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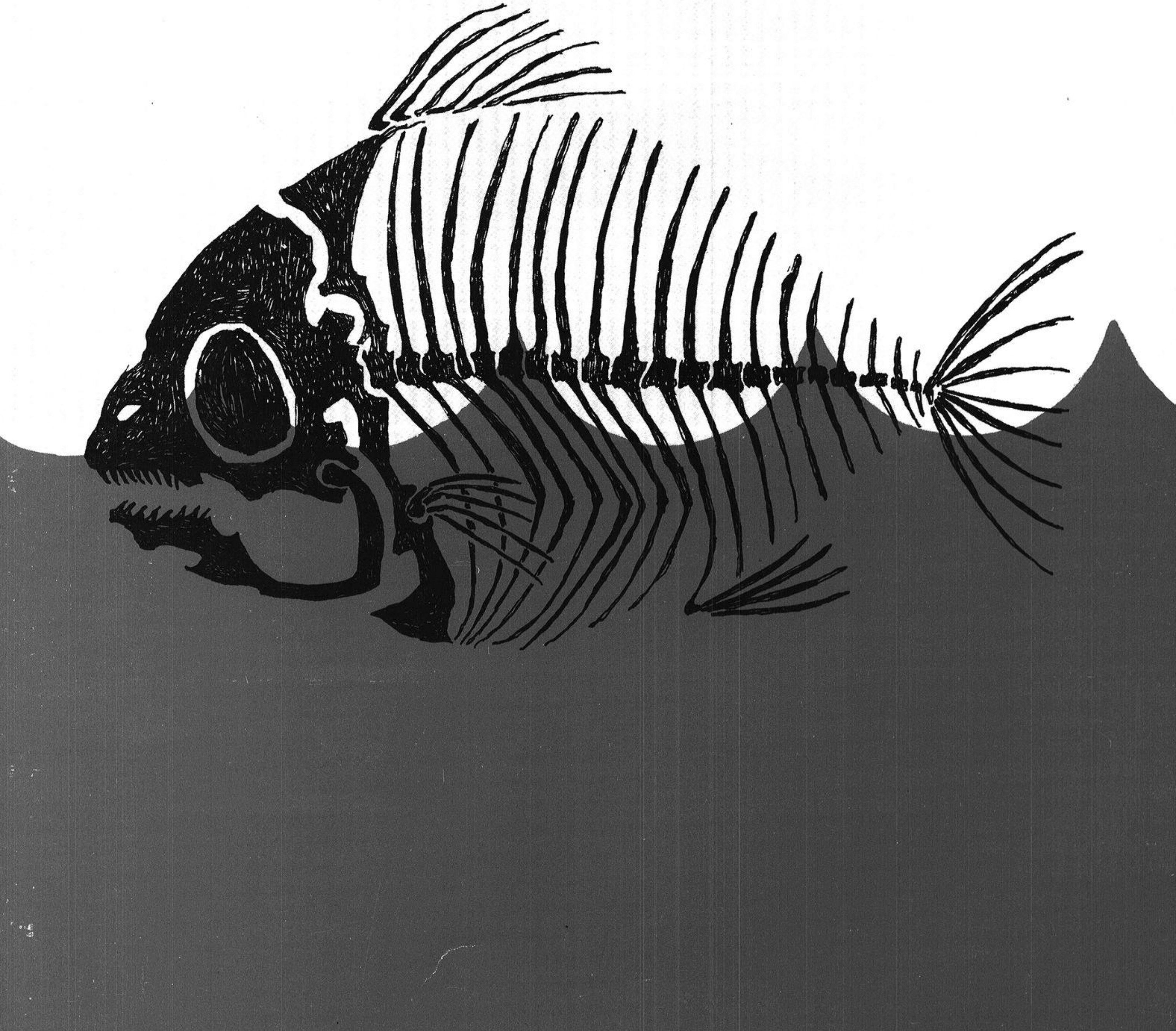

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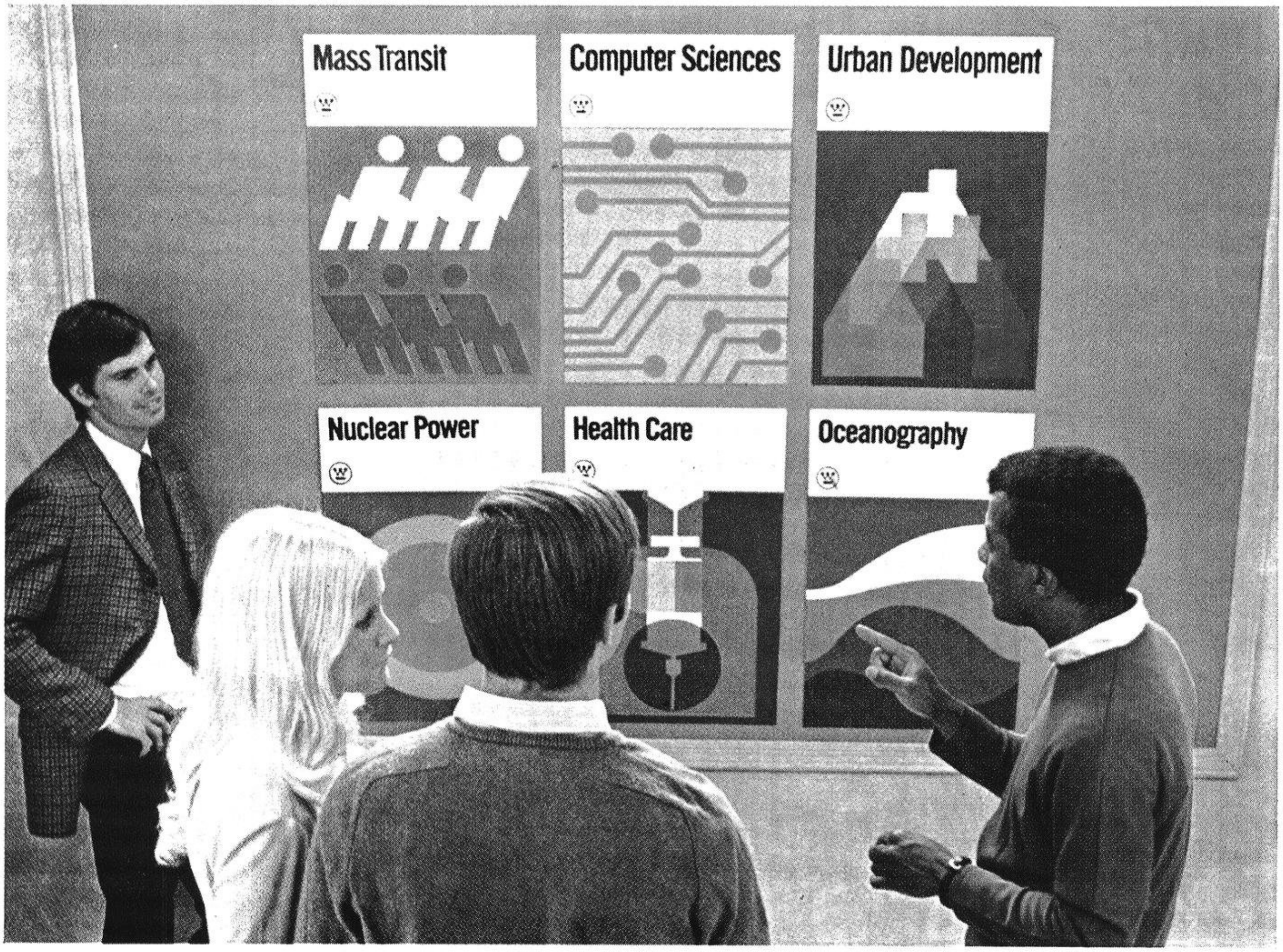

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"We are drifting toward a catastrophe beyond comparison. We shall require a substantially new manner of thinking if mankind is to survive." – **(Albert Einstein)**

CONTENTS:

wisconsin engineer

Our apologies to Professor Gaggioli for failure to recognize him as co-author of "The Elements of Successful Study in Engineering" with Professor Obert in the October issue. Professor Gaggioli is now Chairman of the Department of Mechanical Engineering at Marquette University in Milwaukee, Wisconsin.

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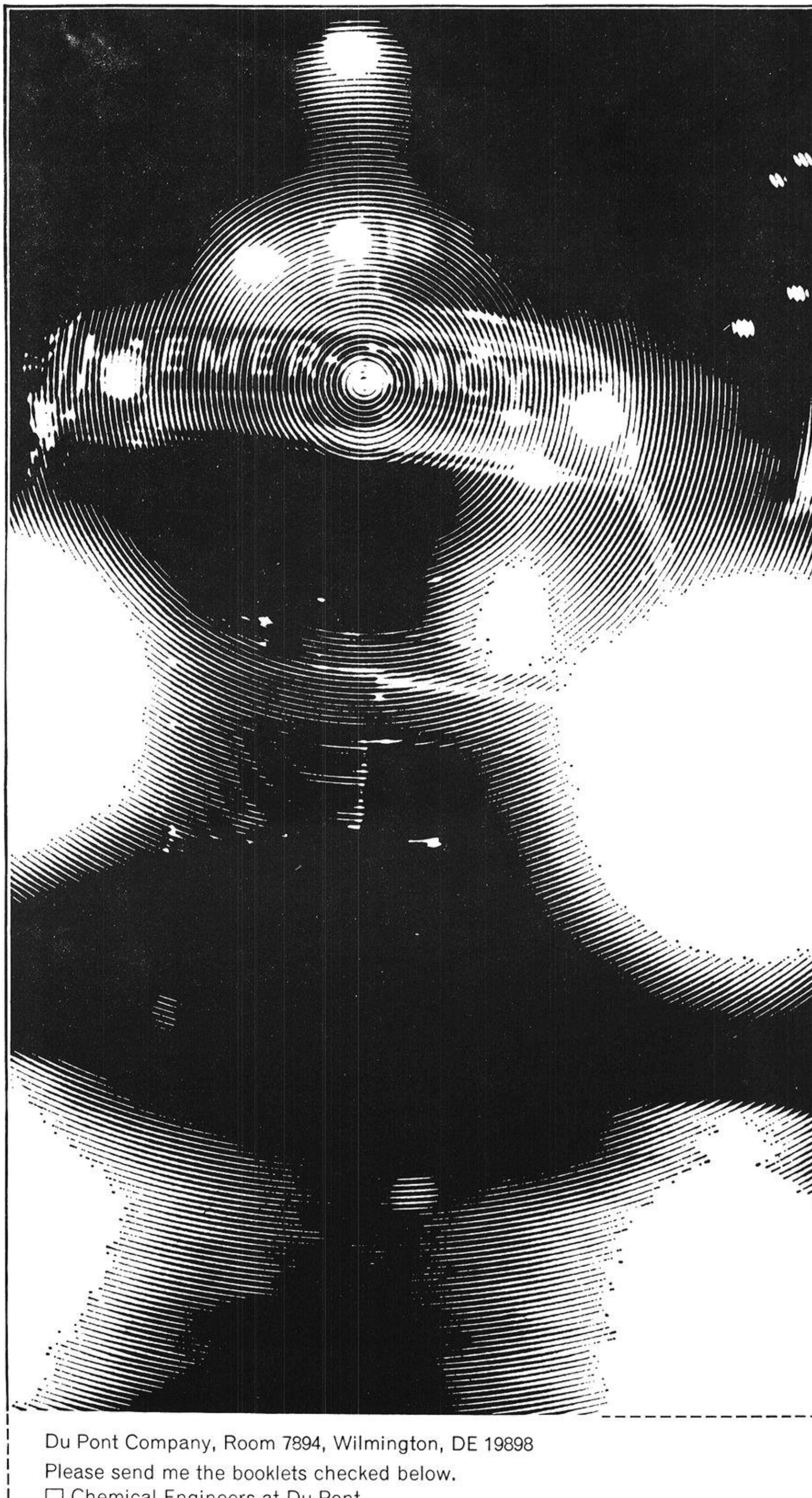

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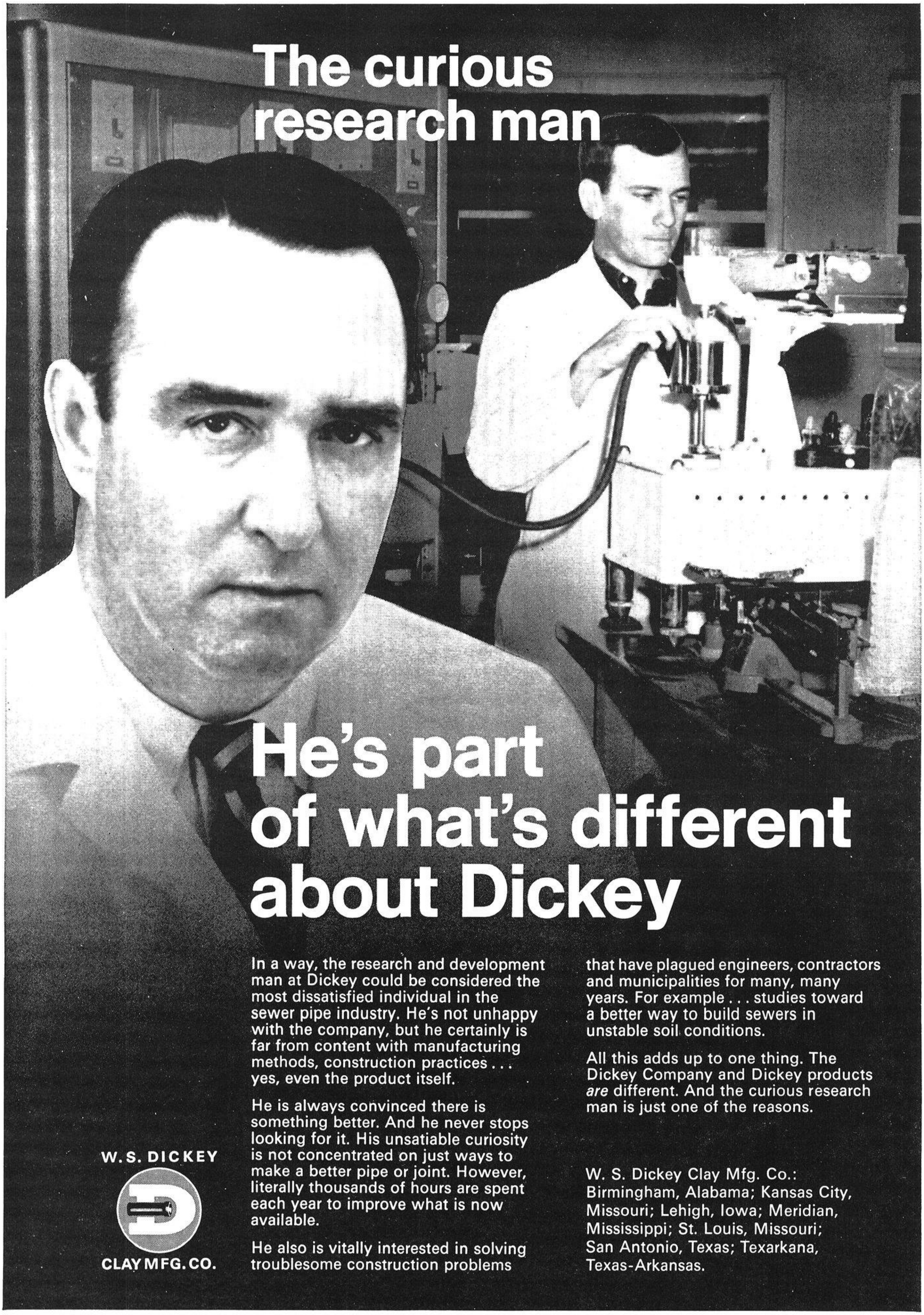
The curious research man
He's part of what's different about Dickey
In a way, the research and development man at Dickey could be considered the most dissatisfied individual in the sewer pipe industry. He's not unhappy with the company, but he certainly is far from content with manufacturing methods, construction practices . . . yes, even the product itself.
He is always convinced there is something better. And he never stops looking for it. His unsatiable curiosity is not concentrated on just ways to make a better pipe or joint. However, literally thousands of hours are spent each year to improve what is now available.
He also is vitally interested in solving troublesome construction problems that have plagued engineers, contractors and municipalities for many, many years. For example . . . studies toward a better way to build sewers in unstable soil conditions.
All this adds up to one thing. The Dickey Company and Dickey products *are* different. And the curious research man is just one of the reasons.
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The University and "The Survival of Man"

The population bomb is ticking away, each tick a nail in our collective coffin.

The balance of terror teeters on its fulcrum of old psychoses.

The races, like weasels at one another's neck, are bleeding society of any meaningful existence.

Pollution threatens to exterminate man in and with his own waste.

Faculty documents No. 279 purports to change the purpose of the University from "The Search for Truth" to "The Survival of Man."

A noble task indeed. And quite belated. It is better than never, though, and in this case the emphasis is on never. Yes, the Industrial Revolution hath wrought some very bad things. The task now is to reverse the process, to make right the wrongs of man against man. "What could be more logical, a more common thing," say the learned men, "than to make the University — the center of all learning — the nucleus of the war to survive?" "Yes," replies the student, "what could be more learned?" A noble task indeed.

Honest and active pursuit of that task remains to be seen.

JERRY GOTTSACKER

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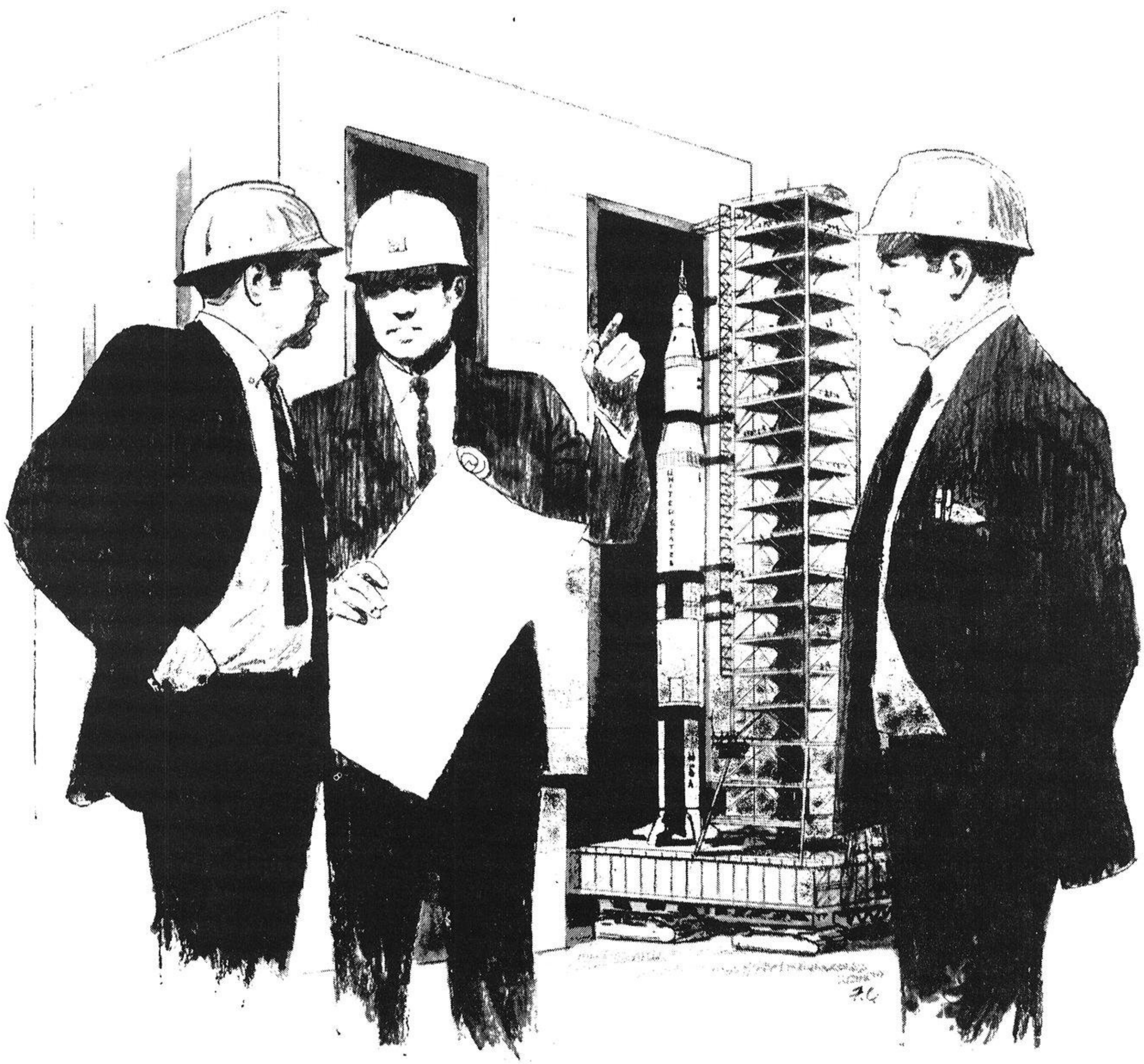

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TALKIN' TECHNOLOGY BLUES

Anita Levin

Engineering students representing each of the Big Ten colleges, Michigan Technological University, the University of Iowa, Marquette University, and the University of Wisconsin-Milwaukee, will attend an engineering student conference sponsored by the University of Wisconsin Polygon Board January 31. The major topic will be the engineer and his responsibility in this technological society.

In previous years, the concepts of effective student group organization and structure have been discussed at similar conferences. In this conference, however, in addition to the usual leadership and organization discussions, the engineering students will concern themselves with the direction of engineering education in regard to the modes of learning, student-teacher relationships, interdisciplinary studies, the objectives of an engineering education, and engineering student activism.

That technology, society, and the engineer can cooperate to produce a better quality of life, will hopefully be a central issue of the conference. Resolution of possible conflicts between company loyalty and societal responsibility will be another area of discussion.

The engineering student's increasing awareness of his role in solving world problems will be represented in an intensive discussion of the environmental crisis. The ecological effects of pollution will be defined with an emphasis on what the engineer can and should do. The conference, one of the largest ever held, has projected itself into areas of increased social concern, a long overdue direction for engineering students.

BIG TEN ENGINEERING CONFERENCE

Friday, January 30, 1970 –

Registration: Main desk, Allen Hall	5:00 p.m.
Evening Meal: Allen Hall	6:30 p.m.
Fireside chat about Conference: Main Lobby, Allen Hall	7:30 p.m.

Saturday, January 31 –

Breakfast: Allen Hall	8:30 a.m.
Group Session I: Memorial Union	9:00-10:30 a.m.
Group Session II: Memorial Union	10:30-12:00 a.m.
Lunch: Plaza Room, Union	12:00 noon
Tour: Engineering Research	
Group Session III: Union	2:00-3:30 p.m.
Group Session IV: Union	3:30-5:00 p.m.
Closing Remarks and Buffet	5:30 p.m.

Each Group Session will consist of five groups of twelve persons each. We will have source people available on each topic.

The Sludge Disposal Problem of the

MADISON METROPOLITAN SEWER DISTRICT

PROF. W. J. BLAEDEL

Dr. Blaedel, coauthor of **Quantitative Analysis**, *earned his Bachelor and Masters degrees from UCLA. After acquiring his Doctorate from Stanford in 1942, Dr. Blaedel taught at Northwestern University, worked on the Manhattan Project, and at the Lawrence Radiation Laboratory. He has been teaching chemistry at the University of Wisconsin since 1947.*

Controversy has surrounded the Madison Metropolitan Sewer District (MMSD) and its relation to our lakes and water supply since its creation in 1930. Laws have been blocked, passed, amended, and repealed, and associations have been formed and dissolved. (Clean Lakes Association, 1931, stated that its first job was to clean up City Hall.) Studies have been made and mistakes have been made that have become textbook examples. Most of the controversy raged around the disposal of the large volume of clear effluent output of the district sewage plant. Strangely, the problem of disposing of the dirty effluent - the sludge - has been virtually ignored, which has led to a monstrous environmental offense whose continued neglect is inexcusable.

Figure 1. The Digested Sludge Effluent.

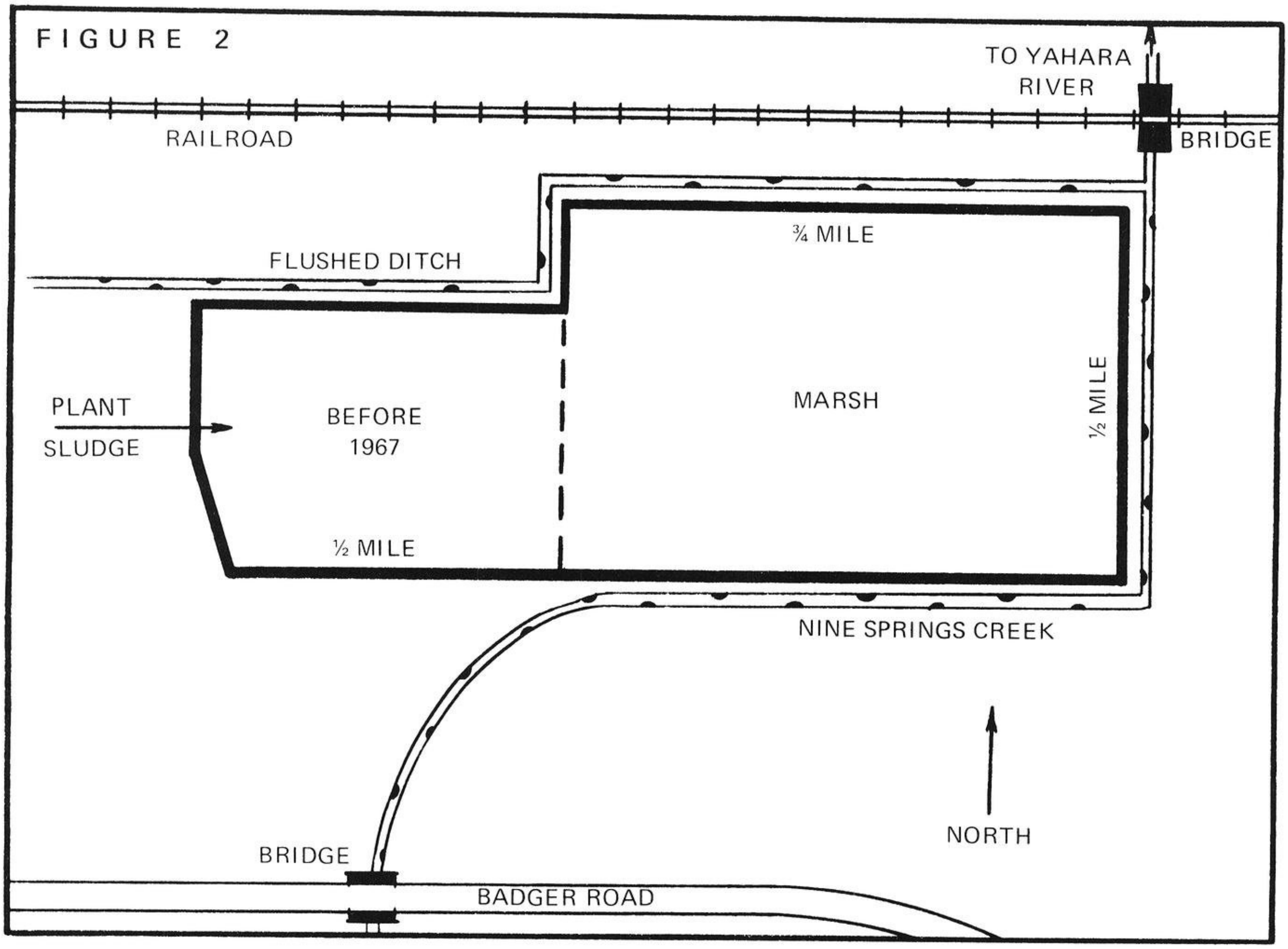

Figure 2. Sludge Disposal Area. (Schematic — Distances are approximate.)

Sewage Treatment at the Nine Springs Plant of the MMSD

Many people have only a vague idea about sewage disposal, so it is important to describe the process. The raw sewage is first passed through settling tanks to remove coarse particulate matter, and thence to activated sludge tanks where organic material is oxidized by aeration in the presence of aerobic bacteria. Processing is automatic and there is no significant odor nuisance. The aerobic bacteria feed on and remove 90-95% of the suspended solids, and are in turn removed by harvesting. The supernatant liquid is quite clear of particulate matter. It is chlorinated to kill residual bacteria, and is then led via underground pipe, open ditch, and Badfish Creek into the Rock River about 20 miles to the South. This is the clear effluent (30 million gallons per day) from the sewage processing plant, no worse in quality than the Rock River into which it is passed. Until the middle fifties, the clear effluent was pumped into the Yahara River, just above Lake Waubesa, the fourth lake in Madison's chain of five lakes. At that time, however, the residents of downstream lakes Waubesa and Kegonsa forced diversion of the effluent around their lakes and into the Rock River.

The harvested activated sludge bacteria also present a disposal problem. They are first digested in large tanks at elevated temperature to give carbon dioxide and methane, a gas which is burned, and a residual digested sludge, a black viscous liquid. This dirty effluent contains about four percent solids and is rich in organics and nutrients (phosphorus and nitrogen). The digested sludge, hereafter called sludge, is dumped indiscriminately right on the marshy ground to the east of the sewage plant. The volume is large, about 150,000 gallons per day, which amounts to about 20 tons of solids per day! Figure 1 shows the sludge flowing from an eight-inch pipe at a typical rate.

Many ways of processing sludge are known and are being used that are better than this way of dumping, and that are within the capability of a city like Madison. There is no excuse for this present method of dumping.

The Sludge Disposal Area

Somewhat over half a square mile is used for dumping the sludge. The perimeter of the area is lined with low dikes that support maintenance roads, as shown schematically by the heavy lines in Figure 2. Nine-Springs Creek has been diverted to flush the south and east sides of the area, and an artificial ditch flushes the north side.

Figure 3 shows the nature of the dumping area during June, looking northeast from the point of

Figure 3. Sludge Disposal Area During Summer.

sludge entry. Figure 4 is an aerial view in January, to show that the sludge flows all winter. Figure 5 is an over-all view, showing the sewage plant and point of sludge entry in the lower left quadrant. The marshy area before the roads were laid on the dikes is shown slightly above center. Drainage is very obvious toward the Yahara River and Lake Waubesa, shown in the uppermost part of Figure 5.

The sludge level inside the dikes stands at 3 to 6 feet above the water levels in the flushing streams, as shown in Figure 6, photographed before the road was laid upon the newly-formed dike along the north side of the area. This head of water guarantees good seepage from the sludge area into the ground water and into the flushing streams which run into the Yahara River and Lake Waubesa. Flushing by the streams occurs along a front of about three miles!

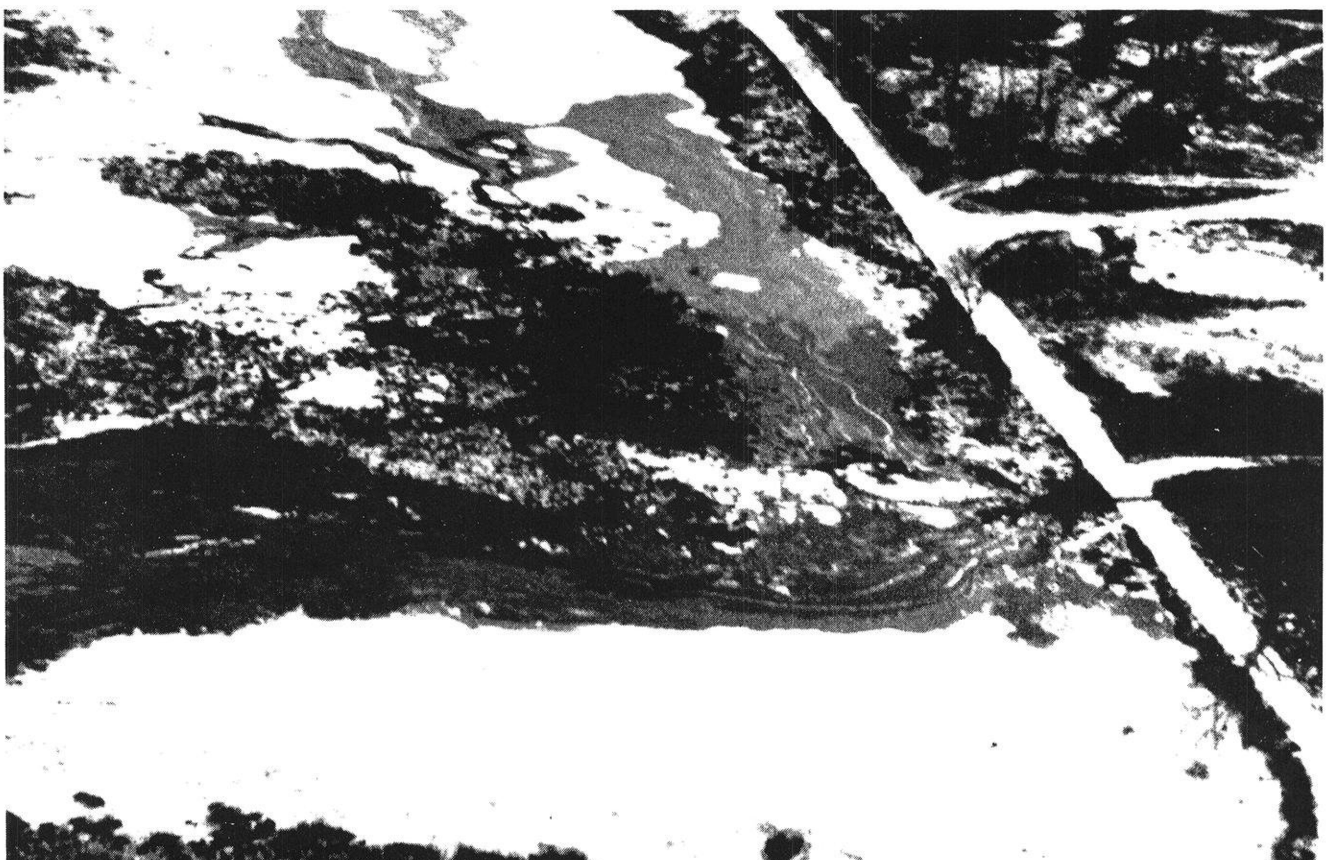

Figure 4. Sludge Disposal Area During Winter.

Figure 5. Over-all Aerial View of Sewage Plant, Sludge Disposal Area, and Lake Waubesa.

Nature of the Offenses

It is ridiculous to think that the sludge from a community of a quarter million people can be dumped into a small, concentrated region without ill effects. The thousands of tons of sludge solids that have been heaped into this area over the decades of use have built up a reservoir that must affect the waters passing through this area on their way downstream. A recent report (Reference 1) strongly suggests that this dump area is a cause of high concentrations of chloride, sulfate, and phosphate that were found in the waters of Mud Lake, a small lake on the Yahara River which marks the entrance of Nine-Springs Creek just above Lake Waubesa. The nutrient dump of the MMSD may contribute significantly to the problems of the two downstream lakes, Waubesa and Kegonsa.

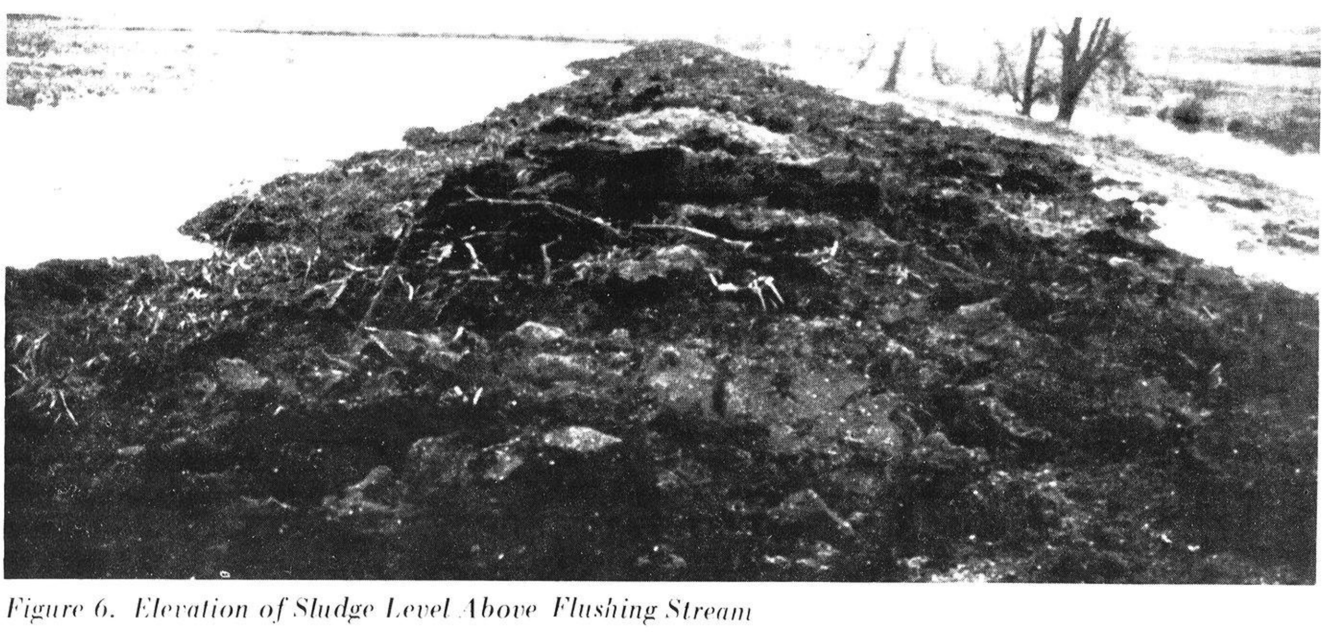

Figure 6. Elevation of Sludge Level Above Flushing Stream

Before 1967, the sludge disposal area was only about a third of its present size. (See Figure 2.) The capacity of this small area had been exceeded for several years. There was constant breakthrough and leakage of the sludge into the marshy area, which didn't have dikes around it, with resultant direct leakage into Nine Springs Creek. During 1967-8, the dump was expanded greatly by appropriation of the marshy area.

Such appropriations are specifically what Wisconsin's important Water Resources Act of 1965 (Reference 2) was designed to prevent. This act gives strong regulatory and enforcement powers to the Department of Resources Development, for the purpose of protecting navigable waters and their shorelands against pollution (Sec. 42.144.26) and conserving them. Shorelands are defined as lying within 300 feet of a river or stream or within 1000 feet of a lake, pond, or flowage. The distance between the sludge inside the dikes and outside flushing streams that flow into the Yahara River ranges between 20 and 200 feet. If the appropriation of this marsh for sludge in 1967-8 did not directly violate the letter of the law in the 1965 Water Resources Act, it certainly violated the intent of that act. Lastly, the MMSD is breaking on a massive scale the State Board of Health laws on private sewage disposal (Reference 3), which say that, ". . . . sludge shall not be disposed of into a lake, stream, ditch, or dry run or be deposited within 25 feet of such watercourses." There are many places where the sludge comes within 25 feet of the flushing ditches. Figure 7 shows several such stretches. The MMSD has set itself above these laws, and dumps the sludge of hundreds of thousands of citizens against the law and in a way that is prohibited for the individual citizens themselves. This is a most pathetic example of the widely practiced but erroneous belief that the city or the group can do no wrong. It leads us to believe that we are immune to punishment for committing those sins collectively that we would be punished for if we committed them as individuals. This belief is the root of many of the modern city's offenses against its environment.

What to Do

The problem of our improper sludge disposal should not be difficult to solve. The need for remedial action is easy to explain. The technology of better disposal methods is available, and we have the machinery for applying one of those methods. All of the citizens of the MMSD contribute about equally to the mess so the responsibility should be about equally shared. There should not be the tendency toward wrangling and buck-passing that seems to be involved in more complex problems, where some groups feel that they contribute less to the problem than other groups, and they should therefore bear less responsibility for solving the problem than others.

Yes, the problem should not be difficult to solve. So, what are we waiting for?

References

1. Lake Use Report No. 16. "Upper Mud Lake, Dane County, Wisconsin. An Inventory With Planning Recommendations." Wisconsin Department of Natural Resources. Division of Conservation. October, 1967

2. Laws of 1965. State of Wisconsin. Chapter 614. "Water Resources Act" Copies available from Department of Resource Development, 1 W. Wilson St., Madison, Wisconsin, 53702.

3. Wisconsin Administration Code. "Private Sewage Disposal." Sec. H 62.20

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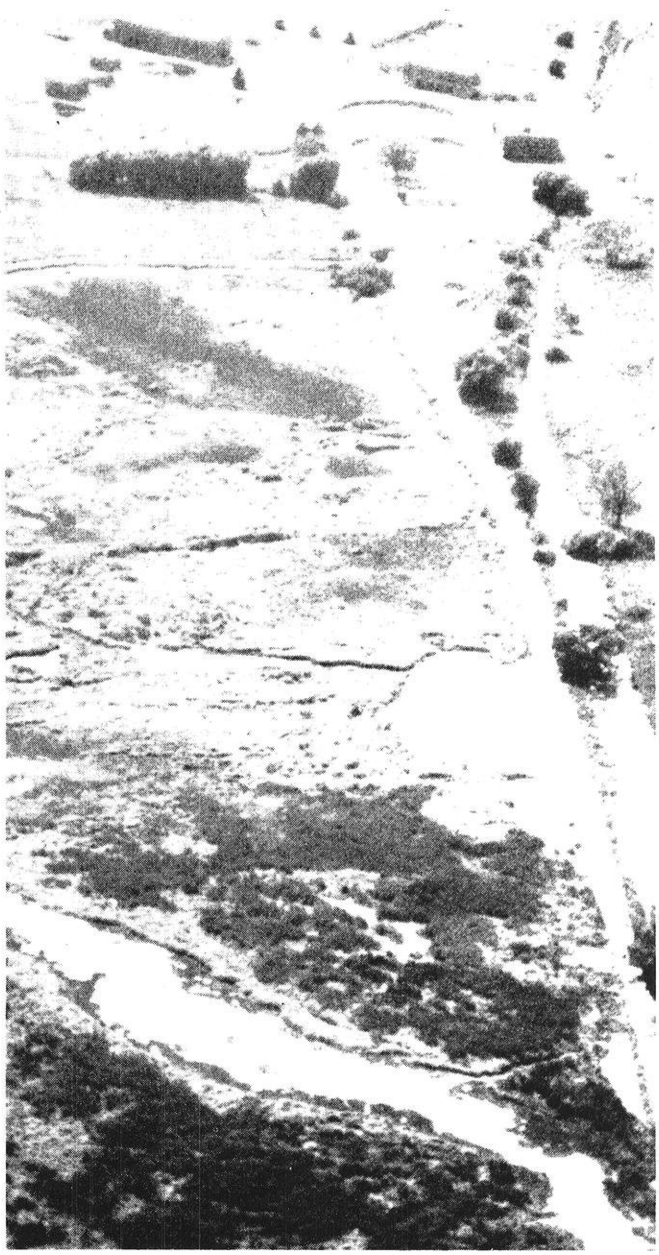

Figure 7. Proximity of Sludge and Flushing Stream at North Dike.

Ever Hear a Mosquito Cough?

PHOTO: ERNEST BRAUN

Progress Report:

E DAY

ROY TULL

The national Environmental Teach-In, or the National E-Day as some people prefer to call it, is planned for April 22, 1970. Nationally, E-Day will be a series of related activities in many communities. The spectrum of activities relating to the environment is as wide as imagination and resourcefulness can make it.

So far in Madison there are about 300 community and University members of the E-Day committee, with membership open to anybody. The next meeting will be announced in the local news media.

The information and coordinating office is located in room 1118 of the Meteorology and Space Science Building at 1225 West Dayton Street (zip 53706). Official hours will be between 9 and 12 in the morning, the telephone number is 263-1796.

The Madison E-Day Committee has been formed into several sub-committees reflecting the various interest groups. For example, there is the Campus Committee which serves to coordinate all of the independent groups on campus, organize some student activities (like the building of a smog booth), and anything else that is relevant to the University. If you are interested in more information or would like to participate, call Roy Tull at 251-2348 or 241-1493. Other committees are the Schools Committee, which will organize activities in area schools, the Labor Committee, the Neighborhood and Households Committee, and more. The idea is to cover all aspects of the community.

An Environmental Art Exhibit is being planned from April 17 to April 26 that will be placed throughout the campus. The exhibition in the various areas will reflect the interest in those areas. For more information call Craig Larenge at 257-2534 (days) or 238-1456 (evenings).

Providing the E-Day Committee can raise $1500.00, it will hire a student office manager half-time for the second semester, this should be more definite about the end of January.

The referendum sub-committee is trying to get a pollution referendum on the Madison ballot for April 7th. If you would like to assist in implementing this call Robin Dennis at 263-1796.

[***]


Duraclean
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STOP SANGUINE -- The Growth of an Ecological Conscience

LOWELL KLESSIG

Lowell Klessig is a National Science Foundation trainee working with the Department of Rural Sociology. He received a Bachelor of Science degree in Biochemistry from the University of Wisconsin and a MS in Molecular Biology from Vanderbilt University.

Preliminary reports of the impending Navy project prompted Lowell and other concerned State citizens to organize a public opposition in the State Committee to Stop Sanguine. Lowell is Secretary of the nine man Executive Committee and was present at the Assembly State Affairs Committee public hearing in Park Falls on December 16. The Committee managed to limit any adversaries by rigorously cross examining Sanguine opponents in the little time allotted them. The State Senate has recently passed a resolution endorsing Sanguine providing the Navy can prove environmental compatibility. Governor Knowles may not have complete trust in our land locked northern Navy for he has appointed Dean Bock of the Graduate School to independently examine and review Project Sanguine findings.

Project Sanguine was the subject of an extensive article by Roy Johnson in the November issue of the *Wisconsin Engineer*. In brief, Project Sanguine is a one-way global communication system proposed by the Navy. The baseline model specified that the transmitting antenna be buried under 26 counties of northern Wisconsin and that it employ 6000 miles of cable, 800 million watts of power, and 240 transmitter sites. Northern Wisconsin was chosen for its geological properties – the low conducitivity bedrock of the Laurentian shield. The need for an extremely large antenna is a function of the extra low frequency of the transmitted wave.

The above information was the soil in which the first seed of concern was sown.

The Seed

By the time the Phase I test facility had become a reality the first seeds of concern had been sown by residents of the affected area in early 1969. The seeds fell on fertile ground. Through bitter personal experience many citizens were becoming aware of and incensed by environmental deterioration. A national leader of these citizens, Senator Gaylord Nelson, began expressing concern about what Sanguine might do to the environment of his home State. Senator Nelson voiced disdain with the problems of erosion and with the direct effects of induced electricity on people: "There are miles of abandoned fences in that part of the country, what happens when a hunter goes through one of those fences charged with 52 volts on a wet day?"

Other individuals speculated that the extensive electromagnetic field of Sanguine might disrupt the normal biological processes of people and wildlife; especially fish, earthworms, and migratory birds. Residents also expressed concern that Sanguine would disrupt domestic communications, reduce tourism, and make the area a prime nuclear target. These residents, united in their love for the northwoods, were the roots from which formal opposition was to sprout.

The Sprout

Formal opposition to Project Sanguine emerged out of a statewide meeting held in Steven's Point on September 21, 1969. It was obvious that the opponents of Sanguine represented a cross section of ages, occupations, geographic residence, and political preference. At this meeting it was also evident that Sanguine had become a major conservation issue and that conservation would be the principle focus of the State Committee to Stop Sanguine. Public education was selected as the most urgent goal for the committee since very few Wisconsinites had yet heard of the project. With a few weeks of concerted effort this goal was being met as a substantial controversy and public debate developed. Consequently, the Pentagon undertook a review of the project only to "discover" that it was now possible to communicate with submerged submarines using a much smaller Sanguine system. It was hinted that such a system could be built in other states and Representative O'Konski bemoaned the "fact" that Wisconsin was losing Sanguine.

While some opponents of Sanguine celebrated a victory for the Wisconsin environment, the State Committee to Stop Sanguine realized that this was just the beginning of the battle. They realized that political and economic poisons would soon be used in an attempt to kill their movement.

The Herbicide

The success of the Stop Sanguine movement in exposing Project Sanguine to public scrutiny brought a vitriol attack from supporters of Sanguine. Congressman Alvin O'Konski described the opponents as "two asinine and stupid Senators, old ladies in tennis shoes, birdwatchers, and those who don't know the difference between an electric shock and a boot from a martini." While the Navy admitted Sanguine would create a couple of hundred permanent jobs, the Congressman claimed up to 17,000 jobs and even asserted that Sanguine would be a tourist attraction. The local business community, long suffering economic depression, was cajoled. They accepted Navy assurances that

Sanguine would not be built unless it was compatible with its environment. They never asked who would determine the standards of compatibility. Instead they occupied their time with diatribes of the State Committee to Stop Sanguine.

This was the setting for the public hearing by the Assembly State Affairs Committee held in Park Falls on December 16. The subject of the hearing was Assembly Joint Resolution 103. Local business leaders appeared in favor of the "blank check" pro-Sanguine resolution. None were questioned as to the basis of their assumptions. After several hours of such testimony, a local disc jockey produced as a point of information a talk-show poll of twenty people and concluded that 90-95% of northern Wisconsin residents favored Sanguine. Again no cross examination of this scientifically illiterate pollster. Finally, after several Navy filibusters in lieu of factual answers, the opponents were allowed to speak. The speechless State Affairs Committee suddenly unleashed a string of verbal barbs to match the length of the Sanguine antenna. Already accused of being Nazis and of illegally solicting funds, the opponents now learned that they were "poisoning the minds of school children." Thus the supporters of the Navy project repeatedly applied the herbicide of verbal violence against the still infant plant of ecological conscience.

A Resistant Variety

This plant has resisted the caustic treatment. Its roots are penetrating deeper. A tap root of dedicated individuals are willing to sacrifice time, money, and possibly careers so that it will live.

As it continually grows in every part of Wisconsin and spreads across the nation, each new member root permits more leaves to proclaim the message of the ecological conscience. The leaves proclaim:

1) A temporary quick-buck for a few will not prevail over the rights of all the citizens for a wholesome environment. The Wisconsin environment is not for sale.

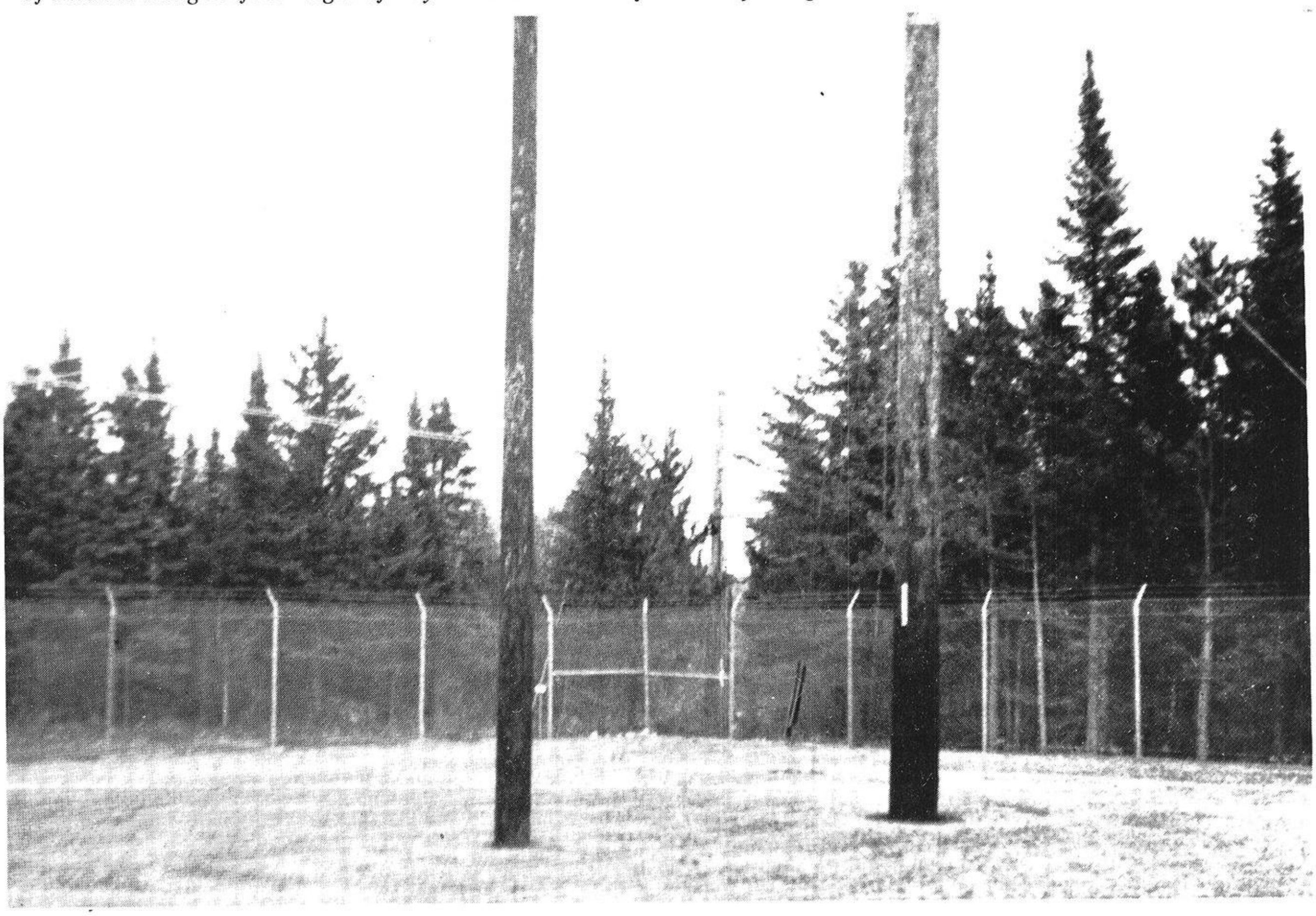
2) Conservationists will not allow a national precedent to be set for the using of national forests for military installations.

3) The people and not the Navy shall decide if Sanguine is compatible with the Wisconsin environment as they perceive it.

The final paragraph in a booklet entitled *What Is Project Sanguine?*, published by the State Committee to Stop Sanguine (Box 7, Ashland, Wisconsin), reads as follows:

Project Sanguine is the most preposterous device ever proposed against the State of Wisconsin. We can only ask, with Dr. Albert Schweitzer: "Who has given them the right to do this? Who is even entitled to give such permission?" [***]

Project Sanguine, Phase I, Clam Lake, Wisconsin: The shot from between the uprights is the collection pole for 28 miles of antenna along 30 foot "right of ways" bulldozed out of the Chequamegon National Forest.

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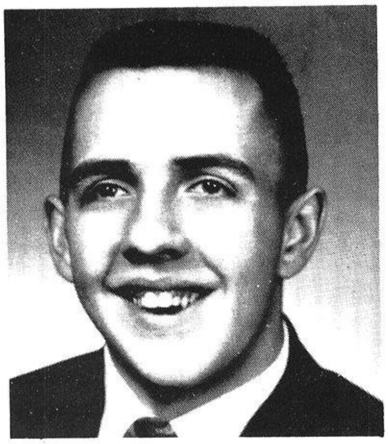
HENRY GORDON



Then there was the one eyed catfish who counted to a hunnerd! But I'm not interested in that space of time. Just before. It was the springtime of the year, and what a bitch she was. Francisco was promoted to stockboy at IGA and someone put a bomb on Mucous Membrane's flight to Casserole Flats, North Dakota. I am certain that the evil demon who placed that bomb on sweet Mucous' plane had no intention of going on that plane as well . . . that would be suicide! And for that matter he didn't want to kill poor Mucous, nuncuperative irridentist emeritus and vaunting Zoroastrian dualist though he be. I know because I put the bomb on that plane. I didn't want to kill Mucous, I didn't even know him. I was just reading the newspaper to find out if I had bumped off anyone significant, a Mellon or perhaps a Kennedy: but no, only a Mucous Membrane. You see, this girl I know . . . well forget it. I remember the first day I met him (I was lying about not knowing him). "and um it is let's see" is how he prefaced everything he said. Herman? oh jeah, the guy with the red shirt. Francisco? the dog food connoisseur. Winkler? didn't he sell the rice from Duchess' wedding for ten dollars a grain? Mucous Membrane? "and um it is let's see." The association was that close. Mucous ate brocolli every Halloween and the rest of the year he ran numbers down at IBM and made cold yogourt soup. "And um it is let's see. I have Ormaxd's own recipe. You use 1 boiled egg, 1 chopped cucumber . . . . ." Francisco was walking down the street with John Herman who was walking down the street as Herman usually walked down the street with John Herman who was walking down the street as Herman usually walked down the street with Francisco. "The way I look at it" Francisco began, "if nobility can hockle a loogie in public, I can certainly tell her how many letters are in it." "Or what kind of dog food it should be fed" Herman added. "Or what kind of dog food it should have." "But what does 'hockle a loogie' mean?" "It's an all purpose expression. You know when you are reading the newspaper and you see three or four films you want to see so you call your best gal and

NOMENCLATURE OF THE CATFISH

say 'hey sweets, let's go hockle a loogie' or when you stand in line for an hour just to hockle a loogie at the malt shop, or when you nose is full and there is no kleenex and you have to have a clean for the annual Christmas day party at grandma's so you hockle a loogie and spit it out, or when . . . " Or when or when or when. He would have gone on for hours. "How is your new job?" Herman butted in. "Royal Pooch–chicken parts with broth for dogs," Francisco hockled a loogied. A cow walked by with a chocolate milk shake.

The plan to blow up the school was immaculate from its very conception. All the buildings would be destroyed with a subsequent economic boycott of any company attempting to replace the broken glass. Fern trees and assorted vegetables would replace the buildings and cows would wander freely everywhere. They even bought milk shakes at the drug store. I remember the first time I saw a cow order a milk shake. It was vanilla, my favorite flavor. I knew then the cows were my friend. I have been a vegetarian ever since. Only problem is that it has gotten to the point where you can never get a shake because the line is so long. You see, cows can stand in line for hours contented to eat grass and wait their turn. Mucous calls it a gift from Ormazd.

When the duchess introduced her cow friend to her parents, she was forbidden to drink milk or visit the store where he was a soda jerk for a week. "Not with that Aryan" they said and that was it. They got married a short time later and Winkler swept up all the rice and sold it for ten dollars a kernel. "Why not?" he mused. Indeed, why not? "Duchess and I had some good ping-pong matches the year before France declared war on Saudi Arabia. I was walking down the street one day when I saw a fat Italian stirring minestroni in a kosher delicatessen. I went in. I went out. My parents were waiting for me, as was my eldest brother. We drove for a while before going swimming. I got bored, and started to take a short cut home rather than wait. I passed through a door into a room where an old man sat. 'Oh excuse me' I said, I must have the wrong passage. 'Please come in' the man said, 'and sit in my chair.' As soon as I sat down he phoned the police charging me with trespassing. 'But that is silly' I said. He called anyway. I tried to leave but the police arrived first. He told his story. I told mine. 'But that is silly' the cop said, and drove me home. When I got there the duchess was waiting for me. And indeed she was.

Dear Henry she said (for she was a woman of letters) your cold yogourt soup is terrible, you are nothing but a mucous membrane.

That is how I got my name.

Let us pray:

Then there was the one eyed catfish who counted to a hunnerd!!!

Thus spoke Zarathustra. [***]

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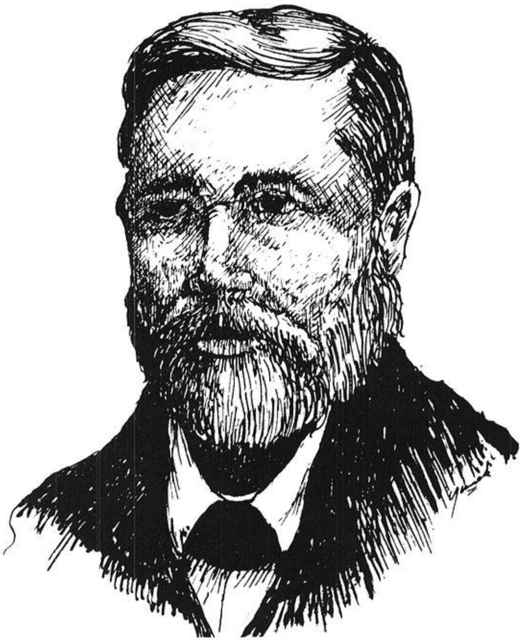
MARK OF EXCELLENCE

In Memoriam

Thomas Crapper
Sanitary Engineer

W. THOMAS LAMM



Having lived the country life for the last five months, bereft of modern conveniences and comforts, I have the advantage of perceiving, in a limited way, how past generations dealt with their problems. Doing without which one has grown up with can be an enlightening experience. It was no problem adjusting to the lack of a garbage disposal or an automatic garage door opener, but how I miss the indoor plumbing.

"We had a fire in the bathroom the other day," goes the joke, "but luckily it never reached the house." At ten degrees below in the middle of the night, it's hardly a joke to have to trudge through the snow to the outhouse. Once one gets there he is shocked, literally, by how cold an outhouse seat can be. In spite of all the excesses of our technology, I must at least give it credit for having brought the bathroom inside.

The pioneers of the bathroom industry deserve no less credit than do those of the auto industry or the communications industry. Though the names of Henry Ford and Alexander Graham Bell are almost universally recognized, who is aware of the mentors of toiletdom? Virtually no one, and I cannot sit easy until their contributions have been brought into proper perspective.

Consider Thomas Crapper, the Henry Ford of the bathroom. An unsung hero if there ever was one, his Valveless Water-Waste Preventer revolutionized the efficient, sanitary disposal of the unmentionable. But credit for Crapper's medium of disposal is negated by another medium, the language. In this case, the medium degrades the message. Just as four letter symbol for lovemaking is connotatively distant from the act, so another four letter word, "crap", derived from Crapper, lends dubious fame to a most distinguished contributor to mankind's comfort.

In the 1870's, Crapper offered an ingenious solution in response to the British Board of Trade plea for an efficient disposal system. His creation, still present beneath the lid of numberless toilet tanks, consisted of a float, a metal arm, and a siphonic action to empty the reservior. His success was insured at the 1884 Health Exhibition where his Waste Preventer superflushed ten large apples, a flat sponge, three wads of paper, and four paper sheets (reportedly stuck to the bowl with grease!).

Crapper went on to develop variations on his original theme. Crapper's Seat Action Automatic Flush was activated by tipping the seat. He developed a special system for prisons and was commisioned by King Edward VII to install the royal bathroom facilities.

Forgotten men have made countless contributions to the betterment of mankind. Thomas Crapper was one of these men and the fruits of his labor were no mere flush in the pan of human innovation. May he rest in peace. |***|

"Wanting more food from the ocean is one thing. Getting it is another," says Art Tuthill of International Nickel.

"Extracting food from the ocean in large quantities takes special machinery.

"Special machinery to get the food.

"Special machinery to process the food.

"Special machinery to transport the food.

"And most important, special machinery that can stand up to the sea.

"Machinery made of materials that will last. Reliable materials priced reasonably enough to make large, intricate machinery self-sufficient and financially practical.

"That's my job at International Nickel," says Tuthill. "Working with the marine industry, interpreting their needs to our researchers. In an effort to develop special materials that will resist the sea's extreme pressures and corrosion.

"We already have alloys of copper and nickel, nickel alloy steels and certain stainless steels, that fulfill these requirements.

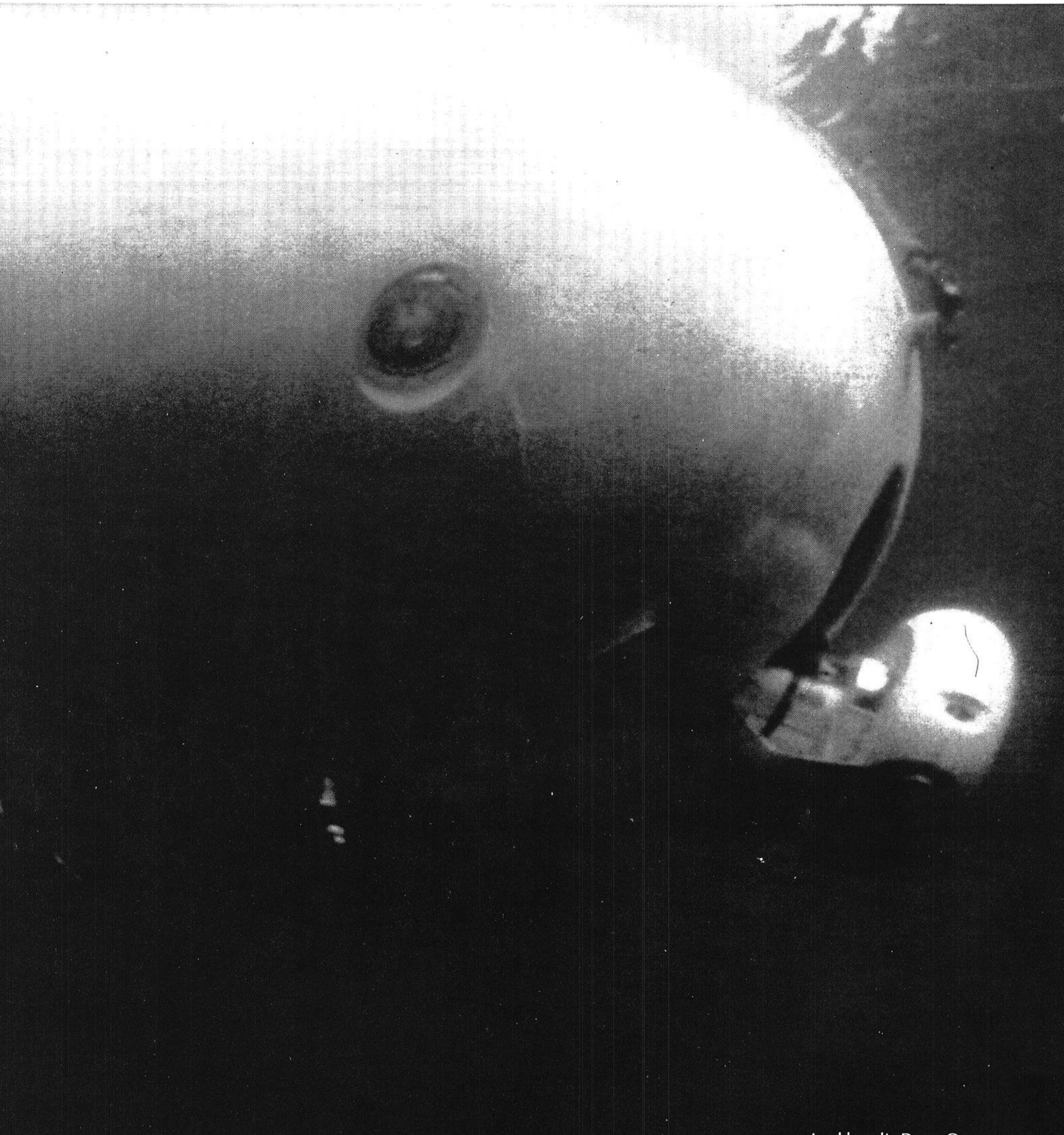
"Nickel maraging steel enabled Lockheed's *Deep Quest* to dive to a record depth of 8,310 feet withstanding fantastic pressure and stress.

"Copper nickels have made desalination possible at reasonable cos And are beginning to find a home in all kinds of boats that work the sea. Fightin hard against salt water corrosion.

"And special grades of stainless ste assure the sanitary conditions necessary for processing the catch.

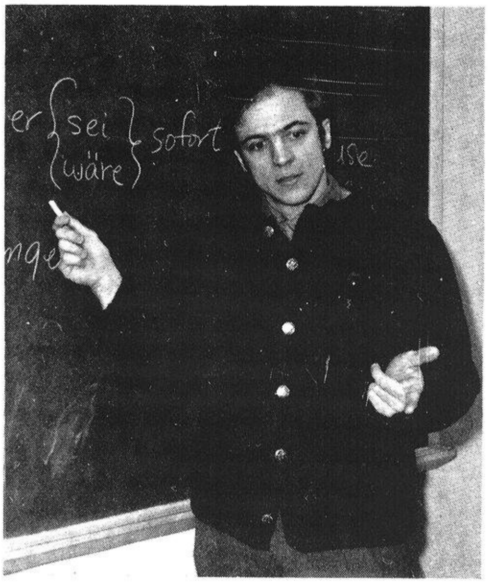
"We have the materials now. And the faster they're made into machines th sea can't destroy, the faster the relief

Machines the sea can't destroy.



The Taxpayer, The TAA, and Education

The University of Wisconsin Teaching Assistants Association, one of some fifty similar organizations across the country, started organizing in the Spring of 1966. Unlike some associations which have won recognition and bargaining powers, the U.W. TAA has come up against the wall in every attempt to gain the lawful rights of a union. The U.W. TAA membership includes 1200 of the 1900 TAs on campus, and is by far the largest and most organized association in the country.



BOB EBERT

Recent University of Wisconsin administration tactics against the Teaching Assistants Association (TAA), collective bargaining agent for the University of Wisconsin - Madison's 1800 Teaching Assistants, indicates that the U.W. is intensifying its anti-union campaign. It seems, in fact, that the administration is willing to spend more money and weaken undergraduate education in an attempt to break the Teaching Assistant's union.

After seven months of bargaining, contract negotiations are deadlocked. Relations between the University and the Teaching Assistants have reached a most critical stage. The TAA, then, would like to outline the steps our union has taken in its quest for just working conditions for these university teachers, and improved education for U.W. students. We feel these developments merit the close attention of every friend and critic of the University.

What Are TA's?

The Teaching Assistant is both a teacher at the university and a graduate student. TA's lead discussion or problem solving sections, prepare and conduct laboratories, evaluate papers and exams, or prepare and deliver lectures. Teaching Assistants are not "teaching aides" as the University often portrays us to the public. 56% of all TA's teach discussion and laboratory sections to supplement the presentations of full time faculty in large lecture classes. Nearly a third are the one and only teacher with whom the student has contact in a course.

Teaching Assistants teach 56% of all instructional hours for undergraduates: 68% of all hours for freshmen and sophomores and 44% for juniors and seniors. They receive only 20% of all salaries and wages allocated for instructional purposes on the Madison campus. Most TA's have Masters degrees. Many have taught for years in high schools and colleges before returning to work on their Ph. D.'s.

The Wall Street Journal(Jan. 8, 1969) calls TA's

"Academia's Serfs." TA's are a captive labor force. Since they cannot transfer graduate credits, they must take what the University offers or go without. A "half time" TA is paid for a 20 hour work week, but a university study shows that he averages 28 hours per week. In addition TA's take 9 to 12 credits of graduate work.

The average TA yearly wage for 1968 was $2770. Many make less than $2300 per year. TA's pay federal income tax, state income tax, in-state tuition ($526 this year). Like everyone else they are hit by Madison's high rents, by inflated food prices. Many must support families.

TA's have no power over the terms and conditions of their employment. They have no say in what they are paid, no assurance of continued employment, no voice in course assignments. Many share cramped and noisy offices with a dozen other TA's. Classes are too large and teaching aides (typewriters, duplicating machines, etc.) too few. As lowest men on the instructional totem pole, TA's are subject to the whims of their superiors. Last spring several TA's were required by their supervising professors to sweep and scrub hallway and laboratory floors in preparation for a "distinguished visitor."

What Is The TAA Doing?

After winning a campus-wide representation election in May, 1969, the TAA immediately began negotiations with the University to obtain a contract covering the terms and conditions of employment for TA's. Since then the TAA has made thirty concrete proposals for changes in the TA system. These include health insurance, provisions for sick leave, a fair work load, and an equitable grievance procedure. To insure just and rational standards of employment the TAA demands protection for TA's against arbitrary discipline or discharge, the opening of secret files kept on TA's, and the elimination of *de facto* minority discrimination in hiring.

An April 26, 1969 "Bargaining Structure Agreement" with the University guarantees TA's the right to collective bargaining over their participation in planning how and what they teach. To this end the TAA has proposed joint student, TA and faculty committees to decide course content and methods and to review TA appointments. To improve education the TAA calls for smaller classes and mandatory student evaluation of TA's.

The Obstacles Before the TAA

In contract negotiations the U.W. administration responded to the Teaching Assistants' union with legal dodges, violations of its April 26 agreement with the TAA, distortions of TAA positions to the faculty and the public, and threats of reprisals against union members and departmental stewards. At the bargaining table itself, U.W. representatives consistently refuse to bargain many crucial areas in good faith.

In violation of the April 26 agreement U.W. Chancellor Young ordered departments to refuse to bargain with the TAA. The TAA filed unfair labor practice charges against the University with the Wisconsin Employment Relations Commission (WERC) in an attempt to obtain legal enforcement of the agreement. It took two months for the WERC to rule that it did not have jurisdiction in disputes between the TAA and the University - another "right" guaranteed to the TAA by the University in the April 26 agreement – because TA's are "unclassified" state employees and the State Labor Act only covers "classified" employees. The WERC did offer to arbitrate the issue if both parties agreed. At first the University would not commit itself to such an agreement. Then several weeks later, they offered to arbitrate the single issue at hand providing they could choose which future disputes they would allow to go to arbitration. Two months later, the University agreed that our agreement called for a third party decision on all disputes. The result of this maneuvering by the University is that a full five months after an issue arose, the TAA has only been able to get them to reaffirm their agreement that a legal channel should be used in settling disputes.

In an attempt to discredit the union in the eyes of the faculty and the public, the University circulated a 42-page "report" distorting the TAA bargaining position. Further misrepresentations based on this false "report" have been circulated by the State Chamber of Commerce. The TAA published documentation of 15 major misrepresentations in the U.W. report. For example, the University reported that our health plan proposal would cost "$50 per TA per month." The next week at the bargaining table, they admitted that the figure was $17 per single TA and $45 to $50 per TA and family (about ¼ of all TA's have families). They called their statement a "slight exaggeration."

Individual TA's have encountered threats, veiled and unveiled. A TAA steward in one department was not reappointed because of his "attitude." In another department beginning TA's were told that union members seldom completed their graduate education.

At the bargaining table the TAA has made 28 revisions of its bargaining proposals since October. The University still refused to respond to many key proposals and has made a scant six changes in its contract demands. Some "changes", for example the administration response to a four-page TAA work- loads proposal, are restatements of the existing inequitable conditions. Equally unacceptable is the administration's grievance pro-

"Every attempt to seek redress of our grievances has been met with deception and evasion"

cedure, in which the final appeal on a large number of issues is to five **management-appointed** tenured faculty members.

Administration bargainers claim that their "limited authority" does not allow them to bargain in some areas. They have consistently refused to recognize that in the April 26 agreement the University agreed to bargain in areas in which the "appointing officers" of the University have discretionary authority. By law the "appointing officers" of the University are the Regents, and, by law, they have wide powers to make change.

Another example of the University's violation of the April 26 agreement leaves doubt about whether it intends to honor this signed agreement at all. The agreement calls for collective bargaining over those areas designated in the Wisconsin statutes covering "classified" state employees; but it also adds other areas for bargaining because of the unique nature of University employment. The most important of these additions guarantees TA's the right to collective bargaining over the mechanisms by which they will participate in planning the courses they teach. The University has since then taken the position that TA's have no rights to determine these mechanisms. This is so serious a violation of the April 26 agreement that the University seems to be acting as though there is no such agreement.

A further U.W. response to the union threatens the taxpayer with increased costs and an even more impersonal education for his children. In what may become the pattern of the future, the English department faculty voted to drop the freshman composition course rather than allow the 70 Teaching Assistants who teach it to participate in planning the admittedly ailing and unpopular course. Now the beginning student will have to rely on his high school training for the writing skills necessary at the university. (The English department faculty violated Wisconsin's anti-secrecy statutes by calling police to keep TA's and students out of the meeting which voted to drop the course; the TAA is bringing a court suit against the English department to stop the University from operating in secret sessions closed to the citizens of Wisconsin.) In addition, the University has threatened in several other departments to do away with TA's and substitute more large lecture sessions taught by assistant professors.

For their 56% of the undergraduate teaching load TA's now get $5.5 million out of the approximately $120 million University annual budget. The TAA proposals now on the table would increase the total TA share to $8.74 million. To replace the TA system with full-time instructors (non Ph.D.'s) would cost nearly $10.5 million. An assistant professor system would cost nearly $12.2 million.

The University has indicated its willingness to spend more of the taxpayer's money and reduce the quality of undergraduate education in order to break a union.

Reports from several universities have found the TA system to be a "necessary evil" for large scale undergraduate instruction. Education based on overworked and underpaid part-time teachers is bad for students, teachers, and taxpayers. But full-time instructors or more assistant professors in larger, more impersonal classes are not solutions for the two major problems facing higher education in America: quality undergraduate education and the inability of the taxpayers to carry greater tax burdens. Improved work-loads and working conditions for TA's, however, would mean better education today and help attract and train good university teachers for tomorrow.

Seven months of bargaining with the U.W. administration, however, have brought TA's no closer to equitable conditions of employment. Abuses and repressions have intensified. The TAA has gone to extraordinary lengths to work through channels as suggested by Chancellor Young when the TAA first requested recognition as a union. Every attempt to seek redress of TAA grievances has been met with deception and evasion.

Teachers throughout this nation have had to take unpleasant steps to win their rights as employees. Teaching Assistants at the University of Wisconsin are being forced by the U.W. administration to consider additional steps to secure rights they have been unable to obtain through patient, rational discourse at the bargaining table.

[***]

Nutrients and Eutrophication

GERALD SEVICK

Gerald Sevick is a senior Civil Engineering student electing Sanitary Engineering. Jerry is specifically concerned with environmental pollution, as might be noted from the following coverage of everyman's evil, the accelerated aging of our waterways.

Eutrophication, the aging of lakes, is not a new subject. It has been with mankind since lakes were formed. The aging process is caused by the gradual addition of minerals, resulting in the growth of undesirable water plants. The rate of influx of minerals into a lake, determines whether eutrophication will proceed naturally or at an accelerated or induced rate.

Natural Eutrophication

When a lake is formed its mineral content is very small. As time progresses, eroded soil and minerals are transported into the lake by shoreline runoff. Figure 1. illustrates the beginning of the collection of eroded soil and minerals. At this stage small water plants begin to grow in the fertile runoff deposits along the shoreline of the lake. More and more plants begin to appear. Growth eventually outweighs death. When a plant does die, it decays and the nutrients within its body become available for new plants to use. Thus a cycle of self sustained life is formed. Marsh foliage and trees then replace the original water plants nearest the shoreline. (See Figure 2.) Because of bottom sedimentation and shoreline recession, the lake becomes shallower and smaller in area. Eventually, the lake becomes a marsh; finally drying up and becoming covered with vegetation. (See Figure 3.) The above process is called natural lake succession or natural eutrophication.

Compared to man's life span, natural eutrophication is a very slow process, taking as many as 50,000 – 100,000 years. Time variations depend on climate. In the tropics favorable growing conditions exist year round. The process proceeds faster in the tropics than in cooler climates where the winter freeze reduces the growing period to about one-half of a year. The time factor is best illustrated by Professor Hasler, of the University of Wisconsin, in Figure 4. Curve (a) represents natural eutrophication and is a plot of organic matter versus time. The shape is the familar "S" curve. Production proceeds rather slowly at first, raises suddenly, and tapers off to reach a plateau at a near constant rate of production. A lake will proceed along this natural time schedule unless there is outside intervention, causing an increasing or decreasing rate of production changes.

Induced Eutrophication

Enrichment of lakes is generally considered a natural phenomenon; but man's intervention can seriously effect the rate of aging in a lake. Human interference may cause a reduction in natural growth rate. The usual result is a tremendous

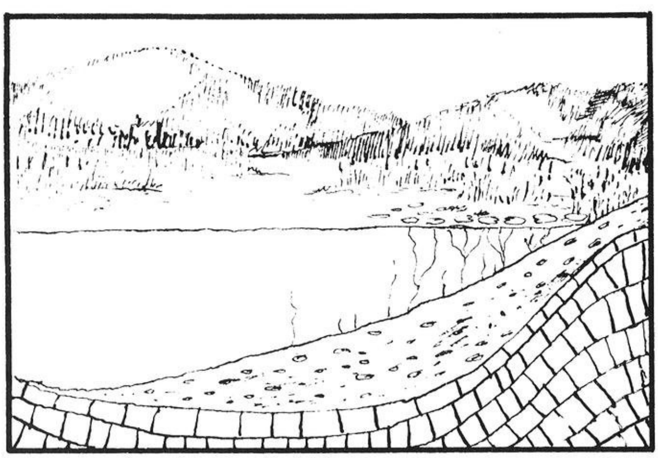


Figure 1. Shoreline Runoff Brings Eroded Soil and Minerals into the Lake

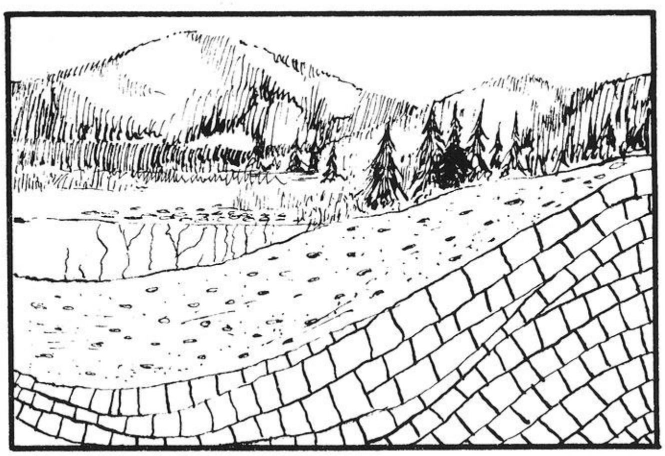


Figure 2. Aquatic Vegetation Flourish and Die

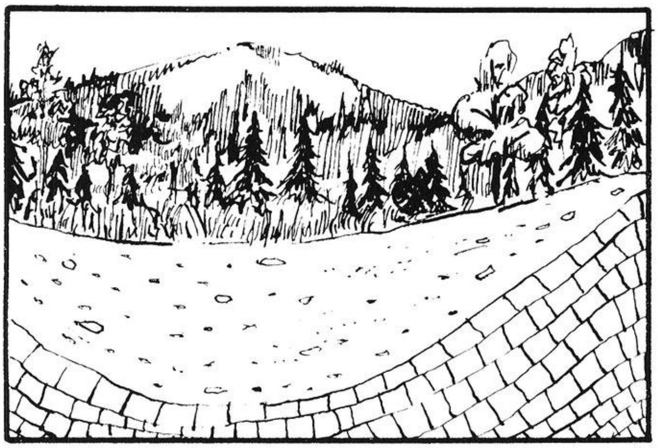


Figure 3. Complete Takeover by Vegetation

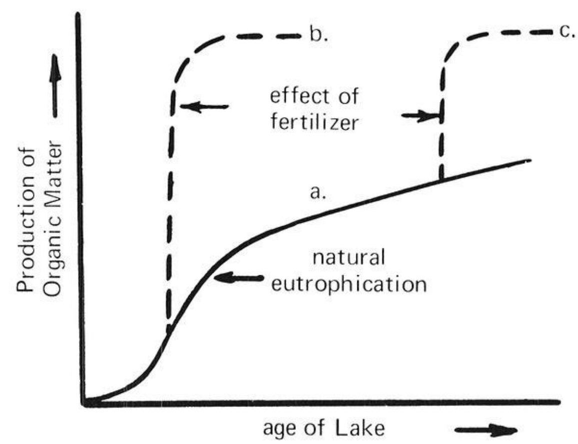
increase in the aging process of a lake. In Figure 4., curve (b) shows the effect of fertilizers or nutrients when a lake is very young (10,000 yrs. old) and curve (c) shows the same effect on older lakes (50,000 yrs. old). Notice that new higher levels of organic matter production are reached in the lakes man has affected. Because of the increased aging rate, death and extinction will come much sooner, for those lakes affected by man.

The speeding up of a lake's life is appropriately called "induced eutrophication." Induced eutrophication may render a lake dead in 10 to 20 years from the time of man's first intervention in its natural life cycle. The rapid aging of lakes is becoming more and more evident today, as is illustrated by the increasing number of lakes which cannot support fish. Also, it can be seen in lakes where bathing or other water sports are prohibited by smell, sanitary conditions, and the general appearance of a eutrophic lake.

Table 1 – Condition of 12 U.S. Lakes

LAKE	LOCATION	Excellent	Good	Fair	Poor	Endangered	Improving
Crater	Oregon	■					
Superior	Great Lakes	■				■	
Tahoe	Calif.-Nev.	■				■	
George	New York		■			■	
Cayuga	New York		■			■	
Washington	Washington			■			■
Okoboji	Iowa		■				■
Mendota	Wisconsin			■		■	
Erie	Great Lakes				■	■	
Douglas	Michigan		■			■	
Apopka	Florida				■		■
Okeechobee	Florida		■			■	

Figure 4 – Time Eutrophication of Lakes



Causes of Induced Eutrophication

Man's major contribution to the causes of induced eutrophication are listed as follows:

1. The discharge of inadequately treated effluents (treated sewage) from municipal sewage treatment plants.
2. Discharge of improperly treated industrial wastes.
3. Uncontrolled drainage from heavily fertilized farm lands.
4. The discharge of inadequately treated or untreated sewage from shoreline cottages.
5. Water run off from urban areas.

The complete control of lake enrichment requires the correction or elimination of all of these basic causes.

Geographic Examples

Many examples of lakes, where the eutrophication process is now proceeding can be cited. All lakes can be examined and classified according to their conditions. (see Table 1. - complied by Prof. Hasler - UW.) Relative lake ages and aging rates can then be compared to determine the seriousness of further intervention by man.

Table 2 – Annual Input and Output of Nutrients for Lake Michigan

	Nitrogen	Phosphorus
Input (million lbs.)	166.1	14.6
Output (million lbs.)	32.2	.8
% Retained	81.0	95.0

Table 3 – Sources of Phosphorus

Mineral Solution	Agricultural	Wastewaters
Soil Leaching	Fertilizer Washoff	Sewage
Bottom Sediment Release	Livestock Excrement	Detergents
		Industrial

Lake Tahoe

Lake Tahoe, located in the Sierra Mountains between California and Nevada, is presently one of the most oligotrophic or plant free lakes in the world. Lake Tahoe is relatively free of nutrients, although, recent studies show that the level of nutrients flowing into the lake is steadily increasing. The increase in nutrient influx is due to an increased population in the Lake Tahoe area. In Table 1., Lake Tahoe is classified as "excellent but endangered," because of the steady increase in nutrient influx.

Lake Michigan

Lake Michigan is classified as being in "good" condition; but it is in danger of becoming fully eutrophic. At present, Lake Michigan shows signs of following the path of Lake Erie. If the present influx of nutrients is not altered or stopped altogether, Lake Michigan will become dead in the near future. The exact time required for this is unknown; but it is estimated at 50 to 100 years.

Lake Michigan's problem centers in the southern area of the lake. It is here where big cities and industry use the lake as a garbage disposal. It is also here where the pollution problem is felt most severely. Annual input and output of nutrients for Lake Michigan is shown in Table 2. The most remarkable thing to notice is the percentage of nutrients retained within the lake. The changes already evident within the lake, coupled with Lake Erie as an example, strongly emphasize the point that Lake Michigan is in severe danger of becoming eutrophic.

Lake Washington

Lake Washington, in the state of Washington, was a relatively clear oligotropic lake until fifty years ago. Since that time ten communities have been dumping sewage effluent into the lake. The lake suffered from a great increase in algae growth in 1958. This growth awakened the public to the fact that something must be done. Effluents were then diverted around the lake. At present Lake Washington is returning to its past condition.

The success of the project to clear up Lake Washington shows that if proper action is taken, eutrophication can be stopped. Lakes can be brought back to conditions that all mankind can enjoy.

SOURCES OF POLLUTING NUTRIENTS

All lakes are subjected to an inflow of nutrients. Two nutrients, phosphorus and nitrogen, are most important when considering plant growth. Other nutrients such as potash and vitamins, B_{12} and thiamine, are involved in plant growth, but are not as important as phosphorus or nitrogen.

Phosphorus as soluble orthophosphate (PO_4) is the most important type of phosphorus in water. Orthophosphate is soluble in water and can be readily used by plant cells, while insoluble types of phosphorus cannot be used by plant cells. Table 3. shows that phosphorus enters lakes from many sources and under many circumstances. The worst sources of phosphorus to lakes are agricultural drainage and wastewaters. Table 4. shows the concentration of phosphorus in lakes and streams, as compared to concentrations in agricultural drainage and waste waters. Notice that waste waters contain over 200% more phosphorus than lake waters.

Nitrogens that are important in the eutrophication process may be in organic or inorganic

Table 4 – Concentration Ranges of Total Phosphorus in Water

Source of Water	Total Phosphorus m.g./liter
Lake Waters	.01 - .04
Forested Streams	.02 - .10
Agrucultural Drainage	.05 - 1.00
Domestic Waste Waters	3.50 - 4.00

forms. Inorganic nitrogens, like soluble phosphorus, can be used more readily by plants than organic nitrogens. Some examples of inorganic nitrogrens are ammonia (NH_3), ammonium (NH_4), and nitrate (NO_3).

As shown in Table 4. waste waters and agricultural drainage contribute the highest amount of phosphorus to lakes and streams. Following is an explanation of why waste waters (sewage and industrial) and agricultural drainage do contribute such a great amount of nutrients to surface waters.

Sewage

Sewage is generally cited as the major contributor of nutrients to lakes and streams. Raw sewage is directly dumped into surface waters without treatment. Treated sewages (effluents) have been given some kind of treatment before they are discharged. Treated sewages originate from treatment plants or septic tanks.

Human excreta contributes most of the phosphorus and nitrogen in sewage waters. For example, adult humans excrete, from their bodies, 1.6 grams of phosphorus and 19.4 grams of nitrogen per day. In Wisconsin the total amount of phosphorus and nitrogen entering surface waters is about 36.3 grams per capita per day. This example shows that human excreta contributes over 40% of the total phosphorus and nitrogen in the sewage waters of Wisconsin.

Detergents are another major contributor of phosphorus and nitrogen to sewage waters. In the United States there is a per capita use of 3.94 gram per day of detergents. Detergents contain polyphosphates which are also soluble in water. These polyphosphates, like orthophosphates, are readily available for plant growth.

Industrial Wastes

Nutrient concentrations in industrial wastes vary considerably from industry to industry. For instance, paper and pulp wastes are low in nutrient levels, while dairy wastes have a high nutrient level. The fact that nutrient levels vary, makes it extremely difficult to put any specific numbers on the amounts of phosphorus and nitrogen contained in industrial wastes.

Table 5 – Pretreatment of Industrial Wastes

Sample	Total Phosphorus (ppm)	
	Raw Wastes	Treated
1	86.4	12.5
2	85.4	14.7

Today, most industries are required to pretreat sewage before discharging it into municipal sewage systems or rivers. Table 5. shows the effect of pretreatment quite adequately. A phosphorus removal of over 80% is indicated between raw and treated industrial wastes.

Agricultural Drainage

Drainage of agricultural lands is the second major contribution to water fertilization. Most people think fertilizers contribute the greater amount of nutrients to agricultural drainage. In the northern United States this is not true. Table 6. shows that animal manure contributes the greatest amount of nutrients to runoff waters in the northern United States. The reason for this is that manure is spread on frozen soils for about five months of the year. In the spring, meltwaters cannot enter the frozen soils; therefore, soluble nutrients are carried with the meltwaters to a lake or stream.

Table 6 – Sources and Amounts of Phosphorus and Nitrogen in Wisconsin Soils

Source	Nitrogen lbs./acre	Phosphorus lbs./acre
Fertilizer	10	8
Precipitation	12	–
Organic Matter Deposition	45	5
Manure	42	12
Total	109	25

A classic example of applying manure on frozen ground is in Wisconsin. In the Lake Mendota watershed, within Dane County, there are approximately 20,000 cows. Each cow produces about 15 tons of manure a year. One-half of this manure is spread on croplands during the winter months; therefore, about 150,000 tons will be spread on frozen soil. Almost all the nutrients in the 150,00 tons of manure spread in the winter reach the surface waters of the Lake Mendota watersheds.

Other sources of polluting nutrients are soil leaching, bottom sediment release, and plant and animal decomposition. These are more complex systems of sources and are not treated in this article.

REMOVAL OF NUTRIENTS

Conventional sewage treatment plants are designed to remove floatable and settleable solids; also, other materials that make demands on the dissolved oxygen content of a lake or stream.

(Continued on Page 42)

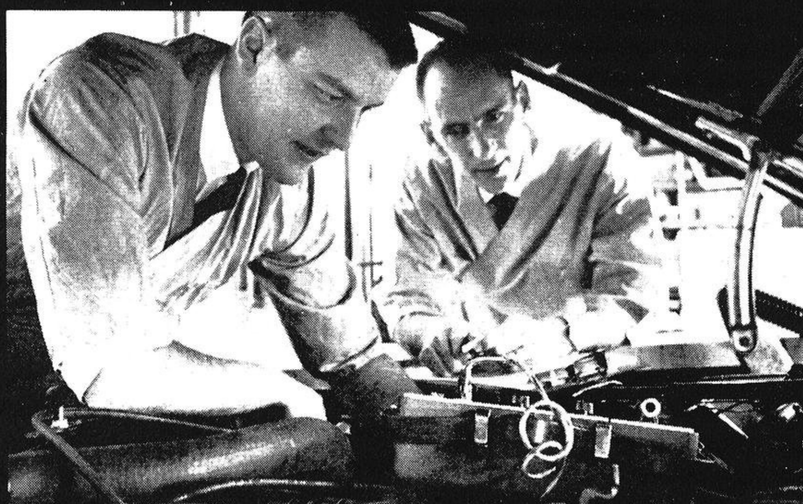


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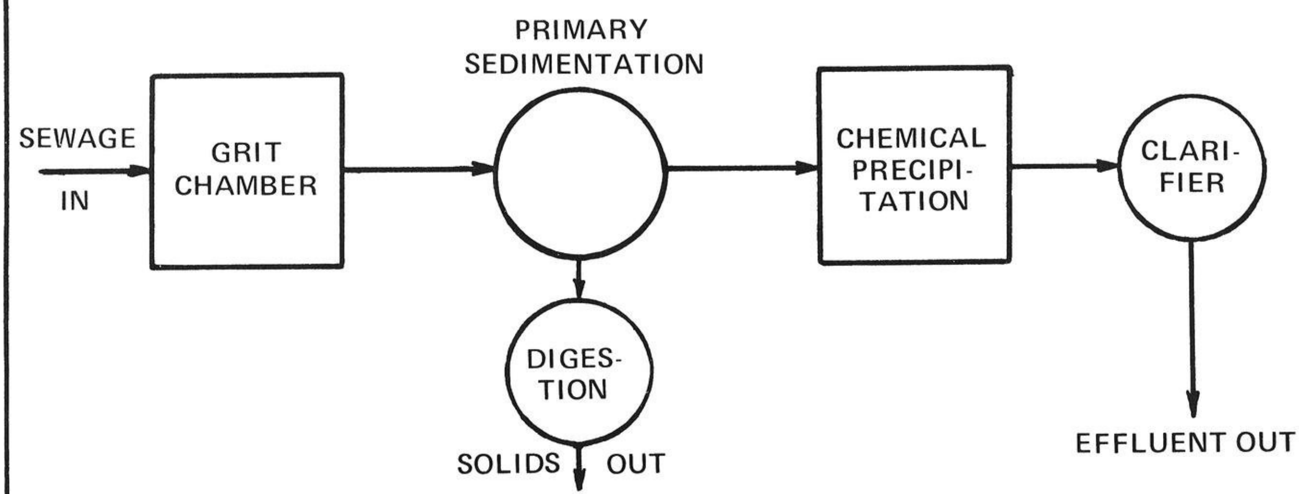
FIGURE 5 – FLOW CHART OF CONVENTIONAL SEWAGE TREATMENT PLANT



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The flow chart of a conventional treatment plant is shown in Figure 5.

Sewage first enters a grit chamber where sand, dirt, gravel, and other solids are settled out of solution. The remaining materials, mostly floatable solids, are removed during primary sedimentation. These solids are then digested by bacteria, dried, and disposed. The sewage then enters a stage of secondary treatment. This treatment removes pollutants that are in solution or suspension. Some types of secondary treatment are trickling filters, activated sludge process, and stabilization ponds. After secondary treatment, sewage is cleared of all particles by a clarifier and discharged into a lake or stream.

Most effluents that come from secondary treatment plants are clear, oxidized, stable, inoffensive in odor, and have a reduced number of pathogens. This effluent, however, contains significant amounts of phosphorus and nitrogen. Conventional treatment does remove about 30% phosphorus and 40% nitrogen, but this is not sufficient.

The beginning of the next section explains methods now employed to remove nutrients from effluents. The remainder is devoted to the removal of nutrients present in lakes and streams.

Removal From Treatment Effluents

Removing nutrients from effluents involves further treatment than that applied in secondary treatment. This further treatment is called tertiary treatment. Tertiary treatment can be performed in many different ways. The most common methods are chemical precipitation and biochemical methods or algal cultures and modified activated sludge processes.

Algal Cultures

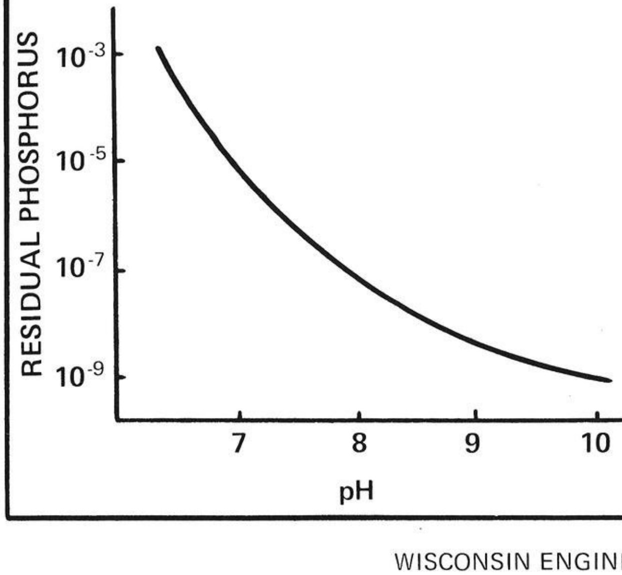
Much interest has been given to the use of algal cultures as a means of removing phosphorus from sewage treatment plant effluents. There is a possible economic advantage to using this process. The algae produced in the process may have a potential market as a protein source for animals and humans.

Phosphorus enters a tertiary pond (stabilization pond) mainly in the soluble orthophosphate state. Once within the pond, phosphorus may be removed by the action of algae or through chemical precipitation as insoluble calcium phosphate. Algae use carbon dioxide from the water and thus raises the pH of the water. As the pH rises calcium phosphate precipitates out of solution.

Phosphorus is also removed from solution by the algae; both by metabolic uptake and by chemical coagulation and absorption. Chemical coagulation and adsorption refer to the adhering of phosphorus molecules to the bodies of algae.

The rate of precipitation of calcium phosphate is determined by the rate at which the value of pH is raised. Algae use carbon dioxide to survive and the rate at which carbon dioxide is used is con-

FIGURE 6 – EFFECT OF pH IN THE PRECIPITATION OF CALCIUM PHOSPHATE



trolled by light intensity. Carbon dioxide content in the water controls pH; therefore light intensity controls precipitation of calcium phosphate. Figure 6. shows why pH is important in removing calcium phosphate from solution. The graph plots pH versus phosphorus. As pH increases the level of phosphorus in solution decreases.

The minimum light intensity requirement for satisfactory algae growth vary from 100 to 200 foot-candles (f.c.). Since algal cultures are kept in outdoor ponds, it is extremely difficult to maintain adequate illumination on any large scale. Ordinary algal culture ponds are constructed to depths of not less than three feet because of area limitations. A depth of one foot of water or less is the maximum depth at which an intensity of 100 f.c. can be supplied. Illumination is almost always sacrificed to save on land area.

In northern climates, during summer months, sunlight may be sufficient to allow pH adjustment to occur. During the winter freeze-over, sunlight or artificial light would not be able to penetrate the layer of ice on the pond. During the winter, the process would not yield sufficient results to compensate for money costs. In warmer climates the process would continue at a satisfactory level year round.

Other problems, besides light intensity are:

1. Carbon must be artifically supplied.
2. Removal efficiency is also affected by temperature fluctuations.
3. Desired forms of algae need constant maintenance.
4. Dead algal cells must be removed before discharging of the effluent.

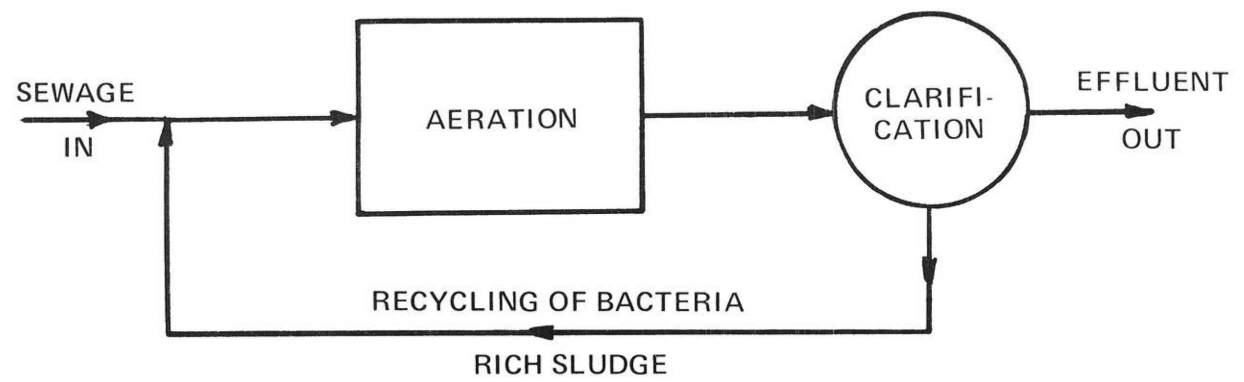
These problems must be overcome before adequate levels of nutrient removal are possible. Removals as high as 96% and 90% for phosphorus and nitrogen respectively, can be achieved if the above conditions are met.

Modified Activated Sludge

Activated sludge is a process where the solids in sewage are mixed with bacteria and oxygen in an aeration tank. (See Figure 7) This reduces the solids to a state where they will no longer decompose. The resulting mixture is called sludge. After aeration the sewage goes into a clarifier. Here the effluent is discharged and the bacteria removed during clarification are recycled into the aeration tank. Recycling assures a constant supply of healthy bacteria.

A modification to the activated sludge process is applied for the removal of nutrients. Conditions for the removal of nitrogen are detrimental to the removal of phosphorus and vice versa. The simultaneous removal of phosphorus and nitrogen has never been achieved. Removal of nitrogen by modified activated sludge method is to pump the sewage from the aeration tank directly to the clarifier. (See Figure 7.) In the modified method an anaerobic tank is inserted between the aerobic tank and clarifier. (See Figure 8 on page 46). The bacteria in the anaerobic tanks function in the absence of oxygen.

FIGURE 7 – FLOW CHART OF ACTIVATED SLUDGE PROCESS



In the aeration tanks, oxygen is circulated with the sewage to promote the formation of nitrates (nitrification). Effluents are then pumped to the anaerobic tank which induces the rapid formation of nitrogen gas (denitrification) by the work of bacteria. The nitrogen gas is then allowed to flow into the atmosphere. The process is completed when effluents are discharged by the clarifier. Up to 90% removal of nitrogen can be accomplished using this method.

The use of the modified sludge process is very effective when removing nitrogen relative to phosphorus or vice versa. In actual practice this is not feasible because nitrogen and phosphorus exist in sewage simultaneously.

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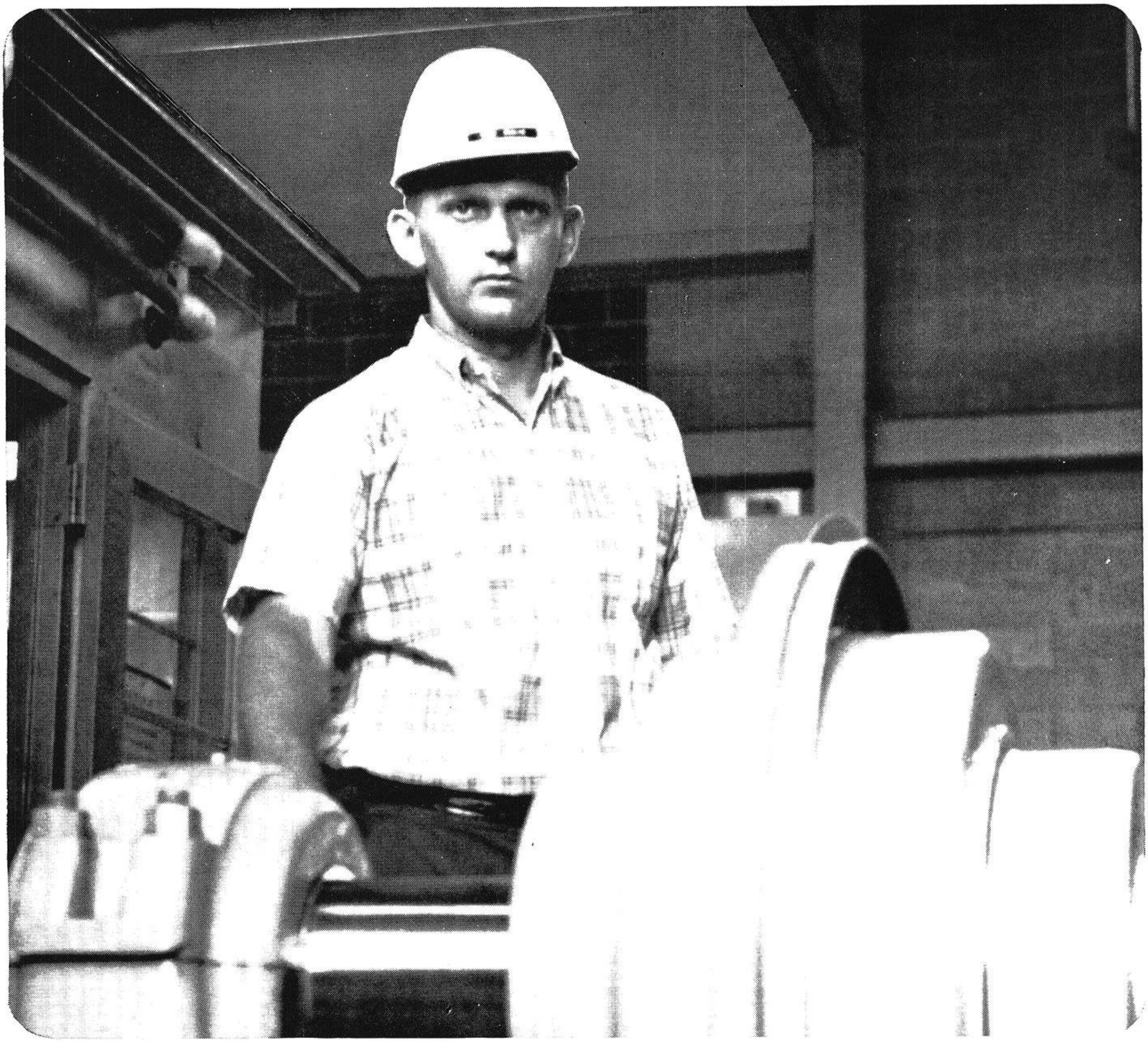
INTERVIEWS

Terry Gooding, Kentucky '65, met the challenge in mining at St. Joe



He's Mine Superintendent at St. Joe's Virburnum mine. It's a responsible, challenging and rewarding job with excellent future prospects. ☐ Terry and his wife Judy and their two children enjoy the good life in Southeast Missouri. He hunts and fishes, plays softball and golf. He takes Judy and the kids to St. Louis, only about 90 minutes drive, to the zoo, shopping, pro baseball and football. ☐ St. Joe has challenging opportunities of many kinds in various locations, Southeast Missouri, Pittsburgh, Upper New York State and New York City. ☐ You may find your challenge and your future with St. Joe.

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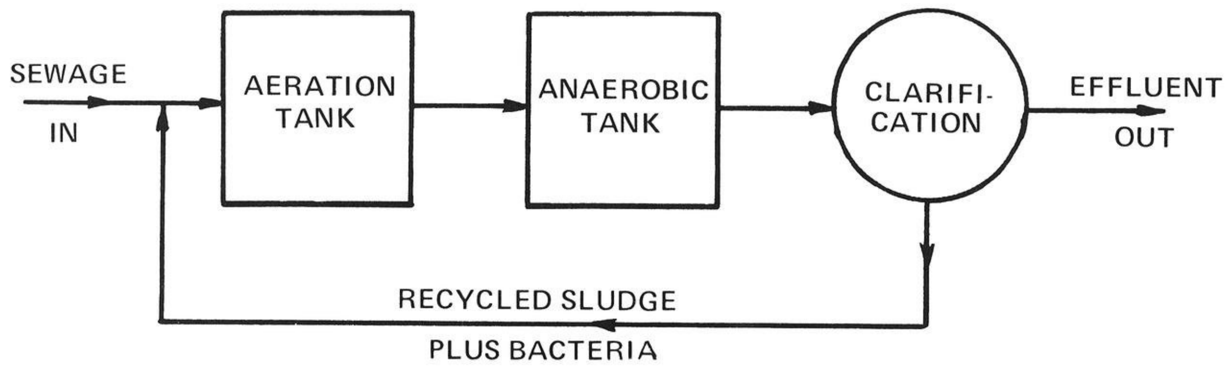
FIGURE 8 – FLOW CHART OF MODIFIED ACTIVATED SLUDGE PROCESS



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Other Methods

The most important factor in eutrophication is control of nutrients that enter receiving waters. If control of nutrients at a sewage treatment plant is unfeasible, other methods must be applied. Two such methods are diversion and irrigation.

Diversion

The prime cause of induced eutrophication is the addition of domestic sewage and sewage effluent into a lake. One way to combat this is by diversion of the waste around a lake. Some examples of diversion are presented below:

1. The diversion of the clear effluent around Lakes Waubesa and Kegonsa in the Madison Chain of Lakes. The clear effluent is diverted through pipelines and open channels, about nine miles, to Badfish Creek.
2. Eutrophication in Lake Washington was reversed by diverting the effluents that once entered the lake.

Obviously, the cost of diversion is high. Construction of pipelines and channels are quite expensive. Smell is always a problem when a channel is used; therefore, care must be taken not to place channels near populated areas.

Irrigation

Sewage has been used for irrigation in the Southwestern United States and Europe where water is in short supply. The use of effluents for irrigation has proved to be economical because the nutrients in the effluents stimulate plant growth. Care must be taken not to over irrigate with sewage. Over fertilization with sewage, as with common fertilizers, can cause plants to die.

Controlled irrigation has been quite successful in Wisconsin, as well as other states. In the future, as more problems develop in our lakes, more communities may find it feasible to dispose of sewage effluents by irrigation.

Removal From Lakes and Streams

Most lakes have some nutrients in them. Some lakes contain more than others. Removal of these nutrients involve different procedures than those used in sewage treatment.

Many methods of removing nutrients from lakes have been tried. Some of these methods have succeeded in giving good results. Others have failed. A few methods now employed in Wisconsin are listed below:

1. Harvesting of algal and plant growth.
2. Aeration of lake bottoms.
3. Dredging of lake bottoms.
4. Dilution.

Harvesting

Of the four methods listed above, harvesting presents the best method for removing nutrients. Once the algae and plants are removed from a lake, the nutrients within their bodies are not available to other water plants. If nutrients are not available, the self sustaining life cycle of algae and water plants is broken.

The cost of harvesting is quite high. Cost coupled with problems of where to dispose of the dried growths may not justify using harvesting. Care in disposal of the dried growths must be taken. No benefit from using harvesting would be accomplished if the growths were deposited in an area where runoff waters could easily carry the nutrients contained in their bodies, into another lake.

Aeration, Dredging, and Dilution

Aeration is a process where a lake bottom is aerated to prevent stratification of water levels. Keeping the water in constant agitation keeps the growth rate of plants to a minimum.

In Wisconsin, dredging of lake bottoms has been used with mixed success. The use of dredging should reduce sunlight penetration by increasing depth. With sufficient sunlight, plant spores on the lake bottom cannot grow.

Dilution has not been used very much in Wisconsin. "Dilution" simply means flushing a lake with fresh water containing a small amount of nutrients. By this method the concentration of nutrients is reduced sufficiently. With fewer nutrients available plants cannot flourish. The obvious problem of this method is where to obtain enough fresh water to sufficiently dilute a lake.

Aeration, dredging, and dilution, like harvesting, are expensive procedures. In some cases expenses must be put aside in order to save a lake from becoming eutrophic.

LOOKING TO THE FUTURE

Previous portions of this report discussed natural eutrophication, induced eutrophication and its apparent causes, and nutrient sources with an idea of their magnitude. Also, some control methods used today were explained. But what does the future hold?

Obviously, the need for further study is evident. One particular problem is accurately measuring eutrophication in a body of water. A "Eutrophication Index" could be used to determine at what stage in the eutrophication process a lake is at. No study has yet been made to determine ways of measuring changes in the eutrophic properties of a lake.

In Wisconsin, legislation has been enacted for the protection of public waters. Some examples are:

1. Prohibition, of non-degradable detergents S. 144.14
2. Reporting of intended new waste sources S. 144.555

Passage of these laws is a step in the right direction, but more must be done and soon. Similar legislation in other states has not been passed. This leads to the fact that the Federal Government should make laws regarding pollution nationwide.

Education can play a big part in combating eutrophication. Farmers could be taught new fertilizing techniques which would limit losses of fertilizer to runoff waters. Property owners around lakes could be shown the harm they are doing by dumping raw sewage into their lakes. Numerous other things could also be done.

No simple solution to the problem of induced eutrophication exists. The alarming problems of our growing population, and the increased per capita nutrient levels, make it exceedingly evident that something must be done soon. Things will get worse before they improve but they will not and cannot improve unless prompt attention and continued action are taken.

[***]