to come, yes. But to the researcher it's a great challenge, and to the researcher in the field of sanitary engineering, it imposes the necessity for teaming up with economists, and agriculturists, and others involved to do research that is going to be interpretable.

Chall: And have meaning for man.

McGauhey: Yes.

Developing the Criteria

Chall: How did you get into this economic study of water?

McGauhey: Several years ago there was a conference on Man in California in the 1980s. It was held on the Davis campus, as I recall. But anyway the intent was that the conference would be a real blue-sky brainstorming event. I turned up as a member of the program committee that was to figure out just how blue the sky should be. One of the questions that came up was, why don't we have a paper on the economic value of water. What is water worth? Not just, what can you sell it for, but what is water worth in a society or civilization that uses water? All of us thought this was a good idea and Frank M. Stead, of course, was one of those advocating the blue-sky concept. We all agreed that this would be a good paper if somebody would write it. So someone said, "Well, McGauhey, you write it."

I agreed reluctantly that I would do it, under two conditions. One of them was that I would say whatever I darned please without trying to document it. The other was that other members of the committee would review it in advance and decide whether it was worth presenting, and make suggestions and corrections. So I wrote this paper and nobody changed

McGauhey: it much. I presented it at the conference and it didn't change the course of history perceptively; but nevertheless it did come and go. Time passed and some money became available in the Water Resources Center and one of the subjects that was of most concern was this matter of how do you evaluate water economically? But who might do some research on it? Well, McGauhey is the only one who has written anything on it. So he is obviously the one who should do it.

I now had funds available and I recruited Mr. Harry Erlich to lead the project. Harry Erlich was an excellent writer. He had been a newspaper reporter and at the time was working for his degree in public administration. He also had a degree in economics, as I recall, and Harry and I went to work on this. He was extremely good at finding material in the library and learning what was going on, and he amassed a tremendous amount of information. We came up with a report on the "Economic Evaluation of Water," Part I, "A Search for Criteria" on the rationale that if there was some unallocated water that was available and was to be allocated, how would one decide into what beneficial uses it should be directed or what combination of beneficial uses should receive it?* How do you make that decision?

We came up, after studying the things that had been written on the subject, with the idea that an appropriate criterion would be to divide the water between the various competing beneficial uses in such a way that it would generate a maximum or optimum growth of the economy. That seemed sensible. But after it was all written and published and we were no longer considered heretics, it became obvious to everyone that we had sort of documented the obvious.

Initially, though, our report had a considerable impact. Some people thought we were saying that agriculture shouldn't have water. In fact, it said

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*P.H. McGauhey and Harry Erlich, "Economic Evaluation of Water," Part I, "A Search for Criteria," Water Resources Center, University of California, December 1957.

McGauhey: in the newspaper one time, on the back page albeit, that McGauhey says that California can't have both agriculture and industry. Someone called me up to see what I thought about this article. I said it was totally irrelevant; don't even bother to think about it. But if it caused any great problem anywhere in the University or in the state I presumed that I would hear about it. If it didn't there was no use to poke at it, because to try to correct what it was you'd said wouldn't be news. If it got in the paper it would be on the back page and nobody would read it anyway, so forget it. I didn't get alarmed about this kind of baloney.

But the concept was soon well accepted and the rationale of our group was that if we accept this criteria and say, "Now we shall divide water on that kind of a basis," what kind of jurisdictional arrangement will it take to do this? So Harry Erlich and I started with the idea that a democratic society could certainly find some way to change the regulations and laws if they prevented society from doing what it wanted to do. What kind of a jurisdiction: should it be a public jurisdiction, what should be its objective? We intended to make a book of Volume II but it got so far out of scale. In fact, Harry Erlich just got so much material together that it finally overwhelmed him. He decided to leave before he would get it totally written and I had to finish it. But it had the makings of a good book, I think, at the time.

We took three particular cases. One in which water was taken by a highly developed economic community, from an area in the Owens Valley that had not yet developed economically. Here we wanted to see what effect this had on the economy of the undeveloped region. Our second case was that of the East Bay Municipal Utility District, where we had a highly organized, well-organized, well-run utility but having a relatively limited objective in water resource development. That is, it couldn't bring in water for irrigation. Under its charter of getting water for the community, it had a constrained objective. We took as our third case the city of Stockton where an attempt was made before there was economic strength in the community

McGauhey: to do what ultimately made sense and what was ultimately done. It was seen and planned fifty years before there was enough economic base in the community to handle a multi-purpose water project.

On the basis of our three case studies we decided that to apply our criterion we had to have a broader type of jurisdiction, which certainly could be set up by government, to provide a basis for policy by which our criterion could be applied. At this point we had about reached the end of the road of public policy considerations as far as our study was concerned. But that was not the end.

People who were interested now said, "Very well, we buy your criterion. We accept the fact that we could set up a jurisdiction to carry out the criterion. But, how do we decide what is the optimum economic good? At this point it was necessary to turn to systems analysis and computer technology, about which I made no pretense of knowing anything, but I couldn't back out. I had to go forward with further work in the area, but I needed some help. I felt reasonably comfortable in searching for criteria and exploring public policy, but this kind of thing was something else. Fortunately, I got E.M. Lofting and later Craig Davis. Craig was working for his doctorate in economics. Lofting, who had some ten years of experience in the industrial world, was also working for a doctorate in economics, but after working on my project for awhile, and before he had finished the work in economics, he decided that he wanted to get into the water resources, so he transferred to water resources and got his doctorate in that area. But he was a good and experienced economist, and both men knew how to deal with the computer. We hired a programmer.

So we made the third volume, Part III, of our report, and went on to Part IV, and various other parts, which dealt with how one might go about dividing water among its many users, so that it would achieve an optimum growth of the economy.

McGauhey: This launched us then into an area of input-output studies, the interrelationships of water and economics and the economic growth of the community. Many agencies became interested and we got money from other sources to supplement our studies and so continued until Lofting, and a group around him, had developed a considerable reputation in this field. At that point we neared the time when I was proposing to retire and we just didn't have anyone in SERL or in engineering with sufficient interest in this kind of area to carry it on. The young men working on the project were eager to get into positions where their futures were assured, rather than working here in the Laboratory forever, on uncertain support. So Dr. Davis went to the University of British Columbia, and Dr. Lofting went with the Corps of Engineers in San Francisco, and later to the U.C. Radiation Laboratory.

This is the story of my entrapment and my exciting years in study of the economic evaluation of water. We did get a lot of mileage out of this study. Unfortunately Volume II is no longer in print. We have loan copies here at SERL. With a bit more time it might have sold well in book form.

Water Quality

McGauhey: We worked at the time I have noted on the method of input-output analysis as a device for policy decisions. That objective was furthered in two ways--part of it as a supplement to the Water Resources Center, and some as additional funds from the Corps of Engineers, from the State of California Water Resources Planning group, and from the Department of Agriculture. We had five small grants to extend the scope of the mathematical model that had been made, to include material areas in which they were particularly interested. So there are some other reports on these phases sponsored by groups which had an interest in both water resources and water quality. On the economic evaluation of water quality, we were originally supported by the

McGauhey: Public Health Service, which finally became what is now the EPA. This project was started by a young man named Richard Frankel, who got his doctorate here and who is now out at the SEATO Graduate School at the moment, but who has been with Resources for the Future in the interval.

Frankel began his study under Professor Orlob, who left us and went to consulting engineering, but who is now back quarter-time, I believe, on our Davis campus as a professor. Orlob and I teamed up on the Frankel project, with Orlob being the one interested in the systems end. Frankel got some support from Resources for the Future--$5,000--which helped him get started and it looked like he was going well on a thesis. So to keep him alive, I applied for funds from the then Public Health Service. We got a three year grant. When Frankel finished his thesis and left here, I had two more years to go and I didn't know exactly what to do about it! I have a talent for getting into that kind of trap.

So we changed the direction of the project a bit and got some economists on the program to do two studies. The first of these was done with the assistance of the Department of Economics, serving as principal adviser to the man--Mr. John Carew--working for me. He eventually got his doctorate by evaluating some quality aspects of San Francisco Bay within an economic framework. Then we went a bit into the technology of Bay water quality control as well as the economics of that technology. Mr. S. Mukherjee got his doctorate in systems analysis and operations research. Thus Mukherjee finished out the project at the time I was ready to retire. I didn't try to carry it any further. But the project served to educate some very good students. Dr. Mukherjee is with Bechtel now as a systems man on water quality control. Dr. Carew is engaged in University teaching.

Reaction to the First Reports

Chall: When your first report came out in 1957 I would think it would have had some rather serious political implications from the standpoint of people who want to do things as usual. The criterion of stimulating an optimum growth of the economy by water allocation might have been considered highly critical of the proposals in the state water plan. I am not sure whether the proposals made in 1957 were substantially different from what they were in 1960 when the ballot measure was put before the voters.

McGauhey: The engineering plan was not changed in that interval.

Chall: The policies on which it was based were changed.

McGauhey: The policies yes. But the engineering plan, you see, only said what could be done and what kind of a schedule could be followed to do it to reach certain ends. Our report was considered a useful contribution at that time, I believe, because it dealt with the kind of things which hadn't been settled as to what criteria you should use in making political decisions, and we spoke to that point.

Chall: Was there any flak from the governor or the Farm Bureau Federation?

McGauhey: No, nobody fears that a university professor is going to cause any serious political ripples. He simply doesn't have the influence. We got only one or two squawks that agriculture was being shortchanged, but we had not said that no water should go to agriculture or anything of the sort! We did get calls from a great number of citizen groups. The League of Women Voters, for example, had Erlich and me to several of their meetings to discuss this problem. And I don't recall how many others called on us; but we did write quite a number of papers and attended probably twenty public meetings at which we were invited to talk about this, and where discussion of this matter took place. There were people trying to make up their minds and they were

McGauhey: not asking us how the water plan ought to be run, whether it was immoral to live in Southern California or this kind of question. [Laughs]

I felt our study had a considerable impact at the time. The second one did too. It documented things that were obvious once you had documented them. Quite often it is necessary to do that kind of thing because if one just makes a statement and someone else says, "Well, I think this is how it is--," you may have a dozen different ideas, and unless somebody documents them, they are just in the realm of opinion. While we didn't set out with the criterion in mind, we did ultimately come to the conclusion that these were appropriate criteria, on the basis of the material we had studied and reviewed, and we didn't hesitate to say what we thought this added up to.

The 160-Acre Limit

Chall: Well, it was interesting to me because it gave some new insights into studies I've been doing on the California water history. Just now I am concerned with the controversies over the 160-acre limitation and all that this has meant from the year 1902 to the present time.

McGauhey: If you have time for a little interesting reading--for a lot of reading, [chuckling] a little of which is interesting, shall I say--borrow Part II and just read to see if you enjoy it. But the narrative concerning the three cases, as I read it over, seems to me to flow along nicely and it has a lot of interesting information in it, which includes this 160-acre question. As I recall we quoted Paul Taylor on that and we had given some consideration to the kind of implications involved in the limitation. There are those who say with some certainty, some conviction on their own part, that this 160-acre business was a deeply political thing.

We point out in our writing that the objectives of society have changed a great deal. At the time the 160-acre went in the objective was to keep

McGauhey: individual families on farms, self-supporting, because agriculture was the economic base of life. When it became no longer feasible for people to live on 160 acres without a pretty intensive type of crop, we then had to go to industrial type farming. Now this meant that either we have very large holdings with smaller increment of profit per unit, or we have to have extremely high prices to pay for the chap working with his hands. You can't use very high priced machinery on a small acreage. So now here we were caught with our whole cultural pattern changed. The basis of our economic system had changed from agriculture to a combination of industry and agriculture, and the commercial activities of urban communities, and yet we had a water policy based on the earlier pattern.

So with all the agriculturists growing cotton in the Central Valley for the Surplus Commodities Corporation and pumping water out of the ground, the time came when they were running out of water in the ground. Then there was only one or two things that anybody could do. One was to try to crack the 160-acre limit and failing that, to try to get the state to develop its own water, in the hope that it would be easier to manipulate the political scene in the state than it is in the nation. There are those who say that this was the politics that led to the whole water plan of California, but nevertheless, whether it was or not, these forces were at work.

Chall: Many young people, and others today, are urging the return to the land. Can they make a living on 160 acres?

McGauhey: They could make it as social drop-outs or queer-balls, but they couldn't make it as viable members of society.

Chall: Is the large acreage necessary for the fruits, and nuts, and vegetables that are really consumer products?

McGauhey: It is not necessary for certain types of vegetables, berries, and a few other high value crops. But the

McGauhey: location of such enterprise is critical. You have to be near a market. You can't be a long distance away. You have to have good land, too, as in some areas of Pennsylvania and Westchester County in New York. In such circumstances it is possible to make money on a small operation. With 160 acres of irrigated land--if you irrigate that much of your land--you run into the question of what it is you are going to grow and how you are going to tend it. If it has to be done by machinery then you must have a very high value crop. Most of agriculture is extractive industry. The value added by labor is relatively small. In terms of water, if you can get 1.75 to 1 return on your investment, you are doing pretty well. In industry if you don't get a 1,000 to 1 in terms of water costs you don't have a really flourishing type of industry.

The extractive nature of agriculture is one of the reasons why if one must work by hand he can't make a living, and if he has to do it by machinery, the machinery costs make a bigger area necessary. So one might become a recluse or a hermit and manage to stay alive on a small piece of land. But at the time we wrote Part II, there were 5,000 farms in California that grossed less than $5,000 a year and some of them were up in the 5,000-acre size. They were big-sized pieces of land but they weren't, of course, all irrigated land.

Chall: If there hadn't been subsidies for water, that brought water from the Central Valley Project into that San Joaquin area, for example, do you think that the land would have been used as it has been for cotton, and rice and things of this kind which opened up these vast acreages?

McGauhey: They might have as long as they had ground water.

Chall: But they are ruining the land.

McGauhey: It's falling in in some places! [Laughs]

A few years ago one cotton farmer in the Fresno area told me with a laugh, "I didn't make a quarter of a million dollars this year. I can't even buy a new Cadillac!" But it is a complex situation and

McGauhey: I feel that subsidy of agriculture, by subsidy of the water for agriculture, was probably necessary originally and probably still is necessary. It was certainly necessary to open up the western country and so tie the United States together. Because as soon as man got west of the adequate rainfall belt--into most of the seventeen western states--he just couldn't occupy the land. We probably wouldn't have unified our land into a nation if we hadn't gone for governmental aid to water development.

In Part II of our report we trace the attempts of men with their own hands or a limited economic base to irrigate western land. They simply could not finance the necessary works by mortgaging the long term potential of land to pay the cost. Government had to step in; and it did so with limitations such as the 160-acre provision so that families could live by agriculture and huge land holdings were discouraged. If we didn't subsidize agriculture but simply let it seek its own market, western agriculture couldn't possibly have developed.

We can grow enough corn in Iowa and Illinois to feed the United States. But there is a lot of difference between a dry corn economy and an economy that lets us have lettuce everyday in the wintertime. So I hold with those who say that with a climate and soil such as we have here in California, it would be a pity not to use it for agriculture if we can find the water. There may be other possible policies than those we have adopted, but we'd have a pretty poorly balanced state economy if we just depended upon retired people that liked the climate in Southern California. I was somewhat surprised to find out how much of the value of our state economy actually did come from agriculture; a lot of it from the processing of agricultural materials and processing, rather than from just the production of agricultural products.

Assumptions

Chall: Today the economic and population statistics are quite different from what they were, and what they were expected to be when you began your study. What do the programmers do about these changes?

McGauhey: We know what to do about it. We don't know how to do it! To get at the economic interrelationships between water use and product we had to take the statistics that we have in California on the amount of water used and the product produced in the whole economy. First we started with eighty-six sectors of the economy and set up a program which would show what would happen if we put X number of acre feet of water into a particular industry. What would be the pattern of increase in product in each of the others? Some of them in fact were very low. This approach involves the assumption that we are not putting in more water and producing more products than anyone can use. So what this revealed was the marginal value. What would water have to cost, or be sold for, before this industry can no longer function? Thus the start was with a static assumption. When one tries to program this dynamically, to say that, suppose now, this industry dries up and that one booms, then we get deeper and deeper into a morass of assumptions. In the simplest mode we also have to assume that the interchange of goods between California and adjacent states remains the same. However, suppose Washington decides not to grow apples but wants to chop down its orchards and make high-rise houses like we do. Then there is a whole shift in the interchange between California and the other states.

We started and did complete an eleven-state model of the interchange. But again it had to be, first a static model and then a dynamic program. A dynamic program can evaluate the effect of changes but it certainly never could answer the whole question. We have to go as far as we can, then make a value judgment and go on again with the computer. The model can't be made into a fixed thing to be used for all time to come.

Chall: I was interested that in his oral history Harvey Banks said that it would have been extremely helpful if he'd had some of the economic studies, like the McGauhey-Erlich study in the water-pricing before letting the contracts.*

McGauhey: Yes. Well, you see, he had to write that plan and it was pretty well done by 1956.

Chall: Yes, the plan was done and I suppose the assumptions of pricing were already based upon it.

McGauhey: Yes, they had to do it on the best information or whatever information they had at the time. This is one of the problems--the difference say between the true researcher and the practicing engineer. There comes a time when we have to pour some concrete and we have to do it on the basis of what knowledge we have at this point in time. Then, when we get a little farther along, we can look back and say if I had just had that tool in time I could have done differently and presumably better.

Chall: Now they have the tools and I wonder how you expect this tool to be used in terms of balancing the resources at the present time, let's say between agriculture and the building of homes. Who's to make the decision that this land has to be saved for agriculture instead of homes?

McGauhey: The people in the legislature that I've talked to through the years have always said, and I agree with them, "Bear in mind that these policy decision are political decisions and will be made by the people whose responsibility it is to make the political decisions. What we would like you as researchers to do is to develop a system, or a procedure, by which we could predict the consequences of alternate decisions. Then, having that capacity, we will make wiser decisions. We might make the one that helps us to get reelected, but nevertheless this is politics."

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*Harvey O. Banks, "California Water Project, 1955-1961," 1967; Regional Oral History Office, The Bancroft Library, University of California, Berkeley.

McGauhey: I personally think it is quite likely that wiser public decisions would accrue if there were some way to take a dozen different proposals that people--apparently in their right minds--are making, and run them through the computer to see what are the probable consequences to the economy, or on the pattern of distribution of people, in doing this as opposed to that. If we had that kind of capability, then for example, water might be used as a policy instrument to direct population or city growth to more appropriate places, and to guide agricultural development in, say, the west side.

But we don't have any way, that I can see, to say to one farmer, "You can subdivide your farm," and to the adjacent owner, "You can't subdivide. You have to keep your land for a greenbelt so that the people who live in the high-rise buildings can look out and see an open space." You can't do this unless society wants to pay him the profit that he would make otherwise. This is where the greenbelt both foundered and floundered, because there is no way society could make that decision. There is no way yet that you can keep the community from moving the city limits out and then suddenly putting the farmer out of business by taxing him at city rates.

So I don't foresee any way that this is going to be done, although I do see emerging, I think quite clearly, a temper in the state and in the nation that we have to do something about land use management, about controls for it.

The first signs we see in California are those of interpreting the Porter-Cologne Act as giving the Water Resources Control Board authority to do some land use controlling in the interest of water quality or of water resources. So I think it has started. We hear it more at the national level although it is going to take a lot of courage to make an effective law so that the effect is useful to us in time. It won't save the Tahoe Basin; but someday I think there will be a great deal of constraint on what one can do with his land. He will be subject to a requirement that his activities fit in with a plan that some organization set up by society, has come up with and that society has, in some proper fashion, approved.

Chall: Then you think that having made the start on economic evaluation studies that this kind of thing will be used as a tool?

McGauhey: It will be used as a tool if only for determining what the consequences of alternative actions would be. Decision makers will be able to choose between alternatives. This, I think, is already being done in a good many contexts. Not in the context of agriculture vs. other kinds of land development, but it is being done in a great many of the decisions that involve strictly engineering projects.

What the outcome may be, I don't know, but nevertheless this kind of approach is being used to study the alternatives of waste disposal in the San Francisco Bay Area. Several models of the Bay made for that purpose are being used. Whether what the model shows ought to be done in what finally is done, may depend on other factors, and those other factors may well be environmental objectives that emerge from considerations other than water quality.

Chall: That's interesting to speculate on, but I suppose that you feel a sense of personal gratification that you were in on the beginning of some kind of important study.

McGauhey: Oh, I don't look back with any feeling that I made any particular contribution. But it has been exciting to be in the mainstream. One of the advantages of having been with the University here, with the Laboratory, was that we operated in the mainstream. It is more fun to play in the deep water than in the shallows, as any child who goes in a swimming pool will demonstrate! [Laughter]

So it is that kind of thing that I think one finds gratifying, rather than what value there was to have been in the pool.

San Francisco Bay Studies

McGauhey: I have been talking at great length about some of the studies which have attracted favorable attention to the University and to the SERL participating faculty. Another area of especial significance has been studies of San Francisco Bay. Bisecting as it does, a community of some four million people, being the outlet for and draining the great Central Valley of California, the Bay is very much a part of the life and interest of people. Conversion of the Peninsula and the Santa Clara Valley from villages and agriculture to high density urban development has intensified concern for the effects of domestic waste water on the ecology and the environmental quality of bay waters. Moreover, the upper reaches of the Bay, although known under assorted names, are bordered by industry, much of it of the chemical or petro-chemical type. This lengthens the spectrum of wastes which may be of significance to water quality in the Bay. In this circumstance it was only natural that the SERL group should be active in studies of San Francisco Bay.

The most extensive of these were conducted for the State of California under the leadership of Professors E.A. Pearson, and R.E. Selleck. Their extensive and intensive study of the Bay over a period of some ten years has revealed the residence time of water in the South Bay; characterized the water of the entire area as to chemical, physical, and biological characteristics; evaluated the productivity of Bay waters; and estimated the toxicity resulting from waste water discharges. The results contained in some eight volumes is the major source of information of the problem of water quality control in San Francisco Bay.

Other studies of the Bay have been made through SERL. Professor H.A. Einstein and Dr. Ray B. Krone traced the movement of sediments in the Bay by the use of radioactive gold. More recently, Dr. W.J. Kaufman is leading a series of studies of toxicity in Bay waters, again as a service to the State of California.

McGauhey: Although I am not prepared to describe in detail the findings of this research, it is one of the major accomplishments of the Laboratory, and the Bay will continue to provide opportunity for the Laboratory to serve the State.

Algal Systems

Chall: Now, what about the whole problem of algal systems? That's clearly important research.

McGauhey: There are a good many aspects to it. The problem itself is that in highly industrialized countries where labor is expensive--Western Europe and the United States, particularly--waste treatment went in the direction of mechanized systems. There was nothing to sell in the way of equipment in a pond, and anybody could build a pond and dump wastes in it. Nobody knew what happened. The poor, undeveloped countries had to use that kind of a pond or else dump wastes into the water supply. They began early to use ponds. As their students came to this country to study they learned how to build sophisticated plants, and they'd go back home but nobody had the money to build a sophisticated plant.

So it was a long time before people began to ask, "Could we put organic matter into a pond, let bacteria break it down and release nutrients that algae want; and then grow all these algae and harvest algae the way we do grass on the ground? Then we would be able to remove from the water the nutrients that were put in with the original organic matter; or at least a fraction of them."

It was that concept that we started out with here at SERL. First, we asked what do we have to do to grow algae? How do we produce a maximum crop and under what circumstances? How much can we grow in waste water, and is it a matter of light, temperature, and other factors we have perhaps not identified? What kind of controls do we have to have? And then, how can we get the algae out? And also, what good are they after we get them out? That

McGauhey: was the thrust of the first work.

It became apparent rather quickly that we could grow more photosynthate on a one-acre pond than we can on an acre of land, no matter what crop we plant on the land; and we can grow it quicker. Algal cells are 55 percent or so protein, and so it would compete well with fish meal or cottonseed meal for animal feed supplement. Animals can eat it, if you mix it in the right proportions to bring the protein down to the proper level. All of these things required research, here at SERL and with animal feeding at Davis.

When we knew how to grow algae Dr. Oswald and Dr. Golueke had the idea that maybe we might use an algal system as a life-support system in space. They started out first with supporting some mice in a completely closed gas and liquid chamber system in which all that was put in was some food for the mice, because they can't eat straight algae. Some of the algae were removed from the system to compensate for the added food. But the gas system was completely closed and all the oxygen that the mice got came from the algae growing on the products of bio-degradation of the bodily wastes of mice and the CO_2 from their breathing. Condensate from the coils used in keeping the chamber cool was the water supply for the mice. The Air Corps supported this study and we got lots of publicity out of it as well as inspiring dozens of children to undertake related studies for their science projects and fairs.

Chall: Did the mice live?

McGauhey: Oh, yes. We ran the experiment as long as forty-two days on one occasion. This is equivalent to six years of the life of a man, and the mice were doing all right. We terminated the experiment because there was no object in carrying it further, but we kept the system going for several years because of public interest in seeing it. Later we built a big unit--a two-man system--but the war reduced the Air Corps' money, and the project is moving a little slowly.

McGauhey: Dr. Oswald's group has just completed a study of the possibility of using algal system for getting rid of chicken manure. This is a big problem in egg and poultry production business because egg production, and poultry production too, is done in a factory now. We don't have chickens running around on the ground kicking up the dust. They stay in cages. Egg and poultry plants could be built right in the city if we had some way of handling the wastes. We've just finished a study that shows, on a hundred-hen basis, that you can, without any difficulty, convert all these wastes to algal cells, and harvest the cells. The cells can be fed back to animals but the harvesting is still expensive. Nevertheless the results of this project represent a major step forward in waste management.

Along the way we've considered how algal systems might be used now that one of the objectives of wastewater treatment is the removal of nutrients. This is an emerging objective, being imposed at Tahoe and Washington, D.C., and various other places. So if we could incorporate these nutrients into algal cells and then harvest them, this might be a good way of stripping out the nutrients. So we're doing a good deal of research on that and the problems associated with it.

Chall: Some of the results of the pond approach with algae, has any of that been converted into on-going projects?

McGauhey: Yes, indeed. Many communities are using ponds, and Dr. Oswald has served as consultant to many people in building and operating them. St. Helena has one pond system that is working very well, Concord has one. There are about one hundred of them in California.

Chall: Is this part of the sewage treatment plant?

McGauhey: Yes. It can be used either just for raw sewage or for secondary treatment, or for final treatment after the waste water has gone through an ordinary treatment plant. We're using it here on sewage from which the solids have been settled, which is called a primary treated sewage--that is our principal source. But at St. Helena they use one pond for the anaerobic digestion of material and other ponds for

McGauhey: treating it more highly. At Santee they're using ponds to produce an effluent highly enough treated for recreational use.

Chall: I see. That means that you're actually allowing algae to be growing in there, purifying the water up to a point...

McGauhey: In these particular ones, algal ponds precede the ones that are actually used for fishing and swimming.

Chall: That's the end result, the water that is used, then. And what becomes of the algae?

McGauhey: They're not operating the pond at Santee so as to grow the maximum number of algae. They operate so that the minimum number of algae are grown. To do this the waste water is first run through a treatment plant that removes much of the nutrients to begin with so that they don't get such great growths as we do in our high-rate ponds. Algae die and are decomposed by bacteria in the bottom sediments just as they do in natural lakes and ponds.

Chall: In Europe--I think during the thirties the Soil Conservation Service adapted them here--they developed fishponds, which operated somewhat on the same principle, where you put the big pond out in a field and let fish live for several years, then drain the pond and grow grains in the soil which had been fertilized by the fish.

McGauhey: The principle is the same. The thing is, the efficiency is less, as the algae convert nutrients to cells very quickly and with high efficiency. If has to go through organism after organism, and ultimately to fish, much efficiency is lost. That is, if we feed high protein food to a steer, we get about 16 percent conversion of protein. Somewhere between 6 and 16 percent conversion is typical of animal efficiency, the rest goes out as waste. With algae you can get a much higher conversion in the 60-70 percent range. In the fish pond they are trying to keep an entire eco-system in the natural state. You put in the organic matter that is unstable, and end up with a crop that's easier to harvest than is algae.

Chall: Yes. And I guess these are used in areas where fish, rather than something else, is a prime source of the diet.

McGauhey: Or you can use the fish for fishmeal--just to make fertilizer, you see. This could be done if we are growing rough fish. Generally these fish ponds have harbored edible fish but there's no reason why it has to be so. As long as we can get them out cheaply, it's no problem to convert fish to dog food or cat food or fertilizer.

Chall: I think they would take the fish out at the end of three years; I don't know what they used them for, but I think in France they ate them. All of the fish droppings made fine fertilizer; they'd dry out the pool and then plant wheat the following year, so that it kept the eco-system in balance.

McGauhey: Yes. If you don't do that, the system may run out of carbon. A growing plant in soil in shallow water has its roots in the fertilized soil but its leaves are up in the atmosphere and hence it can get a lot of carbon dioxide. We can grow such plants by supplying just nitrogen and phosphorous and minor elements, whereas in a pond we have to have a source of carbon. This is the real difficulty in using algae to take the nitrates out of the water that they propose to send down the San Luis Drain. There is enough nitrogen to cause worry lest the drain water over-fertilize the Bay. But to take out the nitrogen with algae, some source of carbon will have to be added. To supply a carbon source to agricultural drain water is part of the expense of getting out the nutrients by biological means.

Chall: Could you develop and harvest algae in such a way as to feed people in areas where there is widespread malnutrition now or famine foreseeable in the future?

McGauhey: Basically, the answer is no. Unfortunately "true believers" have spread the impression that the high yield and growth rate of unicellular algae is a hopeful prospect for assuaging human hunger. The truth is that algal cells are low in carbohydrates. The protein content is high but the material is not readily digestable by human beings, causing a great

McGauhey: deal of bloating of the body. The algal cell material could best be fed to chickens or pigs or goats and so increase the supply of food from such sources. It might also be used as a fertilizer in the manner you described in relation to the fish ponds. To grow algae in a pond, however, nutrients must be made available. Thus human wastes, animal manures, and other organic debris would have to be placed in the pond. Then there is the task of harvesting the algae. I doubt that such a prospect offers much hope for alleviating malnutrition or famine in the undeveloped countries. The best bet it seems to me is to use wastes to fertilize fish ponds and then to eat the fish. The method is inefficient and marginal but not impossible for the technology of non-industrialized societies. So I must conclude that the algal pond is not much of a hope in the situation you suggest.

Chall: It's interesting with all this experimentation with algae, that on one side you develop it, almost grow it, for some beneficial purpose, and on the other hand, in some of the big lakes and other areas, it's a serious problem, and it has to come out.

McGauhey: The serious problem, the one that they call eutrophication, is characterized by an excess of algae at certain times. An aquatic eco-system generally has some species of algae in it at all times. But algal blooms come in waves. When available nutrients are introduced the first response of the system is a crop of algae. Then come the grazers--water fleas and tiny crustacae, and so on to harvest the algae. These grazers are microscopic in size but you can see many of them with the naked eye. They move in and the algae crop disappears. Then, of course, having exhausted their food supply, they die, and become organic matter to be re-cycled by bacterial decomposition.

And so we get these pulses of living things. But a limnological situation isn't that simple. There is also a sequence of algal species that will predominate. Some of them will depend on temperature, time of year, so one of them will wipe the other out in competition for nutrients. With lots of nutrients present a tremendous growth of algae will suddenly

McGauhey: appear. Then the growth will die and decay, and in the decaying process require so much oxygen that the lake becomes an anaerobic, stinking mess.

Chall: That's the concern for man.

McGauhey: That's man's concern, yes. It changes the eco-system some, but at least it doesn't interrupt it completely. So what we want to do is keep the limit of nutrients down to the point that we still grow fish and have water that's nice for swimming, and boating, and suitable for drinking after proper treatment, yet not so enriched that we get a sudden overwhelming bloom of algae that causes difficulty.

Eutrophication can led to very unpleasant conditions. A biologist named Thomas described rather graphically in the literature what happened in a Swiss lake at Zurich, in which the rushes growing in the edge of the water, fertilizing the lake, caused so much material to grow on the bottom that it gave off gas and the gas rose up to the top carrying a carpet of ugly sludge to the top. This carpet drifted toward shore by the wind and the reeds then were physically constrained at the water surface. Then when the wind blew the reeds couldn't sway and they broke off and fell down in a big mish-mash of dead, decaying organic matter. They had a wonderful promenade alongside the lake that people didn't care much about using while this was going on.

Chall: Is much of the problem with the growth of algae in the lakes caused by industrial pollution, by phosphates in the soap for example?

McGauhey: About half of the phosphates, in waste water come from products that we use; but there's enough phosphates in human wastes or in animal manures--if we just consider the milk we drink and the food we eat--to go with all the nitrogen that's available. The problem with the phosphates is that if we put in a tremendous lot of phosphates into water and there isn't enough nitrogen to go with it, the water becomes nitrogen sensitive. If the material carrying the phosphate is degradable organic matter in a quantity sufficient to exhaust the oxygen

McGauhey: resources of the receiving water, the system became anaerobic. Then we get a growth of organisms which can get nitrogen from the atmosphere. With plenty of phosphorus the population of organisms will tend to equal its food supply, increasing to the extent phosphorus will permit.

Even in a normal system an anaerobic situation is going to smell bad anyway. But in this new situation we're confronted with now, the problem is compounded. This is why there has been so much worrying about phosphates in waste water. But no one has shown yet that taking out phosphorus as a part of sewage treatment is going to do much good, except in isolated instances.

We are going to have to cut down the nitrogen concentration, too. One source of nitrogen is human sewage, so if a great amount of the water is used repeatedly we get a build-up in nitrogen. Excess nitrogen comes also from some poor waste management practices. In parts of the Midwest, when the farmer runs out of anything else to do in wintertime, he hauls all the annual manure out and throws it on the frozen ground, and then when the snow melts it flows into the lakes instead of into his field, and initiates a problem with algal growth.

In dairies the practice is to wash out the stables with water, and the holding-pen area is washed down, either by man or by nature. Dairies and feed lots where animals are fattened contribute a tremendous lot of organic matter which nobody knows what to do with. At present it is often held in a pond, and this pond become pretty odorous. Nitrites may be present in the pond and will kill a cow if it drinks from the pond. So we have all manner of problems we haven't resolved yet.

In fertilizing there is a problem of when to put the fertilizer on, and how much to put on in order to produce a crop, yet minimize washoff to surface or ground waters. In the case of corn, for example, we have to put on more fertilizer at the time when the plant stalk isn't growing, but the

McGauhey: ears are setting. The rest of the time we can put on fertilizer and it's used by the plant just about at the rate that it is put on in growing cornstalks. But at the time when the ears are forming, when the salable crop is about to materialize, we must then really pour on the fertilizer in order to get anything to sell. So excess nitrogen is on the ground or in the ground near the end of the growing season. Presumably, this is leachable and some of it can get off into the ground water or surface water. Although we haven't identified that as an extremely serious problem, in the irrigated country we know, for example, that the San Luis Drain will have nitrogen in it from agricultural sources.

So there is a lot of serious problems that are associated with how to get the nutrients out of water. Part of our algal study is in that direction.

Chall: I see. In the meantime, I guess the San Luis Drain may be built before we've solved the problem. Does that kind of thing bother you? Do you ever think of this in the political sphere?

McGauhey: Yes, we think a great deal about it--about the problem of how to come up with answers that are clearly enough defined and certain enough in their proof to justify drastic political action. Some say that the whole ecology of the Bay will change when we start exporting water, and others say, yes, it will change but not all changes are bad; maybe the new ecosystem will be just as happy as the old one, even though it's different. Some people don't want any change at all. Others are fearful that somebody either doesn't know or is obscuring what will be the real nature of this water in the Bay once the drain is built. And so we make models of the Bay--those have been made--and attempt to run them out to determine what the situation will be like.

But we really don't know enough about it to answer this primary question and this does worry me. On the other hand, I don't think we should take such drastic action as to say, well let's just don't go on with any more development of water resources, because we don't know what kind of trouble we're going to get in.

Chall: In the case, let's say, of the San Luis Drain, which is an immediate problem, and the Peripheral Canal, would it be possible to say, "Wait until we've done some more research." Is more research justified?

McGauhey: It would be possible. There are those who feel and document their feelings, how well I don't know, that putting all that land into production on the western side [of the San Joaquin Valley] may well be catastrophic to agriculture because of over-production of things that are marketable at the margin level only now.

Chall: I thought that perhaps your input-output system could be used to answer that kind of question by this time.

McGauhey: The reason that it can't answer it is that we can't get the information necessary to put in it. You can make a model all right, but one doesn't know how the wastes, say from industry, move out of this Bay and in what concentration. Do they go out streaming with the tide or do they disperse? We have a good deal of information but when you make a model of it some assumptions must be made. Either we get a one-dimensional model so that the water is being distributed longitudinally, or we make it two dimensions, a model in which wastes are dispersing laterally as well as longitudinally with the flow.

At best these involve vast over-simplications of what happens in nature, and it isn't that we can't find out what happens in nature, it's that what happens in nature here may not be happening at all over there. That is, the same forces are at work, but they're not working in the same combinations, the same ways. In one case we might end up with a great eddy-current of wastes. In another the flow might sweep it right on out and cause no trouble. So there isn't any easy way to translate from one particular situation to the other, and it's infeasible and essentially impossible at the moment to get all of the kind of information we need, particularly when we begin to ask what is going to be the effect on the eco-system.

New Directions in Public Policy

McGauhey: We're not going to get the answer, I fear, before the answer become evident. [Laughter] Because we are not going to be able to predict what happens. I do think, though, that one thing is certain to happen. This is that the Environmental Protection Agency will consider grants-in-aid for sewage treatment plants only if certain federal water quality standards are met both in the discharge stream and in the receiving water. The grant-in-aid is a big percentage of the cost of building a plant acceptable to the EPA. Even if it should continue to be so that a community could theoretically avoid certain restrictions by going it alone, no such decision is likely to occur. As long as the major portion of taxes go through Washington the taxpayer will take the attitude "Why shouldn't some of it come back here? Why should I now have also to pay all the cost of these bonds to build a treatment plant?" And even though there's a lot of fallacies in this method of financing, nevertheless it's effective.

The next step is going to be that if a city or a municipal utility wants federal money for building a plant, it will have to adopt first some policy on industrial wastes. I'm certain that that's the way it's going to be done in the Bay Area. The kind of things that are going into the Bay as toxic materials can't be taken out in an ordinary sewage treatment plant. So we are just going to have to go back to industry and say, "Look, you can't put this pollutant in the sewer in more than this amount." Or, "You can't put it in at all."

For example, the paint industry here may well be responsible for the kind of an oil slick you can see if you go out in a boat to look for it and know what you're looking for, over the sewer outfalls in the Bay. It may be that the sewage treatment plant can never take it out and the utilities district will have to say to this industry, just for an example, "It's up to you to take it out. The goal of your technology must be not to put it in our drains."

McGauhey: This is how I think the toxicity question is going to be answered.

Chall: This article here, "One Strategy for Pollution Control," approaches it in a somewhat different way, if I can get the sense of it.*

One is that you treat the water as a natural resource like land. If you're going to use it, you pay rent on it.

McGauhey: That has been proposed.

Chall: An "effluent charges" system to pay for using it.

McGauhey: This emerges from a reversal--or discussion, at least, of a reversal--of our age-old idea that air and water are free and belong to everybody. And that if we now say that the water resource belongs to the public--it is a public resource and freedom to use it by any individual or any company is granted only subject to these particular constraints--then, we could make a considerable change in the whole jurisdictional approach to quality management.

One of the limitations is that much of what happens to water is a result of what we do on land, and we haven't yet got to where we say the land is a national resource and you have to husband it in <u>this</u> fashion in order to have permission to use it. Although, I think, legislation on land-use, or maybe I'd better say "environmental quality as related to land," or perhaps even a "land-use system" is going to be proposed pretty soon.

We have simple things like zoning ordinances which say you can't build it here, you can build it somewhere else, or art commissions that say you can only built it this high, or it's got to look like this or that, but that doesn't prevent the over-crowding of our environment with buildings and people, or solve

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*"One Strategy for Pollution Control," <u>Resources</u> (Resources for the Future), June 1970, pp. 5-7.

McGauhey: many of our land-use problems. So if we go to the kind of rationale the article suggests we may well have to include the land as a resource on which we're also going to place some quality standards. Not arbitrary, that all land's got to be alike, but that to carry on this kind of an activity you shall have to maintain this level of environmental quality in this individual circumstance.

Chall: I see. The author is under the impression that the present subsidy system--we grant an industry a certain subsidy, or the federal government gives money to communities to build treatment plants--doesn't properly answer the question, because some of the plants are not really efficient or they're not really the very best kind of plant, and then after they're built nobody's really paying very much attention to what happens. And the same is true of industry's pollution--sometimes they just let a treatment plant in the community take care of it, and then they don't bother with the pollution at its origin.

McGauhey: Well, he has a good point there in saying that the government tends to give money for the purpose of assisting a locality to provide adequate facilities that are currently not adequate.

But this other thing of saying what constitutes adequacy. We have to recognize the inadequacy of the plants to treat many industrial wastes and to force the development of a plant that will handle these problems rather than just relying on the same old treatment system. And the granting or withholding of money also forces the people who are responsible for treatment--local water quality boards--to go upstream, and say, "Look, we have no technological way of taking this out, therefore you can't put it in." Then, it's up to industry.

Now, it wouldn't make much difference to most industry or to a city if water cost two or three or four or five times as much as it does today. Of course we'd complain at the end of the first month, but the cost isn't great in comparison with the whole expense involved in manufacture. In most industry the value added by manufacture is great

McGauhey: enough to deal with greatly increased water costs. It's not strictly true of big water users like pulp and paper, but they're solving that--those industries are doing pretty well.

But where stringent water quality objectives hurts is in water for agriculture. Here's where the big amount of water is, and, as a matter of public policy, we have an arrangement whereby we provide water for agriculture. This policy has been upheld by the Supreme Court various times, and I'm not arguing that subsidies to agricultural water is evil. But as I mentioned before the multiplying factor on water used in agriculture is probably at best not over 1.75 to 1.

If we put upon agriculture what it costs to get the water on land--actual cost to go buy it and deliver it--we'd be out of business in irrigated agriculture. Or we'd have to let the price of food go very high, which would be politically untenable. Or we would have to say we won't grow food in the arid country. We can all live out there and drink the water, but we must eat the dried corn from Iowa of which I previously spoke. Dropping agricultural water subsidies would damage the economies, and make such lopsided economies, that this is not a reasonable or feasible alternative.

The endpoint then is, if we're going to put water on at public expense, who but the public is responsible for taking the salts out of return waters from agriculture. We can go to industry and say, "Look, you can't put that salt in there; you either locate where it doesn't matter, or you can get busy with your inventiveness and figure out a way to take it out, or change the process." They've got lots of ways they can go, and, except for marginal industries, that's probably the way to do it. Industry also has the ability to pass the cost on to the public in the price of its product.

So we can get as tough as we want to with industry, we're paying the bill; although, I must say at this moment, we don't seem to know it. The warm glow that comes with standing unmovable on high principles of environmental quality has not yet felt the cool breeze that comes with the bill.

McGauhey: But if we went to a farmer, and said, "Look, you're discharging out here so many acre-feet of water that's got nitrogen in it. You can't do that." We've really said, "You're out of business." There's no way he can get it out. We don't know how to get it out, or at least we don't know how to get it out economically, so how the dickens can a farmer get it out?

I conclude then that if the public says, "We'll put water on land at our expense," then I think the public is still responsible for what happens to that water. I believe that the first step in recognizing such public responsibility is the idea that the public will build a drain, like the San Luis Drain, possibly taking it off to the ocean, quarantining it and taking it away. But someday they may have to say, "We can't afford that--to throw that water away--we've got to find a way to recapture the water." But this will have to come from something other than just regulating the agriculturist's use of water.

Chall: I would like to have you interpret a little quotation that I took from your book.* You said, "Engineers should become more innovative, but this is difficult because municipal officials are concerned with costs and don't like to risk untried systems. Sometimes, therefore, they continue to accept systems customarily used even if it is poor. This, together with the innate conservatism of public works engineers accounts in part for a dismaying lack of progress in water treatment in more than a generation." Has that changed? Are you finding a different type of engineer around lately?

McGauhey: It's changing, not because these engineers were stone-age chaps who didn't see what was going on, but because when they are spending the public's money, they are in a conservative system. The engineer can't just say, "I'll build a full-scale

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*P.H. McGauhey, Engineering Management of Water Quality (New York: McGraw Hill Book Company, 1968), p. 171.

McGauhey: experimental plant here, and my city will be a big test tube for the world to see." He wouldn't last long in the business. [Laughter] The public just wouldn't tolerate that kind of thing. So there is no choice but to use proven systems. This is what I mean by the innate conservatism of public works. It's just frozen in there.

The way it's being overcome is one I spoke of a few moments ago in which increasingly government takes over the matter of specifying quality standards for resources--water, air and land--and then offers the financial assistance to build plants that meet the standards. This, then, forces innovation, and it takes the onus off the city, and it puts up to the consulting engineer to design a better system.

Chall: And then the consulting engineer has to come to fellows like you.

McGauhey: He often has to go back to those who've been in research to ask, "What can you tell us that can improve existing systems?" This is going on right today.

Chall: It would have to be, because otherwise the whole consulting business would be frozen, too. They make their standard plans, and they can sell them all over the world.

McGauhey: Pulling plans out of the drawer and changing the scale on them. There has been a lot of that done in the world--but this is by no means as common as popularly believed. It has been most often done by the marginal engineer preying upon the belief of the small town official that money spent on engineering is wasted. It is not a practice of the type of engineer that is likely to do the work calling for innovation or up-to-the-minute knowledge. I don't think we will see much of that sort of thing as engineers respond to the assumption of responsibility by government for the quality that it is going to demand for the air, water and land resources. But technology is not automatically advanced by a quantum increase in the holiness of a Washington bureaucrat. Municipal authorities are screaming right now in many areas because the standards have

McGauhey: been raised and the time limits for conforming so tightened that the city can not possibly meet them on schedule. I am consultant to one or two consulting engineers who are working for western cities, and I may say that the answers to the problem of meeting federal requirements are far from clear. It is quite clear that the city and its engineers are going to have to find answers one way or another, if they're going to get any federal construction money. I do not mean to agree here that cities have let pollution go on until forced by government to depart from their evil ways and follow the paths of virtue staked out by holy men in government agencies. Much of what is required by government can be shown to be appropriate in one situation and arbitrary and asinine in another. The point is that government at all levels has been increasingly setting objectives which may not be achievable by conventional systems and hence the findings of research are being more carefully examined and more quickly incorporated into engineering practice than in the past.

But I don't want to explore the wellsprings of governmental ukases today. I believe we are more concerned in our discussion with their impact on research. Shall we pursue this question further?

The Results of Research

Chall: Pursue research, I think, as much as we can.

McGauhey: I believe you asked a little while ago about the fate of the product of research once the researcher himself has written it up, and it has been published in an obscure journal or a technical journal that is not widely read.

Chall: Professor Pearson had a big press conference when he finished his report on Bay pollution. That was rather unique, I thought, in the annals of academic research.

McGauhey: Yes, although day before yesterday we had a big press conference here at SERL on the life-support system. It was on the television and there was some good publicity in the metropolitan newspapers of the Bay Area.

So we do get some momentary recognition on occasion, but I think what becomes of research, and the best thing that becomes of it, is that the graduate students who worked on it, now go out into the profession and make some impact with their advanced knowledge.

Take, for example, the input-output studies of economics: two of the people who worked on it first are now involved in important follow-up studies. Mr. Erlich, who was a public administration and economics student, is with the Corps of Engineers in San Francisco, working on a multiple system approach to the effect of what the Corps of Engineers do from an environmental point of view. Dr. Lofting is with the Corps of Engineers, working out for them an extension of the model that I talked about previously--the model of California's economy, and the economy of the eleven Western states. The Corps of Engineers have some real money to put into such work and the results of our research will not be lost.

Mr. Craig Davis, the first one to get his PhD on the SERL project, is on the professorial staff at the University of British Columbia, developing for Western Canada an economic model of the kind that was done here.

Richard Frankel, whom I mentioned a while ago, went to the army and worked for them for awhile on the same economic analysis. He was the one I cited who was originally supported at SERL by Resources for the Future. Later he went with Resources for the Future for a two-year assignment. Now he is out teaching and is working on some similar approaches for the less-developed parts of the world.

These men are all going to make major contributions to the resolution of some very complex problems. They are among the ones who are out in

McGauhey: real life agencies bringing to them, now, the kind of approach we developed here in research. And here's where the hope lies. Even though the professor and his report may be forgotten, the students who worked on it, as we get enough of them, begin to have some impact. This is, I would say, a further justification of the University's policy of seeing that the research projects that we undertake do involve graduate students, and serve some educational purpose other than just educating or intriguing the professor.

The Professor and the University Structure

Chall: I notice that Professor Pearson is the chairman of a conference on water quality which will be meeting for several days in San Francisco next week. Is it typical in the University system that a professor will teach, carry on research (I noticed, for example, that Professor Pearson has projects going on the Laboratory), can be chairman of a department for awhile, and then also get himself involved as an officer in a major organization in his field? Sometimes all at the same time?

McGauhey: Not only is it typical, it is almost a necessity for a professor in a great university. Perhaps I should turn that statement around and say that if a university is to be a great university it must recruit men who have the energy and the competence to teach, to lead research that both refines the context of their courses and leads to experiments in engineering practice, and to serve as leaders in the profession. In the case of Professor Pearson, along with all the things you point out goes also membership in some of the state level committees on ocean outfalls, because he has established some considerable expertise in that area. And as a result he's called upon to consult with people--with agencies as well as with practicing engineers. So, by the time all of these things get put together, there isn't much time left.

McGauhey: But he himself, like most investigators doesn't do a great deal of the detail of research. The picture of the researcher in a white laboratory coat behind a rack of intriguing glassware is more likely to fit the graduate student or a very basic scientist than the faculty investigator of a major environmental study. But Dr. Pearson does a great deal of the review of the research. He's very meticulous and when the report has been drafted, he goes over it in great detail evaluating and interpreting data. He is very careful to make sure that a report is something that he can live with. He insists that his graduate student on the project extend himself intellectually to interpret and evaluate the data. Such an approach is necessary if the graduate is to have the impact I have cited.

Chall: Then it's a pretty strenuous life for some of these people on the faculty? Four or five years or more at a time, particularly when they're department chairmen. Is it all valuable? Is it all worthwhile in your estimation--this kind of activity?

McGauhey: Obviously I must think it worthwhile or conclude that my lifetime has been misspent. The question raises the issue of whether or not one might have been happier or more useful to mankind if he had adhered to a narrower field and planned it deeper. For my part I believe that one expands his capacity to produce by working in a system that keeps him always at full capacity. This is the basis of the old adage "If you want something done, give it to a busy man to do." From my observations of men I would say that the capacity of a man who has too little to do shrinks to the size of his productivity. Thus the classic professor who spends two hours on the campus three days per week (and there are still some of these around) is more certain than the busy man that he is terribly overworked. Concerning some I have worked with on committees at Berkeley and in other universities I would revise the old adage to say "If you have something you don't want done, give it to Professor ________ to do."

But this is a matter about which I hope to get around to writing in another context. Concerning your question I would say that those who perform at the strenuous level could do even more if it

McGauhey: were not for inescapable inefficiencies in the system.

The tendency for the University, I'm afraid, is to get over-organized. Just as the whole profession of engineering is over-organized. I belong to, at least, fifteen organizations each one of which seems to be legitimate and to serve a purpose. But these in themselves consume quite a bit of time--just being in them and participating in the profession as a practitioner of the profession.

Within the University, of course, we have a tremendous number of committees. Everything is done by committees. And committees move like glaciers, you know, to begin with. Although in the end I think the committee system comes up with some very sound conclusions, it nevertheless takes an awful lot of peoples' time.

The department chairman or the division chairman is at the receiving end of paper chutes from a considerable number of administrative sources. The administrator spends his full time in generating paper and has the prerogative of sending it along down the line. However, it gets hung up on his desk, so by the time it goes down to the department it is already due back in the chancellor's office.

The bigger the University gets, in my opinion, the more administratively top heavy it gets. And the more administration you have, the more people who are employed to generate paper. And this paper has to go somewhere. And a lot of it has to go down to the level of departments. Then quite often the paper demands, or at least requests that the chairman come up with an opinion of the department. The department chairman is expected to speak for the department. And then when you try to speak for sixty people, you have to get them together. This is physically impossible because of the percentage who are presenting learned papers, or are in Europe, at any given moment. Moreover, it is intellectually impossible as well because their capacity for disagreement is expanded by indignation over what the paper requests of them. The best the chairman

McGauhey: can do is to appoint some more committees at the department level. And we end up with committees dealing with curriculum, for example, at the division level, at the department level, at the college level, at the University, or at least at the campus level, and the state-wide level. And it takes a lot of time, consumes a lot of energy, and its cost-effectiveness is too frightening to compute.

Yet I don't see exactly how one might run a teaching operation by just going off in a vacuum with students and teaching them, particularly in this area of environmental control. What are we going to teach them, particularly in a graduate school? We really don't have much to teach in engineering unless we participate in research and in the profession. The alternative is to do as they do in some undeveloped countries: the professor just recites the notes which he took when he was in college. What we know of environmental control becomes obsolete pretty fast. In the fast-moving world we have today, scientific and engineering as well as social, the cultural changes are so rapid that it becomes absolutely necessary that a professor be doing something in research. Also he must be having some contact with people because you can do only what people will let you do. So, again there's no use for research on things that have no relevance at all to what humanity wants or will accept.

Therefore, just to be sufficiently informed to teach or lead a class at the graduate level in a modern context makes it necessary that a man be pretty active on all fronts in his field.

Chall: I would think there would be some way to cut someplace along the line. But I suppose only the people in the field would be able to analyze this.

McGauhey: I don't know how to go about cutting it. I know some people who say "Well, I just can't do it. You'll just have to get somebody else." But much of the reputation of the University depends upon a man doing his job. Sometimes he is motivated by the old dog in the manger concept. Sometimes you have to do something because the penalty for not

McGauhey: doing it is for somebody else to do it. And that somebody else isn't going to do it the way you want it done. Or is going to do it and get the rewards.

Then, this may be kind of a negative approach, but nevertheless, if the University wants to have a world-wide reputation or a national reputation or any kind of a reputation for excellence, it has to do two things. It has to do those things that result in it getting credit and it has to surround itself, or at least staff itself, with people who do more than an ordinary amount of thinking and turn out more than an ordinary amount of product. And this is one of the tasks that one comes up against in administering at a departmental level, or at least that the administration comes up against when it is thinking about what is a proper teaching load in view of the other activities that go along with making teaching relevant.

One of the things they come up against is the question of whether a man who's doing his job and doing it well is justified in putting an appreciable amount of energy into other activities outside the University, if they don't directly contribute to the stature of the University. This often comes up in relation to consulting activities. One professor justifies his activities on the rationale, "Well, I'm doing a good job." But "good" isn't good enough for an excellent university. We have to do a little better than the ordinary good job.

I've always contended that if we hire people of greater than normal capacity, then the University has a right to expect greater than normal production from them, and in turn greater than normal, or greater than average, at least, reputation as a result of this. This is an area that is hard to deal with, and yet it is something that we have to think about.

Chall: It's a standard that you set, isn't it?

McGauhey: Yes. You have to set the standards high, and then get high-quality men to staff this kind of an organization.

Teaching

Chall: I don't know about the students in the engineering departments, but in other areas of the University they've been upset with the fact that in their undergraduate years, at least, they aren't dealing with the major minds of the department, because the professors are doing their research and working with graduate students. Is this a problem that you have had to contend with?

McGauhey: I've not had to contend with it in the Department of Civil Engineering and in the College of Engineering where the classes are not so large. There've been, certainly, cases where individual professors were hard to get to, but this I don't think is really a bad situation. I don't think I know of any students who've had difficulty getting to see the professor if they really want to. The big problem is to get them to come around, at least before they get into so much trouble nobody can help them.

Chall: Get the students to come around, you mean?

McGauhey: Yes. Before they're beyond help. I don't think we have too much of a problem there. It is true that the professors largely work with graduate students, but on the other hand, half of our people are graduate students, and a lot of that working with them is in a research area.

The real problem with the undergraduate occurs when classes are very large. I was just talking with Rolf Eliasson of Stanford a few moments ago. He had a class, "Man in his Environment" with four hundred people in it. But he kept an open door, and they came through that door, and he's taken all summer to try to recover. Spring quarter was a strenuous activity! [Laughter]

Where there are large classes there are often numerous teaching assistants involved. The student can't get past the TA to see the professor, or may justly feel that the professor is someone that appears in the huge lecture hall beyond the resolving power of the human eye. We don't have much teaching

McGauhey: done in engineering--in fact we don't have any teaching done in civil engineering that I've ever come across--that was done by teaching assistants. Their task in our organization is to take the problem sets and grade them, not necessarily to put a final grade on them, just criticize them, and go into the detail of writing on the margins what the student overlooked, or did wrong. In my classes, at least, the TA used solutions that I provided.

I used to tell them, "I only ask you the kind of questions I can answer myself. I only give you the kind of problems I can work. Therefore, it shouldn't be too hard." Sometimes the student found that I made an error. I always liked this to happen because it made for good relations with students when I came to class with the confession that I had goofed, then distributed the correct solution, and upped the grades of those who had it right. I had the teaching assistants in my class pass the student's problem solutions through my office for final grading. In general these teaching assistants hold office hours, and if the student wants to know, what did you mean by this--what's this you're criticizing here--then he goes first to the teaching assistant. But the teaching assistant then, if it's a matter of context, refers him to the professor. This way you can get a lot of the underbrush chopped out, you might say, without wasting manpower on the problems or detail that isn't necessary.

But then where teaching assistants are leading in laboratory experiments, the professor is on hand. He may not be standing right there, but he's in the vicinity, so that the teaching assistant is largely manning the machines or saving the equipment.

We don't have any real cause for widespread complaint of mishandling of teaching of our own students. But it is different when these students go to other departments, particularly engineers or scientists going to a humanities department. The people in the humanities are, understandably, concerned to teach their graduate students. So if they get five hundred in one class, of people from a group like engineering, it is awfully easy to take

McGauhey: the attitude: "Well, these fellows are unteachable anyway or they wouldn't be taking engineering. They'd be over here studying under us if they were interested in this field." And so, they pass them down the line to a teaching assistant. If they didn't pass them down the line, they wouldn't have manpower enough to teach them anyway.

In many classes the lectures have been given by the professor to two or three or four or five hundred students. Then to measure any of the impact on the student, the professor simply cannot do it. He has to have some subcontractors to work with smaller groups to evaluate the impact. Sometimes they call these quiz sections, or discussion sections, or recitation sections--with years, the terminology has changed. This approach brings the high-level professor into view, but the students never get close to him. Even at best--even if students would sit in the front row, which they don't like to do--they would not get very close to him.

And I don't think this is any reflection on the integrity of the professor. It's just that if the University is going to accept mass teaching, this is one of the evils of it. If we're not going to have mass teaching, then we have to make a far greater investment in facilities and staff. Either we have to go for greater investment or limited enrollment. We can't hire a Nobel Prize winner for every twenty students. We get at Berkeley far more prize winners than the normal university. But if we had hired all the talent in the world just to teach five hundred students, it would take a lot of money and a lot of recruiting to get these people all to work on one group in one university.

Objectives of Education

Chall: Partly a problem of size then?

McGauhey: It's partly a problem of size and, of course, an objective. And I'm not, personally, too worried about the fact that some of these people are working in large classes as long as they're confronted with

McGauhey: a professor that challenges them to think and get interested in the subject. Certainly for engineers, with the time they have to spend on it, are not going to become economists, or philosphers, or historians by attending undergraduate classes. The need is to get them interested enough to study these subjects in the years ahead.

There's some who say and I concur with them that, "The educated man is an old man." So if we are going to get them educated, the first thing is to get them interested because no one is going to sit and hold their hand all their lives. They've got to become interested. And it's this challenge that awakes an interest and opens an avenue. If the student gets the feel of how to follow this avenue he may go on to become educated in that area. If he doesn't follow it, the impact of his attending class--the half life of human knowledge being what it is--is probably pretty small.

I feel that in engineering we've done a good job of teaching. It may have involved a lot of unsolved problems. We've had to work at solving them as we went along just as the rest of the educational world has.

One of those problems is the objectives of the course or of the entire program. What do we expect to achieve if we are successful in our educational effort? In engineering, I think, it would be almost necessary to say that we expect a student to have learned enough about the fundamentals that he can go ahead and develop, as the knowledge of fundamentals develops, without someone to guide him. And enough, perhaps, guidance in those courses that you can't learn just by sitting down and reading.

In my lifetime I've only known one chap who was born knowing differential equations. And he, by the way, is one of the men who designed the Feather River Dam. He was a classmate of mine who never bothered to get a degree because he already knew so much about it by the time he started that it was hardly worthwhile waiting around.

Generally most of us need some guidance. But in the case of some other fields or some other

McGauhey: subject matter, a person by individual studies can learn a great deal about it and become an expert in it if he gets that first excitement of interest in it. Excitement of interest is the reason for some of our courses. Even though they may be poorly taught, as long as that doesn't drive the student away from it, it has served a purpose in generating interest in some facet of our society.

When I was in high school it was, of course, normal for everyone either to have to take Latin or think pretty fast how to get out of it. But there was no way to get out of reading Shakespeare. I am persuaded that if any of the high school students had the slightest idea what Shakespeare was talking about, the authorities would have banned it. This would have caused all students to read Shakespeare and the lives of many more would have been enriched. But high school English actually did more to keep people from reading Shakespeare than any other particular activity. And largely I say because no one (well, perhaps I shouldn't say no one), but in general, students didn't have the slightest idea what was going on in Shakespeare's plays.

Chall: Bet the teachers didn't either.

McGauhey: That I'd buy, too, in several instances I could cite.

V OUTSIDE CONSULTING

The Philosophy of Consultation

McGauhey: We were talking the other day about this matter of outside consulting.

Chall: Yes. I did want to talk to you about your various consultations because I know you've done a great deal of it around the country and abroad even.

McGauhey: Perhaps we ought to begin with the matter of philosophy of consulting. When I was starting out in teaching there weren't many opportunities for consulting and we had bigger teaching loads than now seem feasible to professors. But even at that time the philosophy pervaded the academic world that a professor ought to do some outside work, whether during the summer or on a consulting basis, so that he kept in contact with the engineering profession. To this end there were attempts from time to time to set up financing so that one might take a leave to do some outside work.

However, I was in a bit more fortunate situation. When I started teaching at Virginia Tech, the civil engineering department did all the engineering for the campus. This included everything from roads, and streets, and grading, and some building design, to design, construction, and operation of the waste-water treatment plant and the water supply. So I had all of this kind of experience working with contractors, and drilling wells, and doing a good many things, aside from outside consulting. It was thought at that time and I still hold to the notion, that the young professor often tries to get into

McGauhey: consulting too soon. He may have nothing to sell, and he may dilute the efforts that would lead to his advancement, or to his development as a professional man and a teacher, and moreover, he runs the risk of letting consulting fees get into his standard of living and so eventually give too much attention to consulting.

I started from the very beginning not letting any money I got for consulting become involved in my standard of living. I put it in what I called "The McGauhey Foundation," which was generally broke but mainly used for buying my wife's ticket when we traveled. So it never got into a situation where I had to keep up this kind of thing. I did some consulting on several jobs in my early years with the mining industry and with the city of Chicago in hydrology. At that time they were going to build a sunken freeway and didn't know whether it would fill up with water or not during heavy rains. So they had some of us in as hydrologists to deal with that question.

Most of my consulting work I began after I reached the full professor grade. I did some consulting when I was in Southern California. I did a bit in Virginia. But most of it since I've been at the University of California. The consulting that I've done overseas was largely upon assignment by the University itself.

Some of the Assignments

Kuwait

McGauhey: The first trip I took overseas was to Kuwait with the British Petroleum, the Kuwait Oil Company--half British Petroleum and half an American company. In this particular situation the British had set up a city, ten years previously, in which they had built all of the utilities and were responsible for their management. They wanted to see, ten years later, the outcome of their program of water distillation

McGauhey: from the ocean, their solid waste disposal system, the wastewater disposal system, some unique problems they have there related to flies, and general public health engineering problems. So I went over there with the consent of the University. The University thought this was something that one of its staff might well be doing to the credit of the University. So they let me go there for a month and I had a rather interesting experience.

Chall: Just you?

McGauhey: I went with Professor Bruce from Kings College in London. But Professor Bruce had to leave before it was over, due to some problems with his family, and I ended up writing the report and taking all the people who had been good to me out to dinner--for which, incidentally, the oil company ultimately paid! [Laughs]

Chall: Were you paid for this by the University?

McGauhey: No, I was paid by the oil company but the University let me keep that as extra pay because of the nature of the request and nature of the assignment. They felt that it was to the advantage of the University for one of its staff to get this kind of experience.

Chall: How had the works shown up at the end of the ten year period? Were they in pretty good shape?

McGauhey: Well, some very interesting things happened. One is, that Bechtel had built a whole new oil facility at Mina Al Ahmadi and the old oil lines that were submerged and went out to where the ships would anchor, were still there. They used them for sewers and dumped the sewage from the city of Ahmadi into the Persian Gulf.

Chall: Untreated?

McGauhey: Untreated. But big clams, six inches across, soon moved into these outfall lines and clogged them up. When one would get clogged they'd cut it off upstream from the clams, then the clams would move in again. By the time I got there they were dumping sewage right at the tide line.

McGauhey: Of course this was a pretty touchy political situation because some of the sheiks had their summer places along the head of the Persian Gulf, just a few hundred yards away. While they weren't particularly worried about the water quality there was always the possibility, politically, that they might say, "Ours may be a backward country but even we want better standards than this. Obviously you're just here to exploit our oil." Such an eventuality would mean trouble and the oil company didn't want to be the cause of trouble.

We made a float right away to see where all this waste water was going in the Gulf. We put out some big oil drums as floats at the discharge point of the sewer and followed them by boat. They floated out into the Gulf and then turned around and came right back into the boat harbor and up to the intake of the pumps that pump water into the sea water distillation plant. It did no harm. The sheik himself had three yachts in the same harbor and they dump all their wastes right into the basin. But it was quite politically difficult and environmentally undesirable.

One of the most interesting things, if I may just digress to tell you this: We went out of town to a place which was called Raudatain which was sixty miles north of Ahmadi near the Shattal Arab where the Tigris and Euphrates come together. They were going to build a pumping station there to deliver oil from a new oil field to the wharf at Mina. The problem was to keep about two hundred men housed for operating this pumping station way out in the desert. Of course, the Arabs being family-minded, this meant that there would be about 1200 people and no one knows how many goats and donkeys at the site. But we could supply water for that. The question of what to do with waste water was simply answered in terms of our culture. Just pipe it downwind out into the desert a mile and tell it to get lost.

Well in Arabia this is no answer at all because if we were to do this the Bedouins will spring up overnight around it with their donkeys and goats. In Islam all of the spiritual wastes as well as the physiological ones are associated with sewage.

McGauhey: Thus it is a somewhat more fearsome material than even we think it is. So as soon as the Bedoua found out that this was waste water, they would consider it an indignity that the infidel would not be permitted to impose upon the faithful and so raise a lot of fuss. If we put a fence around the wastewater pond then, these being unlettered people, would take the attitude that here in this country where there is no water, the confounded infidel fences us away from the water. So the common engineering answer was no answer at all. We just had to keep it under control and treat it and use it for irrigating trees to make a windbreak because there was no way to get rid of it. [Laughs]

This was some of the kind of things that I learned there and which Americans haven't always learned as soon as they should that things we do have to be culturally acceptable and may have very little to do with a simple engineering answer. It may not be an answer at all.

Chall: When were you in Kuwait?

McGauhey: That was in 1958, as I recall.

Chall: How were the problems of pollution in the Persian Gulf resolved?

McGauhey: I must admit that I really don't know. At the time I left there were alternate plans. One was to exclude from the sewer the sea water that was used in Ahmadi for cooling air conditioning units. This was to make the sewage low enough in chlorides to respond to normal biological treatment. The treated effluent was then to be used by the oil company to irrigate tamarisk trees as windbreaks. Windbreaks are quite useful there because during certain seasons sandstorms may turn day into night, and both day and night into nightmares.

The alternative was to settle the sewage to remove solids and chlorinate the effluent, discharging it further out into the gulf. These ideas were well received by the oil company at the time. However, the oil business being what it is, or was, oilmen plunge from high optimism into darkest gloom if the

McGauhey: price of oil drops one-tenth cent per barrel. Gloom descended soon after I left and I later heard that nothing was done. Then later again I heard that chlorination was being practiced. After that I lost touch with the situation, hence I really don't know the outcome.

The only thing I know of the consequences of this venture is that I was deeply impressed with the need for understanding the social and cultural aspects of the other country before attempting to apply U.S. technology to its problems. I attempted to bring this fact home to students thereafter. If I was successful it justified, perhaps, the University's judgment that some educational good would come from letting me go.

Chall: With respect to the problem of treating waste water at the pumping station at Raudatain, would we, today, not look upon this as an impossible thing, now that we are reclaiming waste water?

McGauhey: Well, the possibility exists. But it is still difficult right here in California and in the West where water is scarce--it is still difficult to overcome the psychological association of water with waste. I've often suggested that this won't last forever and have pointed out in some of my writings that one would hardly hesitate to eat oatmeal hauled in a freight car because the freight car had once hauled a load of fertilizer. I contend that water is the same kind of thing. It is a transport system. We don't have to throw away the freight car just because we hauled something in it. We unload it and we have the water back again. This is what waste-water treatment is all about. I think it will become acceptable, but at the present it is, for reasons of social and cultural attitudes, and also because of some of our uncertainties about the virus problem, not suited to direct reuse. We prefer to put it underground and let it lose identity.

Chall: But they are using it in Santee now. It is underground but also for recreation.

McGauhey: That's true. It is put into the ground and brought back out again for recreational use and irrigation.

Israel

Chall: By the same token, it might make some of the desert bloom in the Middle East.

McGauhey: Well, they are doing a lot in Israel. I went, by the way, to Israel on a consulting tour.

Chall: You did? When was that?

McGauhey: That was--let me make sure what year it was because the half-life of human memory being what it is the past loses clarity. It was in the summer of 1963 that I went to Israel. By that time the University had changed my payroll status and ruled that I was on a nine months appointment. I was paid a stipend for being director and I interpreted that, personally, as being compensation for staying here on the job except for a month's vacation, although that was not the strict interpretation of the University.

So I went over on the invitation of the AID--the State Department--in response to a request from the Israeli government for someone who knew something about groundwater recharge or the use of reclaimed water for groundwater recharge, and worked there with the Tahal, which is the Israeli semi-government organization for water resources.

This was also an interesting assignment and I prepared a report for AID before I left. I found there that they were using waste water everywhere to great advantage. They were using it for irrigation, particularly of crops that weren't to be eaten raw or green. Their standards of sanitation were inherited from us, I guess. Certainly they are the equal of ours. But they were not letting any water go to waste if they didn't have to and they were really making orange groves, and alfalfa, all manner of crops, bloom beautifully. So that was one of the interesting overseas assignments.

Chall: You found that they were doing a great deal with a computer there, too, in terms of when the water was going to be used?

McGauhey: Oh yes.

Chall: I've heard that they were advancing their computer technology for this purpose.

McGauhey: They were certainly aware of it and alert and using it.

India

McGauhey: In 1965, I went to India on an assignment for the University. The University of California was one of nine universities in a consortium to establish an engineering school--the Indian Institute of Technology at Kanpur. I went overseas again with AID sponsorship through the University to look over the programs in sanitary and public health engineering in institutions in India and to discuss with agencies that hire graduates from these schools, what they would do with a graduate if they had one, and ultimately to help decide whether it was appropriate to establish a public health engineering program at I.I.T. Kanpur.

I spent twenty-one days, flying by night and working by day, in the monsoon season, visiting institutions throughout India. Then the rest of the seven week tour I spent in the institute itself at Kanpur. I also looked at the sanitary installations around the country and found again some interesting and difficult cultural problems. One of the situations with the difference in attitude toward fresh water between myself and the villagers. At one village the World Health Organization had built a water well and put a pump on it. Nobody objected to this. People who lived close to it were perfectly happy to use it, but those who were 150 feet away would just come out with a brass bowl and dip water out of a mud hole a cow was standing in. They didn't think it worthwhile to bother to go to the well.

McGauhey: It developed that the fresh water from the pump ran out alongside a narrow road and the headmaster of the village finally demanded that the WHO build a concrete channel about forty or fifty feet long to carry this water away from the site of the well to essentially nowhere; but this was what he wanted. World Health was trying to show how cheaply a village could build a well and this ran up the cost.

However the rationale was interesting: it was that before the well was built they only had a mud hole in the street during the rainy season. But now that they had a well, they had a mud hole all year round! Well the road was only about eight feet wide and right below the site was a grassy slope that led into a pond. People were in the pond everyday washing their water buffalo as we might wash an automobile. The spillage at this well being fresh water, I said, "Why don't we just put a tube under the road here and let this water run down into the pond."

The answer was, "Ah, but this was not permitted." I attempted to find out who would not permit it. There was a vague notion that it was the Ministry of Health. Going over India I never did get an answer until finally I was talking with one of my former students who was high up in the Indian government and a very fine and able engineer who had done graduate study here in Berkeley. He said, "What we're trying to tell you is that we never have done it and by golly we are not going to!"

So working in that kind of circumstance, in what I would call a culture-bound society, one has to do things in a different fashion than an impatient American might do in our particular cultural framework.

Chall: Is it possible to solve some of these problems in health while using water in the old traditional ways?

McGauhey: I am worried about the possibility of doing anything very rapidly in India. It is difficult to get anyone to take responsibility. If one takes responsibility then someone has something on him. Because there is lots of manpower in India, a great deal of work involves just passing papers from one person to

McGauhey: another and it takes a long time to accomplish anything. So I don't know about solving its problem of basic sanitation.

In one village I visited World Health had built a device for making an Eastern type toilet. It was made of burlap and portland cement in two sections which could be put together and installed with two pits in the ground. One pit was used for about a year; then a curved clay pipe which drained into it was just flipped over to deliver wastes to the other pit for another year or so. This whole installation could be made for seven rupees, which was about $1.47 at that time. A village industry had been established and was making these devices. The problem was to get anyone to use them. To induce the people to use it WHO got the village headmaster, who was comparable to our mayor, and who was interested in this industry to install it. They installed it out in the compound behind his house. But people normally accustomed to seek the fields, took the attitude, why go over to that thing when I am right here. When I visited the place the toilet obviously had never been used. It could be flushed with just a half gallon of water poured from a can; but the can looked like red lace. It had rusted out without ever having been used, just sitting there in the weather.

So WHO had some psychologists try to find out why people didn't use the facility. Well, they learned that the Hindu (or at least some branch of that philosophy), if he went to the toilet under a cover, that is with a roof over his head, must immediately change all his garments. Having only one garment, this was quite obviously an impractical routine. So this precluded his use of it.

Then the clincher on the whole thing was that the women seek the fields at night and it is a social occasion; and they weren't about to have their social life disrupted because some boob in the United States thought they ought to have this kind of a facility. This is what the sociologists reported to us; this is the reason they couldn't get the simplest sanitation program going. Well, some 80 percent of India's vast number of people live in 30,000 villages, and sanitation and the

McGauhey: attitudes toward it don't move out into these villages as they do into the cities. One of the reasons is that when the people that we educate here go back home they want to live in the city. They don't want to go out in the village. So the brains are stacked up in the city and not out where they are most needed.

Chall: Is the incidence of disease greater in the villages under these conditions than it is in the cities? Certainly it would be more dangerous in the cities if you didn't have proper sanitary facilities?

McGauhey: Yes, a great deal more so, because waste water is collected in the principal cities, albeit discharged after some treatment which may break down or be poorly operative but nevertheless it is concentrated at some point of discharge rather than left where one could come in contact with bare feet or where it will go into a well. For example, in the country one of the problems with the wells is that they are open at the top. Initially the water in a dug well may be clean. But poor people there live essentially in two dimensions. They squat on the ground and they have all their possessions there upon the ground. Among these possessions is a rope and a bucket for pulling up water. This rope is thrown on the ground where animal manure and human wastes abound. When water is needed they tie the rope to the bucket, stand with their toes over the edge of the well, and throw this bucket into the well and pull it up again. It doesn't take many of these trips to get water before the well is contaminated.

Such pollution is eliminated in the city by a simple water treatment plant, albeit the same people that run the treatment plant do not operate the distribution system. So a city may be very proud that its water is chlorinated and fit to drink at the plant, but you may still have to boil it to drink it downtown. For this the treatment people disclaim responsibility. Their pride is in producing the water, not delivering it because that is somebody else's responsibility. If it didn't get there fit to drink, don't look at me. So there's some problems of organization.

McGauhey: But in the city the health is a whole lot better among the people who are not extremely poor. Of course in Calcutta, which is notoriously bad, a lot of people are in what we would consider pretty abject poverty. When the temperature drops five degrees, thousands of people may die of pneumonia. They are just that close to the borderline. So what we can do over there is uncertain. My hopes were, and they are partially being fulfilled in the Institute, that we could get a graduate school in which the problems of the East could be dealt with by Easterners, or by people with their education finished in the United States or Britain or some other country. Then with the kind of education and the qualifications necessary to be a professor in one of our universities, they could teach students the kind of thing that we can't teach them here--how to achieve basic sanitation. In the U.S. basic sanitation is taken for granted. We have highly diversified engineering organizations, and we have the possibility of a considerable specialty area in engineering education. Being highly mechanized we naturally teach our student how to function in an industrialized society. In the U.S. school neither we nor the foreign student learns what the foreign student needs at home.

Chall: I suppose that in any country of this kind where they have their own culture, it would be always better if you could get well-trained people, and let them handle the problems in terms of their culture.

McGauhey: Well this is why I hold great store for IIT--at least what its prospect is. There we could give graduate courses dealing with the kind of things that those countries need. They don't need experts in activated sludge treatment. They don't need to know how to build a South Tahoe plant--that kind of thing--or a reclamation plant, because that is not the problem. We can't do very much to meet the needs of the student that comes here. He just has to fit in with ours and study the kinds of things that our students, graduates, will be doing in the United States.

McGauhey: I asked my former students in India about the result of this useless educational experience. They told me one of three things happens. The student may go back, and when he can get no job doing the kind of thing that we have educated him to do here, he is frustrated and unhappy. To avoid this he may just decide to forget it all, to go back where he was and erase it out of his mind. Or third, he may be so unwilling to recognize his own shortcomings and like many humans try to pass the buck to somebody else, and so end up with a lasting hatred for the country that educated him.

Chall: And disoriented him to his own culture.

McGauhey: What we do so much, not by design but by inadvertence, is to disorient students to their own culture and so they either don't want to go back, or going back are unhappy. If we could set up an institute--and this is what our dream was at Kanpur--if we could set up an organization or an institute that would educate people for their own culture or for the culture of the Southwest, it would be a good thing. Happily a good deal of that is going on in Bangkok at SEATO's graduate school there.

Chall: SEATO Graduate School? You mean it is run by the SEATO governments?

McGauhey: Yes. We have one of our former professors of civil engineering there, John Hugh Jones. He went to Bangkok for a couple of years and has stayed on now for more than ten years. He stayed, and I hear from him occasionally through people who travel by. He likes it very much.

We are achieving some of these more appropriate goals out in Hawaii also at the East-West Center. There we are educating people of a Polynesian background to deal with the problems of the South Pacific. You don't send a red-headed Irishman there to tell the natives how to do their business. They have a unique approach and they will use things they make themselves and won't use things you make and give to them. It is far better to have somebody who looks more like them than my sending a red-headed Irishman.

Chall: You're right. It has taken us about a quarter of a century to arrive at this conclusion though, hasn't it?

McGauhey: Yes. America's missionary spirit dies hard.

Chall: Your wife went with you to India?

McGauhey: Yes.

Chall: So you were able to travel as a tourist as well as a visiting and working professor.

McGauhey: My wife traveled with me as a tourist and I went on a working assignment. We had with us a young man in India. One of my assignments was to observe this young man who they had in mind for an assistant professorship at IIT, Kanpur, and decide whether he was suitable for PhD work in the United States. He was one of my traveling companions and was extremely intelligent. On my favorable report AID sent him to Berkeley. He got his doctorate with us and went back to teach at IIT. His name is Guru Dass Agrawal. He made straight A's in his work here and managed to live through two years with us. How, I do not know, because he insisted on walking right up the middle of the street just like he did in India. Coming to my house he had several narrow escapes, but [laughing] nevertheless lived. He got back to India.

Chile

McGauhey: The other overseas work that I've done as a consultant was paid for by the Ford Foundation, but here again the University was involved. It sent me and Dean Whinnery [John R.] down to the Catholic University of Chile in Santiago. I was there for five weeks (and my wife was with me) to determine whether that university had the potential to make real educational use of funds they had applied for from the foundation. It did, indeed, have the potential and several of its staff came here to Berkeley on an exchange basis and got their advanced

McGauhey: degrees. Unfortunately, under the present (Allende) government things have happened. I don't know the full story except that some of the professors I knew left the country the day of the election.

Chall: Is that right? Is this an on-going useful institution for the country?

McGauhey: Oh yes. It is a long established university with a good engineering school and it got more money after that original grant and developed very well. Under the present political regime, I don't know what the status of the university may be. But it was a very pleasant assignment. Chile is a delightful country. It was the one in South America that I held a great deal of hope for. If they survive this present regime my hope will be revived, I think, because they are very fine people living in a fine climate.

Santiago is in a valley just about as far south of the equator as Paso Robles is north. It is Peru, and Ecuador, and Columbia, and Bolivia that you get into the high country. In Chile there is some high mountains in the south. I've been there in the lake country. It is certainly beautiful and even I can catch trout there.

Lake Tahoe

Chall: What about your consulting work at Lake Tahoe?

McGauhey: That is some of the kind of consulting I've gone into since I retired. But along the way I did a good many small, one-day jobs. I did take on, in 1961, the Lake Tahoe Area Council task as chairman of a board of consultants which set forth a rather unique approach to an engineering study and helped guide this study by a consulting engineer. Professor Pearson and I, and Professor Rohlich from Wisconsin comprised the board through most of its tenure. At the beginning Professor Eliasson from Stanford was on it.

McGauhey: After the engineering study was completed in 1964, we got some money from the then Water Pollution Control Administration, now the Environmental Protection Agency, to continue some studies of water quality. I did that as a part-time consultant--a day or so a month, probably was about what it amounted to. That was what I got paid for anyway. But both Professor Pearson and I did a lot of work at Tahoe as a public service.

Chall: This was federal?

McGauhey: Federal, yes. After a year or so the Feds decided not to allow consultant fees in the council's budget. That left me in the role of project director. But I have sufficient interest to put in quite a lot of public service work and get paid for a few days a year.

Chall: Now you are project director of what? This is Lake Tahoe, right?

McGauhey: Project director on demonstration grants to the Lake Tahoe Area Council which I help generate.

Chall: Demonstration?

McGauhey: Yes. The project was entitled "Eutrophication of Surface Waters, Lake Tahoe." There we added a parallel one which has the same title but involves Indian Creek Reservoir. That is where the treated waste water from South Tahoe is impounded for recreational purposes and used for irrigation. The prospect is that that project will continue this coming year (1972); so I'll still be involved with that for another year anyway.

Chall: You're not involved in consultation and decision about the so-called General Plan at Lake Tahoe?

McGauhey: I've had some interviews with those people and have written for the press on it and probably will go Friday on to one of these TV shows to discuss it.

Chall: This Friday?

McGauhey: Yes. But it isn't a problem that can be solved by

McGauhey: the kind of thing we're doing in LTAC. The problem there is one of what is done to the land. Ultimately the damage that is done to the land is reflected back in water quality. One can't stand down at the water's edge and say, "Don't chop down that tree because here comes the pollution." It is a longer term problem and there is no hope that by looking at water quality we can control what's done to the land. I have told the reporter for the Sacramento Bee in an article they published the other day, and I probably will, on Friday, say on television that the way the land is being torn up it won't be a suitable environment for a lake, regardless of whether it is blue, green or brown by the time they get through. The quality of the water will be a secondary consideration if this becomes the high-rise urbanized situation toward which it seems to be heading.

Chall: But your job as a consultant is, apparently, to look at the water and see what is happening in terms of eutrophication. And the eutrophication, as I understand it is based upon the silt. Is that part of it?

McGauhey: Well mainly the fertilizers, the nitrogen and phosphorus.

Chall: It comes from where?

McGauhey: Some of it comes from rain and some of it comes from disturbing the soil and from runoff washing debris into the lake. These sources produce nitrogen concentrations in water about double the normal amount that would go in from a wilderness area. We have turned out several reports on the Lake Tahoe situation, but they are scientific reports, rather than political policy statments.

Chall: You assume that from your scientific reports the policy makers will get the message?

McGauhey: I assume that they'll pay no attention to them whatever.

McGauhey: The original study that the board of consultants directed was made by the consulting engineering firm of Engineering Science. Harvey Ludwig, the president, you know, was once an associate professor here and one of our graduates from the University. This report recommended removing waste from the basin as one of the alternatives and made other recommendations concerning the collection, and these are being carried out. The difficult problem is that there are no laws in the United States that constrain Americans from using the land largely as they see fit. This, of course, is part of the heritage of Americans: freeholding and free use of land. So we have, as a pollution control measure, attempted to overcome that limitation by looking harder and harder at the water and putting tighter and tighter standards upon its quality.

The economic pressures at Tahoe are just the same as they are at any other subdivision that's part of the situation. The methods of construction are essentially taken up to Tahoe and used the same as they would be in Fremont. So we have great pressure for subdivisions and to develop the economy of the region. The region is unique and it therefore should require unique controls and unique construction methods with unique planning. But we use the same non-unique ones that we use elsewhere and so the land is being torn up and it is being torn up in great haste now to beat the September 22nd creation of a planning agency. This agency may or may not prove to be effective but nevertheless, anything that is torn up by the time the agency comes into being will not be stopped. The result is that developers have got everything moving that will move day and night, tearing up the basin in a fashion that leads me to believe that the loss of the basin will be on the land and not in the water.

They're going to build a lot of marinas and concentrate people on the waterfront, and going to get a great deal of debris into the water, and the impression is going to be that the water is bad even though it is going to take a long time out in the middle of the lake before the whole thing is destroyed. By that time, I think or at least I fear, that nobody will care much because, as I put it, the basin won't

McGauhey: be a suitable environment for a lake.

Chall: Have you any feelings about the regional planning agency that was set up by the federal government? How is that as a functioning organization?

McGauhey: Well, it is not too effective. The principal problem is that at the time it was set up the County Board of Supervisors had already approved all sorts of things and this regional agency then elected to say that well, since these supervisors approved it then we can't come in now and disapprove. This is the story that has gone on, agency after agency. They dream up plans and then nobody pays any attention, or immediately gets exceptions.

The Board of Supervisors of Douglas County in Nevada, and Placer County (not quite as bad) in California, have a great deal of difficulty in bringing themselves to refuse construction that broadens the tax base. There is a great deal of noise made but when you look at the record you find very few things that have ever been proposed that haven't been ultimately approved.

Chall: Just within this last year or two, when they are working on the general plan, apparently.

Do you know Stephen Brandt? Do you care to comment on his activities with the League to Save Lake Tahoe?

McGauhey: I have met and talked with Mr. Brandt and am certainly in agreement with the League's objectives. I don't know that I am competent to evaluate Mr. Brandt's efforts per se because I really do not know their bounds. The League, however, has one advantage: it can take a definite point of view and persist in it. Not being, as I understand, a tax-exempt organization, it cannot be intimidated by the usual routines by which politicians quiet down organizations. One drawback, however, is that it is the voice of people who throughout the state of California believe that Lake Tahoe should be saved for man's esthetic, in contrast with his economic, enjoyment. Thus its interests are more objective than that of the developers who live in the

McGauhey: basin. The Lake Tahoe Area Council can, of course, not entirely team up with the League because it is a non-profit membership organization. Because its members include people whose financial interests are in the basin, it cannot fight its own members. That is, its continuance depends upon the retention of membership, hence it cannot take action of the type that the League might take without merely committing suicide.

The League is confronted by the same phenomena that constrain others in the Lake Tahoe area. That is, by the time any agency has accommodated two states and several counties, its composition includes the land developer, the banker who makes real estate loans, the procurer for a big investment prospect, etc. This insures that what it does may not be very radical except that it helps compound the number of approvals one has to get to do anything in the basin. The individual is confounded by the system but the big investor with a thirty billion dollar project can still make his voice heard.

Chall: Now there are two general plans, one that was laid out by the consultants which, I guess, the landowners and the South Lake Tahoe City have decided was impossible.

McGauhey: Here is the most recent general plan.

Chall: Is that Mr. Richard Heikka's?

McGauhey: Yes. Well, you see, you paint all the steep land and all the tops of the mountains green and say that represents recreation. So it makes it look like the whole basin is recreational land.

Chall: I see. But it doesn't show that it might be houses?

McGauhey: Well, it does show--along here [showing the plan], at the Incline, and over there the red lines which mean high-density residential. They don't look quite as fearsome on this chart as they do if you drive along the lake and take a look at it. Not only is the lakefront obliterated by buildings, but the appearance of these buildings is such an affront to the human eye as to warrant redefining architecture as the "cult of the ugly."

McGauhey: The Lake Tahoe basin is an area where there is a lot of work to be done and where a lot of things have not been done. It's too bad, really, that the federal government did not declare that it had authority there because the lake is interstate water. Ten years ago they threatened to do this. It's too bad that it did not. Development of the land might have been planned so that the housing was set back from the lake and left the trees and the waterfront more or less natural. But the pressure right now is to build more marinas. The pressure to get by the Corps of Engineers at the north end of the lake is for the purpose of making it possible to build a hundred more condominiums. It is not public beach. It is to provide a private marina for this many more people. So one can hardly be less than somewhat cynical if you look at Tahoe through the eyes of one who thinks of it as a national asset that ought to be maintained as something of national importance.

Wastewater Treatment

McGauhey: Some of the other consulting work that I have done has been less continuous than the Tahoe study. Some of it extends over a year or two but may only involve a day now and then. At the present time, since I've retired, I've taken on jobs in the District of Columbia.

Chall: What are you doing there?

McGauhey: This was on wastewater treatment, as a special consultant to the District, to review engineering plans as they were developed. Right now I am doing essentially the same thing on a somewhat smaller scale for the City of San Francisco.

I am also consultant to the City of Escondido in San Diego on a similar project, and a number of projects with a good many of our graduates over at Bechtel Corporation, and Brown and Caldwell, Consulting Engineers. These are specific projects on the San Francisco Bay wastewater disposal.

Solid Waste Disposal

Chall: This all has to do with the wastewater disposal treatment done around the Bay Area here.

McGauhey: Yes, all these here are in wastewater reclamation and disposal. I've done some on solid wastes with Aerojet General and with the State Health Department with their solid waste planning.

Chall: Are you getting anywhere there, with solid waste?

McGauhey: Gains are being made in the state. California is by no means in danger of being overwhelmed by solid wastes. The rhetoric is mostly political and jurisdictional. The state already leads in disposal technology. We can solve our problems quickly when the need really arises.

Chall: You've been working on that since 1956 or so, since before this Laboratory was opened?

McGauhey: Well, I've been working on it since 1951. Poking at solid wastes is an activity in which I have done a great deal of public service and research more than consulting, because there hasn't been a great deal of demand for consultants. When the demand comes it is a demand for something that nobody knows how to do [laughs] and I try to keep out of tasks I don't have any idea how to tackle!

I do have a major consulting job coming up with the state of Wisconsin on solid waste recycling, and another with a consulting firm engaged in studies for the Seattle metropolitan area. The field is beginning to open.

Hawaii

McGauhey: I am serving as consultant to the University of Hawaii on its sea grant project for coastal water quality. This, of course, may end at any time but I have been there four and a half months of the last year already

McGauhey: working on that, and some four months of 1972.

Chall: That is the coastal water quality problem. Does that have to do with sewage disposal?

McGauhey: Yes, the sewage, and raw industrial wastes, and run-off from land--the whole activity of man that ends up with increased or changed materials going into the estuaries and into the coastal waters.

Chall: Is this for the entire island chain?

McGauhey: It is for the state, but most of the work is being done on Oahu and Kauai. Although we may do some, if we get enough money, on Maui. It isn't a task that is intended to solve all the problem. It is intended to find out how to solve some of the problem. So we have taken a typical situation of the sugar industry, one of mixed agriculture, one of urban development and one of undeveloped land and made detailed studies of the land use--water quality relationships. We are measuring quality by the well-being of aquatic organisms and societies, rather than simply by laboratory analyses. We have a great number of marine biologists and ecologists involved in this project, because they abound in Hawaii and they are very sensitive to the quality of the water.

Chall: Has there been much degradation?

McGauhey: There is evidence of degradation, not all of it of a permanent nature. Loss of coral, particularly in Kaneohe Bay, which is probably the finest bay in the islands, has been attributed to waste waters. There is treated waste going into Kaneohe. Algae are growing and killing coral. Nobody is too certain what the cause is but they do know that chlorinated wastes will kill coral. They are very concerned to find out what the problem is and to solve it. They are already designing a system to go to deep water, to take the treated wastes out of Kaneohe Bay and another one to clean up Pearl Harbor by going to deep water with partially treated sewage.

There is a lot going on and they have just as many true-believers out there as anywhere. They

McGauhey: have some--what I call eco-maniacs, you know, tunnel-visioned types--that see only one answer, which would only cause another problem to come into ascendancy.

Writing and Lecturing

Chall: How come you have to write articles for Waste Age?

McGauhey: Well, I agreed to serve as an editorial writer for them until they decide whether they go broke or not. [Laughs] Maybe we won't know for a while, but I'm having a lot of fun with it. It is one of those things that I write for fun--except that generally when the times comes to do it and they name the subject--it is always something that I don't know anything about so I have to think up a whole new point of view in order to meet the deadline, and to meet the objective of that particular issue.

I have some other writing I wanted to do but I get called to a lot of these places where they want someone to give a talk, for an honorarium, and suddenly find that they won't be happy unless they have something that they can put in the proceedings. I have to write some dad-blamed thing that I had no intention of writing.

I wrote one on solid wastes for the 1972 Yearbook of Science on the Future of the Encyclopedia Britannica.

One area of interest that has carried over from my pre-retirement days is that of presenting seminars or special lectures to graduate students and faculty members at other universities. This is a part of the academic scene everywhere. It is related to consulting in that it pays a modest honorarium plus travel expenses within the usual university's limits. It is related to teaching in that it brings to the audience a different point of view or some new information. The system works in academia in this fashion. A university department sets up a seminar series for

McGauhey: its graduate students and faculty, with some general theme. It then identifies people who might have something to say on particular subjects. The next step is to write a letter inviting each individual, including the stock phrase, "I am sorry that we cannot offer you a proper consulting fee for this, but we can offer you a modest honorarium of X dollars (usually $100 or $150) and reimburse you for out of pocket travel expenses." Sometimes it is thought well to add a few remarks about the glories of the surrounding area in the spring or fall, or in whatever season the talk is to take place. We do a lot of this in the academic world; sometimes getting off with just buying the speaker's lunch if we are smart enough to catch him in the area. I continue to do a considerable amount of this although I have no longer any way to return the compliment.

Chall: On what topics do you lecture?

McGauhey: I am not particular--I will talk about anything they wish. Generally, however, they check to see what is on my mind that is pertinent to their program, and we work out, by phone, which of several topics might be of most concern to the group which is to be addressed. Sometimes I speak on such matters as solid waste management, water reclamation, leaching from dumps, engineered soil systems, or some other topic of current engineering interest. Sometimes, I talk about man and his environment from one or another point of view. Often it is about what we should expect of education in the future; or on how to bring numerous disciplines into environmental design of public works. I enjoy most talking about sujects that force me to use my imagination, to generate a new idea and to apply what I know (or believe at the moment) about the habits and foibles of man to either the absurdities or the opportunities that surround his quest for environmental quality, improvement or resource conservation. I prefer to discuss ideas that as far as I know have not been previously explored.

Curriculum, Research and Other Matters

Chall: What about your work last year for the Chancellor? [Roger Heyns].

McGauhey: To answer that question in a manner that has any meaning to the person who might some day persist to this point in the record of our discussions during the past few days, I think I should state briefly what this work was all about, expecially the need for it. I am sure you recall that about two years ago environment suddenly came up as the buzzword of the moment. At that time we had a considerable peaking of the notion that the University should be an action-oriented, or perhaps an activist camp. Students were impatient with the task of learning. They wanted to solve, within the University program, the problems of the moment without going to all the trouble of learning how to solve problems. I contended in many of those public and university lectures that I spoke about a few moments ago, that should the University devote its attention to solutions to the crisis problems evident at the moment our programs would be futile.

My reasoning was that by the time the student got out into the real world equipped to cope with aluminum cans by the roadside, we would not be utilizing aluminum cans. His how-to-do-it knowledge would be useless. Meanwhile, back at the campus another generation of students would be learning how to attack the crisis of that moment. Furthermore, the rate of onset of imagined crises was such that no student could finish his program before the crisis that he was learning to face had been replaced by a succession of at least three others. In any event our graduates would be in a how-to-do-it educational effort far more viscious than the old how-to-do-it courses we traded in for humanities and science, because he would be forever obsolete at the moment of his graduation.

Obviously, if a university program was to be worth support by public funds it should teach students the basic principles by which one attacks problems; the reasons why people behave like they do--or at

McGauhey: least how they behave; some economic, political, and technological facts of life; and so on. In this manner we would continue to turn out graduates who could attack any crises that comes along and so make some contribution to man's social and cultural advancement. Although this might be reactionary in the sight of students, I contended it was the purpose of a university to provide such an education. If the individual wanted at once to pick up cans, let him apply to the highway department for a job, and not fool around marching up and down demanding that the university initiate a curriculum in can collecting.

So my contention was that the student who wanted to be active in environmental studies would have to acquire the discipline and the basic information necessary for solving problems, most of which were not at the moment identified. However, I contended the student should have the opportunity to learn from the very beginning of his program what relevance the tools he was acquiring might have to environmental management. Moreover, he should have some time to work in projects which kept his interest in environment alive. That is, he should not be told, "Just go ahead and learn the basic foundamentals of problem solving, and then some day you can get at some problems." Thus it was my belief that the interest of the individual student should be nurtured by his program, thereby heightening his ability to confront whatever succession of crises he might encounter in the future. Further, I contended that the opportunity for a student to apply his knowledge to environmental problems should exist in every department, but it should not constrain another student in the same department from pursuing a similar interest in design, research, or pure self development.

Paralleling the student insanity to which I refer, every department of the University suddenly discovered that it was the true center of gravity of environmental concern. Thus each wanted to initiate some kind of a program of environmental studies. Some departments found this more appealing than others because they had in fact outlived their usefulness, were running out of students, and so were in need of some gimmick to insure their continuity. These

McGauhey: departments were particularly anxious to get on with environmental programs and to capitalize on the wave of student desire to leave off learning for participation in some mass project which I have likened to can collecting.

Interestingly, but not surprisingly, the most insistent of the departments desirous of taking over environmental studies were those which had the least context in terms of basic principles of problem solving, and who dreamed that only by destroying the structure of the University and substituting some entirely new "innovative" approach could man cope with problems of his environment. The concept was that by creating "generalists" in environmental studies great leadership would accrue to those who understood everything but could do nothing.

With the financial constraints on the University becoming increasingly damaging, and some student interest remaining in producing the systems and the scientific know-how to achieve environmental goals, the Chancellor's office thought it desirable to look into the situation and to evaluate the role of the University in environmental studies. Obviously, the major objective of each department could not be its own version of something called environmental studies.

It was in this situation that I spent six months working half-time for the Chancellor to find out just what was going on within the Berkeley campus and to report my findings to him. I did complete the study and turned my report over to the Chancellor with the recommendation that it be reviewed and refined by the University. At that point we changed chancellors. The new Chancellor, Albert Bowker, was, of course, quite busy and as far as I know never got around to looking at the report. But some copies of it were distributed by his office to people on the campus who were interested in the program of environmental studies. The report was intended to show, and did show how the University could use the strengths on which its reputation was built in achieving the environmental education goals of any student without encroaching on the educational goals of any other student.

McGauhey: I suppose it was disappointing to some in that it didn't recommend dismantling the University summarily in order to cope with the first buzzword in the sequence to come. But what it proposed is very much what has developed at Berkeley and in other universities which went through the same soul searching. Berkeley was by no means the only place the student and departmental proposals to save the environment documented the child-like naivete of which we in universities are capable.

In the report I also spoke to the point of research, first how we might get greater visibility for the University for what we are already doing, by interpreting it in an environmental context, and how we might deliberately keep up a program of information that would cause the public and the legislature to realize the extent to which we are involved in environmental management. I suggested that the results of our vast output of technical reports might be interpreted in understandable language and utilized to the benefit of the University and the public.

So having finished my report I had completed my agreed assignment. Possibly I could have stayed on but I didn't want to take on the actual management of any program. It is a big enough job to tell people how to run their business, without having to go in and run it!

Chall: [Laughs] Leave it at that.

This wasn't a unique kind of assignment for you because you had been working for a number of years on a project like this.

McGauhey: I had done that kind of thing before; analysis of an overall situation. In fact I finished one a year or so ago on evaluation of the policies and activities of our Water Resources Center.

Chall: Yes, I've read that--at least the little brochure that they put out about various types of research that are now being recommended.

McGauhey: That was our committee report. I wrote a companion report myself, which I believe really had more effect than the one our committee finally put out. When committees start doing things the rhetoric generally gets loftier and loftier as times goes on. Eventually it becomes so obscure that it doesn't really say very much of anything to anyone who doesn't already know what it is you are talking about. I believe that the second version of our report was far better than the final one as far as telling anybody what was on our minds. You might be interested in it. I'll give you a copy if you are.

Chall: I'd like that.

McGauhey: Then I had done some work for Utah State University, not as extensive as at Berkeley, but in advising them on educational programs; on organizing programs in the environmental area and in the water resources area. They ended up by hiring two of our staff to do some of these things and gave me an honorary Doctor of Science [laughs]. It is about all the reward you could possibly expect for that sort of activity.

Chall: Saying, as you do now, that dealing with water just one facet of the problem and maybe the most minor facet, because what happens on the land is so very important, then I imagine that the thing that you have to do is bring into the field people in other disciplines--in agriculture, in geography and forestry.

McGauhey: This was the case in preparing this proposal for the University of Hawaii. Here we had fourteen professors in ten disciplines involved and we met every week for awhile there while preparing the proposal. To get proposals out of a team of professors you must write the proposal yourself. I did this, then I sent it to each individual with a note: "Here's what is going to appear in your name if you don't correct it." Obviously I don't know all about everything so I put the experts in a position of having to produce or appear pretty ignorant to their own peers. But by setting the framework it took a load off the busy professor. He had only to correct my version and the proposal was ready. It worked out

McGauhey: very well. The result was an organized multi-discipline approach and, I think, a fairly unique kind of a proposal. At least it was enough of a tear-jerker to get us some money at a time when prospects were far from hopeful.

Chall: You look back and it's all been exciting you've told me. No one thing stands out as more exciting than another?

McGauhey: In considering that question I am reminded of Mr. Smith, the gardener in charge of a rose garden of some three thousand varieties at Virginia Polytechnic Institute. When asked by a visitor which rose he thought most beautiful, he replied, "The last one I looked at." I think I can say in good conscience that I have never had anything to do that I didn't find interesting. The trouble was that there were so many interesting things I didn't have time to get around to exploring!

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APPENDIX

TO RAISE A CAT

by

P.H. McGauhey

Dr. Bjerstein was on his way to the faculty club to play a few hands of gin rummy and have his lunch before going home for the afternoon when the idea first struck. Bjerstein was a behaviorial scientist whose flair for inconsequential research had won for him considerable stature among his peers. Thus it was not unprecedented that the vagaries of his mind should lead him willy nilly into the realm of scholarly creativity. If his memory was no more imperfect than the professional norm, the article had appeared in College Humor magazine about the middle of the nineteen twenties and was entitled "How To Raise a Cat". With good economy of words, as the professor recalled, it directed: "Go into the nearest alley and find a cat. Bend over. Grasp the cat by the scruff of the neck with the left hand and by the tail with the right hand. Straighten up."

Dr. Bjerstein brushed aside any residue of a sense of humor which he may have had as a youth, or of the ridiculous which may have colored his mature judgment, because he was interested in the cat rather than in the situation. He postulated that the feeling of wellbeing lurking in the creature's subconscious since the days when it was carried about by the scruff of the neck by its mother would essentially offset the traumatic memories of being hoist by the tail by a brat whose parents thought every child should have a pet and so learn to be kind to dumb animals. If this surmise proved correct the cat's legs would hang straight down and there would be no preceptible change in the animal's heartbeat.

The consequence of incorrectness of such a postulate were not considered by Professor Bjerstein because by that time he had reached the door of the faculty club and had to consider where he might have left his keys.

Dr. Bjerstein did not immediately get on with a research proposal. He was not a man easily deflected from his normal routines. Besides he had to lead his graduate students in a window-smashing assault on the President's office; then participate in a long series of faculty senate meetings to consider whether the administrative tongue clacking that followed the incident constituted a violation of academic freedom. Consequently the deadline for submitting proposals caught Dr. Bjerstein somewhat unawares and his request had to be put together in a rather hasty fashion.

In order to tailor the project to the time scale of a doctoral dissertation, and to the elastic limit of most granting agencies, Dr. Bjerstein requested support for a three-year period. His budgetary computations began with a stipend for one graduate student. But then the Department was short of stenographic assistance so he included a full time secretary. This made necessary appropriate office furniture and, for some curious reason, two electric typewriters. Computer time and programming services being necessary to assure the grantor that the investigator is abreast of the times, Bjerstein included these items also. When it came to "Travel" he remembered the Society's January meeting in Majorca and so upped the cost of "attendance at scholarly meetings" to three thousand dollars. By this time the first year's budget totalled some $108,000, plus appropriate overhead to the University to cover the confusion in accounting generated by scholars such as Bjerstein.

After a period of bureaucratic gestation during which one typewriter was deleted and travel funds were reduced to one thousand dollars per year, the granting agency approved Dr. Bjerstein's project. However, there was some disagreement in the reviewing committee which was compromised by allowing only two years of support. As often in the case of academic research these two years passed unveventfully. Bjerstein attended several scholarly meetings; the secretary tidied up his normally chaotic desk and looked after his personal correspondence; and the graduate student made a search of the literature. Unfortunately as the end of the grant period approached he had not yet located the original reference which had inspired Dr. Bjerstein that day on the way to the faculty club some two years previous. Obviously, if the good professor's theory was to be evaluated experimentally the project must be renewed and extended. To this end Dr. Bjerstein turned his attention as the project had now become a comfortable habit - and the thought of losing the secretary was a bit frightening.

By this time, however, the research climate had changed significantly. The University was gung-ho for multidiscipline projects; national priorities had turned from the gentle dreams of academicians to a virulent concern for problems or urban blight, degredation of the environment, and, so as not to overlook anything, to something called ecosystems. To these new constraints Dr. Bjerstein turned his attention; and with such delightful results that he marveled that he had not thought of them sooner.

If there be an alley, he reasoned, there must exist within the city an old degraded neighborhood. Subdividers and builders have not included alleys for a quarter of a century. Obviously the city is long overdue for urban renewal and the research team should therefore include a city planner. Moreover, the presence of a cat in the alley could only mean that the place is infested with rats and mice. If there are rats and mice, there must be rubbish. If there is rubbish, culturally deprived people must live there. Unquestionably the whole place is a ghetto, occupied by frustrated men and women deprived of civil rights, overwhelmed with poverty and despair, ripe for communism, and with no recourse but rioting to bring their plight to the attention of a callous Establishment. The prospect was enough to incite Dr. Bjerstein to break every window in the university. But that would have to wait until renewal of the project was assured. He would need a city planner to renew the housing; a public health specialist to deal with the rats; an engineer to cope with the rubbish; a sociologist to deal with the people; a political scientist to fend off the communists; and, of course, Dr. Bjerstein himself to observe the reactions of the cat.

This time Dr. Bjerstein had the perfect proposal. His project was sufficiently multidisciplined to delight the University. It had all the factors of poverty, crime, and urban decay needed to give it national priority. And it cost 1.5 million dollars for three years. Thus it was expensive enough and absurd enough to be attractive to the major foundations. How could he lose?

The answer was unexpected both by Dr. Bjerstein and the academic world in general. By the time the new proposal by Bjerstein et al had cleared the University hurdles, the national scene had undergome a further change. The plight of cities, the rise of crime, and the restlessness of poverty, it was reasoned, had grown to critical dimensions in spite of years of research. Action; construction; demonstration of new systems were now in vogue and research had declined in prestige. Besides the nation had elected to fight communism overseas. This proved so costly that it was no longer possible to fight it at home - at least not through multidiscipline research.

Dr. Bjerstein had to be satisfied with a mere $10,000 and a one-year extension of his project in which to carry out its important experimental phase -- to raise a cat.

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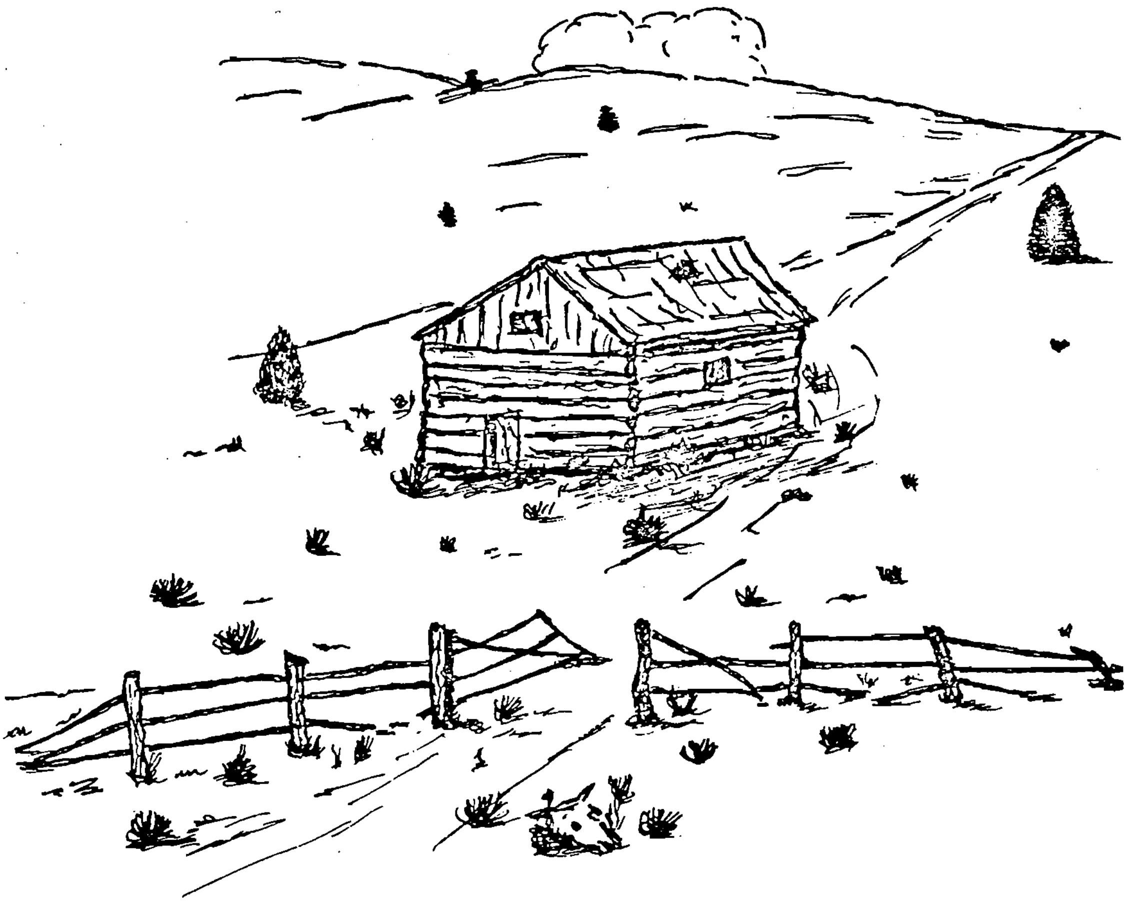
February 1974

Early in life I developed a love for poetry and during my college days spent many hours in the library reading classic and contemporary verse. In those days, which most of the people alive today might consider as predating the dawn of mankind, the Waring Blender had not been invented. Therefore poetry was still somewhat structured and more often than not conveyed some impressions of life to the reader, or at least persuaded him that the poet in some manner had a depth of perception of the subtleties of nature and the emotions and vicissitudes of mankind. Of course, there was some attempt to randomize words or to symbolize non-thought in terms of non-language, but the technology for producing "poetry" by dropping Webster into the blender did not exist. My first attempts at verse go back to high school days and a recent encounter with some old high school annuals reveals that more of it got into these annual publications than I remember. Thank goodness, the publications no longer exist. They did show, however, that in verse as well as in other aspects of my life I was quite highly disciplined--a bad approach to poetry.

I long ago ceased to designate my writings as poetry, preferring the word "verse" as being less presumptive and better for the ego than "doggerel". In the two examples which follow I say something I wanted to say, in the way I wanted to say it. Others may classify them as they choose.

Pioneer



He came with bull-tongue plow and grubbing hoe
To clear away the crop the Lord had sown;
To make a field with tilth and ordered rows;
To make a spot on earth to call his own.

Sagebrush and juniper and needle grass,
Greasewood and rabbit brush and creosote,
Succumbed to sharpened steel and searing fire,
That earth each year might wear a greener coat.

The new wife brought a cow with suckling calf,
A rooster and a half a dozen hens -
The wedding gifts of uncles in the east
Who settled where the arid west begins.

By sweat and toil he prospered for a while;
All life bore fruit, and blessings multiplied;
But speeding years outraced ambition's scale;
The subtle hand of Time reversed the tide.

An ox that weighed a ton stepped on his foot.
A falling timber broke his collar bone.
So opened avenues to aches and pains
By which impending weather change is known.

The red rust came to take the bull-tongue plow.
Microbe and insect lurked in post and rail.
The barn grew weary, leaning all awry,
As joist and rafter sagged as if to fail.

The children grew, and wed, and moved away.
He sold the stock and harness when they'd gone.
A sheepman bought the land, but left the house
And let the pioneer and wife a while stay on.

I think the Lord admired this rugged soul
Who fought him for the land men thought was free.
He sent his tares to take the field away -
But let the old man die with dignity.

THE BRAVE AND STRONG

He who climbs the highest mountain
Feels no need to seek the pass.
He who conquers creeping glaciers
Must disdain the dark crevasse.

He who stalks the lurking tiger
Discards the wisdom to beware.
Who defies the restless ocean
May neglect to say a prayer.

Who must show the world his courage
Seeks his own respect to win.
In the Valley of the Shadow
I have walked with braver men.

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In a world surveyed by flying saucers in periodic waves we are not surprised to learn of a report produced by a process of apparition and prepared by an observer from Laputa. Readers who are so inclined are invited to comment on these observations or perhaps to rebut them.

ON THE NATURE OF PUBLIC HEALTH: A PREVIEW OF LITERATURE

P. H. McGauhey, M.S., F.A.P.H.A.

"STUDIES on the Physical and Psychological Structure of the Nuclei of Certain Conceptual Systems Existing on an Obscure Minor Planet, and the Mechanism of Their Creation."

Under this somewhat ponderous title there has recently appeared* a report which because of its pertinence, or impertinence, seems worthy of our attention. Its author is an ultra-scientific observer from somewhere in ultra-space about whom little is known beyond the fact that unusual qualities of mind enabled him to analyze conceptual systems in a manner such as atomic physicists might apply to physical systems; and an inordinate curiosity led him to direct his attention to certain aspects of human affairs. Unfortunately the report is written in a language nobody can read, hence it is reviewed here necessarily in imperfect form.

Communities

Our observer reports that while idly scanning a minor planet generally conceded to exhibit no characteristics of interest to the serious ultra-scientist, he came across what at first appeared to be relatively formless conglomerate masses within a matrix or universe of pseudo-reality. On closer observation, however, these masses exhibited enough structural similarity to suggest that there existed some degree of order which was recurrent in each of the psychological blobs. To describe these blobs the scientist coined the word "communities" and employed a modern artist, who specialized in attempts to express non-dimensional psychological matters in graphic form, to prepare a lantern slide which might be useful later in lectures before ultra-learned societies. It looked somewhat like Figure 1.

The Public Health Organization

Intrigued by his preliminary observations, the ultra-scientist began to examine in detail the structure of the community. He found it to consist of a whole series of conceptual systems linked together in a sufficient variety of forms to suggest a random, rather than a systematic association. Like any good scientist, Dr. Ultra vowed to explore each of these submolecular systems as soon as they could be classified and financial support developed. He was particularly intrigued, however, by one peculiar submolecule which seemed to appear at the heart of each community system essentially always in the same

* By process of apparition.

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