Proceedings of third annual convention of the Wisconsin State Drainage Association. Madison, Wisconsin, March 27, 28 and 29, 1917. Also report of field meeting, Racine: October 10 and 11, 1916. 1917

Wisconsin State Drainage Association
Madison, Wisconsin: The Association, 1917

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PROCEEDINGS

OF

THIRD ANNUAL CONVENTION

OF

The Wisconsin State Drainage Association

MADISON, WISCONSIN

MARCH 27, 28 AND 29, 1917

ALSO REPORT OF

FIELD MEETING, RACINE

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EDITED BY THE SECRETARY

PUBLISHED NOVEMBER 1917

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VICE PRESIDENT—A. P. Nelson, Racine
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Write to the Secretary for a Program of the Annual Convention to be held in the new Soils Building of the College of Agriculture, Madison, February 5 to 8, 1918. A part of the Program has been arranged by the Wisconsin Soil Improvement Association, whose convention will be held in conjunction with ours.

THEY ARE READY TO HELP YOU.

Come to the Annual Convention at Madison, February 5 to 8, 1918. See the exhibit of soils, crops, tile and machinery.

These are some of the men who met to exchange ideas on land drainage at the annual convention March 27 to 29, 1917. Every one of them is going to try to come to the next annual convention at Madison, February 5 to 8, 1918, to continue the discussions and to get the benefit of the program of the Soil Improvement Association.—Photo by Garrett & Ruud, Madison, Wis.

THIRD ANNUAL CONVENTION

Wisconsin State Drainage Association

PROCEEDINGS.

The Wisconsin State Drainage Association has held two meetings during the past year; a field meeting in Racine and Kenosha counties on October 10 and 11, 1916, and the Annual Convention at Madison, March 27, 28 and 29, 1917.

The field trip at Racine was about 80 miles in length and traversed five drainage districts. About 75 men took the trip.

Racine Field Meeting

The following clipping from the Wisconsin Agriculturist describes it:

It took a field trip to convince some of the doubters at the Wisconsin State Drainage Convention held at Racine, that W. J. Hansche had made onion land worth $500 an acre out of a peat marsh that grew nothing but cat-tails, and for which he paid only $60 an acre. On that trip all doubts were removed. There was the onion patch, and in plain sight were patches of marsh that had not been fully drained, on which there were still cat-tails. Mr. Hansche's land is not so peaty as it was; in fact, the reddish soil which he formerly had, has settled and become dark in color.

On Mr. Gunther's land in the same county the soil auger told the eighty-five visitors that the peat was nine feet deep. For about two feet near the surface it had decomposed, but below that it was red and raw. You could see it shake for a rod on each side of you when you stepped heavily. Nevertheless, the record showed that a good crop of cabbages had been removed.

It was on A. P. Nelson's farm that the visitors saw how neatly the spoil banks of a dredge ditch could be leveled and sodded. Mr. Nelson, at a cost of about 15 cents a rod, has smoothed the banks so that they can be cultivated. He has also tiled all of his marsh into the open ditch as an outlet. His tax for the open ditch was about $10 an care, and it cost him about $20 an acre to lay the supplementary lines of tile. Today on a 200 acre farm, most of which was formerly marsh aside from raising 10 acres of cabbage which is netting him about $500 an acre, Mr. Nelson's milk check each month is about $700.00. Each month he receives from the cows fed on marsh land enough to pay for draining about 25 acres of land. The beauty of it is that the land remains there ready to give him an equal return each month indefinitely.

Just across the fence from Mr. Nelson's land there were 40 acres which had not been tiled. It was served by the same outlet ditch as was Mr. Nelson's land, but without the supplementary lines of tile it could not be cultivated. The only excuse offered was that the owner was too busy to tile his marsh. The mistake is that he does not sell it to some one who has the time and inclination to tile it and make it valuable.

The visitors spent so much time asking Mr. Nelson questions about his drainage that it was then lunch time, but Irving G. Wheeler insisted upon showing the visitors the crop of corn which he had raised on drained peat in the Hoosier Creek district. Here also the big ditch has been supplemented with tile, and the visitors found the crop of corn as good in every respect as it was represented to be by Mr. Wheeler. Mr. Wheeler admitted that he had laid 3 inch tile. The feeling prevailed that larger tile should have been laid. Drainage engineers generally do not lay anything less than a 5 inch tile even for the shortest lateral. The cost of 3 inch tile laid 3 feet deep is about 75 cents a rod, while that of a 5 inch tile is not over 90 cents including tile and labor. For an increase in cost of only about 20 per cent you are nearly trebling the efficiency of your tile. Three inch tile may work as well as the 5 inch for a time, but if silt settles in the tile it obstructs the small tile much more than it does the larger one.

After lunch at Burlington during which several of the members expressed their appreciation of the generosity of the good people of Racine county, the procession of "show me" people started north for the Norway and Dover district. It was here that the most distressing feature confronting the drainage situation in Wisconsin showed itself. The excellent ditch which has been dug in the Norway and Dover district stands almost full of water because of the dam at Rochester which backs the water into the ditch and keeps wet 5,000 acres of land. The farmers have wanted to buy the dam, offering three times what it is worth, but the owners refuse to sell.

This condition had its effect upon the visitors. There was not a man who viewed this condition who did not go back home determined to do all he can to get his assemblyman and senator to vote for a bill which will empower the Railroad Commission of Wisconsin upon request to appraise the actual value of a water power for commercial purposes, and then to give the farmers a right to buy the dam at the price fixed by the Railroad Commission. Such a law will rob nobody, but will convert frog ponds into corn fields.

In other parts of the Norway and Dover district, where the land was high enough to be above the back water from the Rochester dam, drainage conditions were good, and the contrast between these portions and that nearer the dam was effective.

Before the visitors reached Racine it was too dark to see the crew of tilers at work laying the large tile in the Root River Drainage District. However, during the day they saw a great deal of land that had been improved by large tile. They also saw a dry land dredge digging the perfect slopes of 1 to 1 so essential in a good outlet ditch.

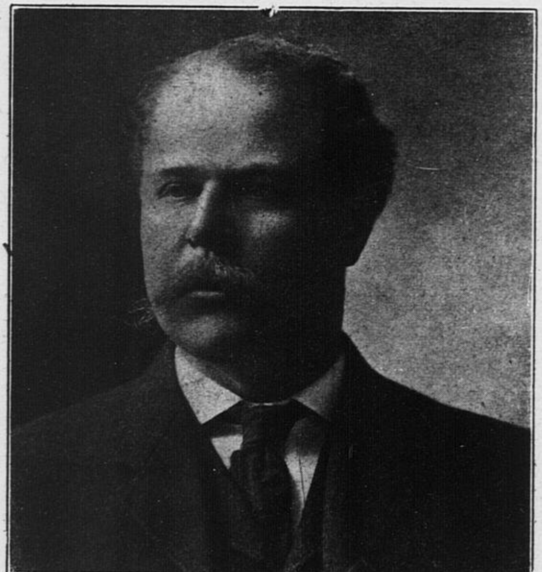
The visitors went out to get an eye full, and they got it. They had been shown, to their entire satisfaction, the value of drainage.

The afternoon and evening of October 10 was devoted to papers and discussions in the Assembly Room of the Racine Commercial Club. Secretary Reed of the Commercial Club welcomed the visitors.

THE ANNUAL CONVENTION

The Madison Convention was postponed to the late date of March 27 to facilitate the work of the legislative committee.

In the Auditorium of Agricultural Hall Dean Russell of the College of Agriculture extended a welcome to the visitors at the annual convention. He spoke of the value of getting together to discuss matters of common interest. He pointed out the progress that has been made in making Wisconsin more productive by improving the soil now cultivated, and by extending the area of cultivation over stump and flooded lands. Speaking of the importance of land drainage, he said:



DEAN H. L. RUSSELL

College of Agriculture.

"Two of the big agricultural problems which we have in Wisconsin today are those dealing with the reclamation of four million acres of wet lands and nine and one-half to ten million acres of cut over timber lands. These unproductive areas occupy nearly one-half of the State's total area.

"The careful attention of government authorities might well be directed towards either one of these problems. If one-half of the money which has been spent by the government on the irrigation of sage brush deserts had been spent on such problems as these, the returns would have been greatly multiplied. Up to July, 1914, approximately one hundred million dollars had been spent on these government projects and, according to the report of the Reclamation Service of the Interior Department, the crop returns from these areas have been as follows:

1912	$13,825,000
1913	15,732,000
1914	16,475,000
1915	18,164,000

"This one hundred million dollars spent on the reclamation of desert lands would have reclaimed over 3,000,000 acres of Wisconsin's wet clays and mucks, or an area equal to seven times that which has been reclaimed by the government. Such reclaimed wet lands will readily produce farm products $25 per acre. Prof. Jones has numerous records of the returns from such soils and many of these amount to $30, $60 and even $75 per acre. Figuring on a $25 basis a total return of $75,000,000 per year could be expected, or an amount equivalent to from 4 to 6 times the returns from the government reclamation projects.

"Another very important fact in connection with Wisconsin's vast waste area is that the markets are close at hand, over 15,000,000 consumers being within a night's ride of her borders. On the government irrigation projects nearly one-half of the value of the crops has had to go to pay the transportation charges. With Wisconsin's cows to convert the coarser products of our lands, preserved by a silo perhaps, into milk, cream, cheese and butter, our garden and grain products find a ready market and our forage crops do not lie in a stack 40 miles from a railroad, for want of a buyer."

Dean Russell's talk so impressed his hearers, that he was induced to enlarge upon his address at the banquet held a day later, and to repeat parts of it for the benefit of those who did not hear it at the first session.

The banquet was held at 6 o'clock on Wednesday evening, March 28. Peter J. Myers was toastmaster and about 60 were present. About fifteen of the banquetters responded to toasts.

The afternoon session on March 28 was held in the Hearing Room of the Capitol to accommodate members of the Assembly who had expressed a desire to hear the address of Mr. Carl Foll. Over 200 heard his talk.

The other sessions were held at the Auditorium of Agricultural Hall. The average attendance of the several sessions was about 60.

Both the papers of the Racine Convention and those of the Madison Convention are presented in this report. Much of the discussion that followed the papers has been omitted, first, because of lack of space, and second, because many of the points touched on in the discussion are covered in the papers. Unless indicated otherwise the papers were read at the Madison Convention.

PROFITS OF DRAINAGE.

William Hansche, Truck Gardener, Racine, Wisconsin.

(Racine Convention)

About 18 years ago there was a marsh of 120 acres just south of the city. It produced slough grass, mud turtles, frogs and fish. Farmers used to go there to cut a little wild hay to cover their strawberries, but the income to Mrs. Cutting, the owner, was less than 100 dollars a year.

To the amusement of our neighbors who thought we were crazy, my brothers and I bought this land for 61 dollars an acre. We got a surveyor to lay out a tile drainage system for us. The main was a 15 inch sewer pipe extending to Lake Michigan. It cost us over 2,000 dollars, for it was 10 feet deep in places. Then we spent about 25 dollars an acre for laterals. This was the best investment we ever made.

We plowed it up and have raised all kinds of truck crops there. It is too rich for grain but fine for cabbage, onions and potatoes. We have raised 33 tons of cabbage, 250 bushels of potatoes and 600 bushels of onions per acre.

I believe that I could duplicate this performance on any marsh land in the state.

Discussion.

Mr. Myers. Tell of the character of the soil.

Mr. Hansche. Part of it was peat to a depth of four feet, that burned like paper when it got dry enough. Beneath the peat was clay. In some places the clay came within a foot of the surface. The peat has got heavier and finer with cultivation.

Mr. Lucas. How does it stand drouth?

Mr. Hansche. Better than the highland. One year of extreme drouth I recall distinctly that the onions and cabbage were better on this land than on higher and heavier land. It also gets dry and workable in the spring earlier than the clay land.

Dr. Sherwood. How deep are your laterals?

Mr. Hansche. Three to four feet. They are four rods apart.

Mr. Coffin. Did you raise cabbage the first year?

Mr. Hansche. I did not put in the laterals for a year after I put in the main because I wanted the peat to settle. After putting in all of the laterals, I left it stand for two or three years, until the marsh grass had died out naturally. We put on manure in September, plowed it before winter, and put in cabbage the following spring.

Mr. Lucas. What kind of fertilizer did you use?

Mr. Hansche. Chiefly barn manure from Chicago, a carload of about 15 wagon loads to the acre every other year. In late years we have used a balanced commercial fertilizer. With the same application of fertilizer marsh lands produce better than uplands. My balanced fertilizer is 2% nitrogen, 8% phosphorus and 10% potash. We get the barn manure delivered at our station for about one dollar a ton, and we figure that a dollar spent for barn manure at this rate is worth two dollars spent for the commercial fertilizer, half a ton to the acre.

Mr. Cheesman. Have you ever applied lime to your soil?

Mr. Hansche. No, sir.

Mr. Gallagher. Have you raised corn on peat?

Mr. Hansche. Yes, and a good crop too. It grows a little longer in the fall on the marsh land and may get hit by the frost.

Dr. Sherwood. What mistakes have you made with your 120 acres?

Mr. Hansche. The 15 inch main falling one inch per 100 feet is not big enough at all times to drain 120 acres of land, receiving the run off from about 150 acres of surrounding land. I wish I had a 20 inch outlet.

Mr. Cheesman. What would you be willing to pay for your 120 acres as it is now situated?

Mr. Hansche. I would not invest in that kind of land now. I would take my money and buy some wild marsh land and do the same with that as I have done with these 120 acres.

DAIRY FARMING ON PEAT.

Carl Foll, Holstein Breeder, Deerfield, Wisconsin.

Sometime ago Professor Jones sent word to me "Will you come to the meeting of our Drainage Convention and give us a talk on peat farming?" I promised to come. Now, worthy listeners, I am only a common farmer. Don't expect from me a fine talk, like a lawyer gives, or like a minister, or like a professor from the Experiment Station. I was born and raised in a foreign country. I cannot talk the American language as plainly and correctly as you gentlemen who have been born and raised in this country, so if I make mistakes in talking the American language, please pardon me.

Forty years ago, when I came to this country, I knew nothing about farming. I had never plowed a furrow in my own country; I had never seeded grain by hand or by machine; had never mowed grass with a scythe or with a machine; in short, I didn't know anything about farming.

The first thing after I landed in Deerfield I looked for work. I found work, and hired out on a farm for the year. I worked on that farm for nearly four years. During this time I tried to study farming all I could. I kept an agricultural paper, and I went to some successful farmers I knew, looked over their farms and had a good talk with them. Then I studied the crops. If you go thru the country at the time the crops are growing, you can learn a great deal. I must say you can learn something about these things that a professor from the Experiment Station cannot teach you.

After a while I had a chance to buy a farm on a contract, and I thought to myself, "If I take this chance I cannot lose much because I have not got much." So I made a contract and started farming for myself.

I would like to explain to you about the farm on which I started to work. It was the poorest farm in the town of Deerfield—a peat farm. It was a farm of 187 acres of which about 60 acres were under plow, 5 acres timber land, about 20 acres marsh, and the rest of the land was covered with willow brush, tamarack stumps and tamaracks, and was rough and wet. Many times the cattle became mired and I had to go in with a spade and dig them out. That was the condition of the farm on which I started.

I bought the farm in the fall and after I bought it my problem was how to make improvements on this poor peat land. The following spring we had lots of water in the marsh through which ran an old ditch. After most of the water had run away, I went through that marsh with a pair of hip-boots and examined it. By doing this, I could plainly see that the old ditch was not running the proper way. So I staked out a new ditch, but that did not dig it. No money; no help; two little boys, one four years old, the other only two! But, if you have a will, you will find a way. I knew I had no money to build that ditch, so I went to the former owner of the land and explained it to him. He told me, "Go on, young man, build that ditch, and if you have no money I will advance you the money without interest for a whole year." So I hired a man to dig the ditch, and I made that ditch 10 feet wide at the top, 3 feet in the bottom and 3½ to 4 feet deep. The ditch was completed during the first days of June, and I felt that the money I spent for that ditch was well spent. Early in July I had my other marsh all cut and brought in the hay in good shape. Some years we could not cut that marsh until late in July or until August.

During the summer, the marsh got pretty dry. Cattle could walk over it without miring. One day I went on the marsh with a spade and examined the soil. I found in some places 3 to 4 inches of black soil on the top, and below was raw peat; in other places I found 5, 6 to 8 inches deep of black soil, then raw peat; in still other places I found a foot and more of black soil and then the raw peat. I decided that if that marsh could grow willow brushes it should be able to produce some hay. On the side of the new ditch I cleaned off the willow brushes from 5 acres, dug up the tamarack stumps, leveled off the big bogs, dragged it and seeded it down with timothy and red top. After a while my seeding came up nicely. The middle of October I had a very nice stand of timothy; but the last part of October and first part of November we had a lot of rain. After the rain was over, I went and examined my seeding and I saw it was covered from 1 to 3 inches with water, and that water stayed there until it froze up.

The next spring we had a lot of water again, and on my marsh the seeding was covered with water. It was so wet I could not walk through it until the first part of June. Then I could see weeds starting to grow quickly. Some of my timothy started, too, but I made up my mind that I had to watch those weeds or they would kill the seeding entirely. So the first part of July I concluded to cut the weeds down, but how could I cut them? I could not go in with the horses as it was too soft. I went to a blacksmith and I got wooden marsh shoes made, 18 inches square. We put them on the horses and found that they could then walk on the soft ground. I used the mower to cut the hay, but sank down with it several times and had a hard time to get the mower up again. Finally I got it cut. After it was dry, I used a horse-rake, but could not go in with a wagon and stack it. So we piled it. I hired another man, and we took poles and carried it together. After a while, my timothy that was left started to grow for second crop—some weeds too. The middle of September, I cut that same marsh again. Then it was fairly dry, and I hauled it out with a wagon. It was pretty fair hay.

The same year I cleared another 5 acres and seeded it down, but had no better results the second year than I had the first year. I believe that the hay that I got from those 10 acres would not pay me for the work that I had done on it. So I made up my mind that it was no use to spend my hard labor on that peat marsh. I left matters rest for a number of years.

After a while the farmers organized an association and bought out a mill pond which was about 5 miles away from my marsh. About 100 rods away from my marsh was Koshkonong Creek. That creek ran into the millpond and the millpond backed up that creek, and that was what made the underground of my marsh so very wet. *After the farmers bought the milldam,* the creek went down from a foot and a half to two feet, and the underground of my marsh got a good deal drier. I then made up my mind that it was time to improve the marsh. I went on with my same work, took five acres, leveled it off, seeded it down; but, I had no better results than with my first five acres that I seeded down.

But still I did not give up. I took another 5 acres the next year, and seeded it down. The same result followed.

Now I shall tell you a little more. Before the millpond came away, the marsh produced generally at two cuttings, from 50 to 60 tons of marsh grass a year. After the millpond had been away about four years, that same marsh went down in the yield. The marsh grass got thinner and shorter, and wild barley, June grass, and lots of other weeds started in. I had only half the hay that I had the time the millpond was there. I had to go out cutting hay on shares, rented grass, to get hay enough for my cattle.

I could now see plainly that in this way, I could make nothing more than a bare living on my peat farm. So I decided to sell the farm. I went to a real estate man and gave it over for sale, but he could not sell it. The people to whom they showed that peat farm would not buy it. The next year I deducted a thousand dollars in the price, and offered the agent, 3 per cent commission. But, still he could not sell it. So I was bound to stay on it. I could not move away and leave the farm because I did not have much. I tell you I was the uneasiest man that you could find. The boys were growing up—they had to have schooling, and where could I earn enough to give them an education? I made up my mind that I would have to experiment with that peat farm in a small way, and I'll tell you what I did.

I dug a hole on my upland 4 feet square and about 2 feet deep. Then I took that raw peat from the marsh and filled the hole up, put a little manure on the top and let it lay over winter. The following spring (middle of May) I took a spade and spaded it over, raked it off with a garden rake, and planted 25 kernels of corn. The corn came up nicely. Every Sunday morning, after I was through with my chores, I went over there, hoed that corn, and picked out the weeds by hand. The corn grew up 10 and 12 feet high. In the fall I cut the corn down and husked it, and I had 28 ears of corn. It was not quite ripe, but it was as big as any corn I ever raised. After I had husked my corn I stood there and looked at that peat and thought to myself, "Now, you d—n peat, you raise corn here and in the marsh you raise weeds. What is the matter with you?" But the peat didn't answer at all. I stood there and thought and thought, "What is the reason?" I found no reason other than that here was drainage while in the marsh there was no drainage.

I had discovered that peat raised corn, but how was I to drain the marsh? I had seen in agricultural papers some articles on tiling but I had never seen tiles and didn't know how to lay them. I went to the first clearing that I had made on the marsh at the side of the new ditch, measured off 100 feet and began to dig another small ditch about 2½ feet wide and about 20 inches deep. I ran the ditch along on the side of the old ditch about 26 rods and then slanted off into the old ditch. Where I started the second ditch I made another slanted ditch into the old ditch, so I had practically one acre that was ditched all around. The water ran nicely from my new ditch into the old one. After a while that land got dry and I could go in with the horses. I built a little bridge over the new ditch, and plowed the land. About a week after I plowed it (it was pretty late) it froze up. In the winter time I covered that acre with 12 loads of barnyard manure. The following spring, after I was through with my other corn the last part of May, I went over there with a pulverizer, pulverized the land, dragged it and planted corn. I bought the Yellow Flint corn. The corn came up nicely. We had to hoe it twice as the weeds grew very quickly. In the fall we harvested that corn and I had 42 bushel baskets of corn,—solid Flint corn. Now I could see that the peat marsh could produce corn if it was drained. I plowed that same piece over again in the fall, took another 12 loads of manure in the winter-time and spread over it, and raised another crop of corn. The next year I had 63 bushels of solid Flint corn.

This was enough to show me that that peat land could produce corn if it was properly tiled,—but how to tile it was a problem to me. I asked several about tiling. They laughed at me, and said, "Why do you want to tile that peat? That peat is good for nothing." I didn't argue with the people—I knew from my own experience that peat would produce corn.

I knew a neighbor's boy who had taken the short course in agriculture at the University. I went to see him and he said that they taught tiling at the college, but since his land was rolling he had not paid much attention to that work. How I wished I could go to that school!

Then a bright idea struck me. I had a boy who had finished graded school, and I decided to send him to Madison. He argued that he had schooling enough for the farm. By fall, however, he had changed his mind. Perhaps the gold watch I gave him helped. At any rate he entered the Short Course that fall.

At Christmas time he had learned nothing about tiling. The same was true in March. But a year later he came home with his diploma and a medal won judging live stock. He had also learned how to tile and to use a level, and had had many talks with the instructor in soils about the proper fertilizer to use for peat.

That summer after we had our grain stacked he borrowed a level from the Agricultural college and he and his younger brother began to survey the marsh. They set a lot of stakes and put marks on them that I did not understand, but by night he had made a map and a plan. He explained it to me and then I understood it. He made a list of the tile of different sizes that we needed. I had to borrow money to pay for the tile and the tools with which to lay them.

While we were laying that tile a good friend of mine came to me and offered advice. He advised me to quit burying money in the peat marsh. I thanked him for his good intentions, but kept on tiling, and am glad I did. In four weeks we had tiled 10 acres. It looked good to see the water running out of the 6 inch outlet. A 12 quart pail full every three minutes. In two weeks the tile had stopped running, because they had the 10 acres dry. With three horses we plowed that marsh where no horse had ever walked before without bog-shoes.

In the middle we left a strip for a road. We had, in the barnyard, about 40 or 50 loads of manure, and we put it on the top of the plowed land. In the winter time we finished manuring it. Next year, about the 25th of May, we went in there with three horses on the pulverizer and two horses on the drag, and we put in the corn. It took us about 8 or 9 days. Then we dragged it twice while it was coming up.

One Saturday I went down to see the corn and I made up my mind I had to start Monday and cultivate that corn. Weeds were springing up pretty thick. From Saturday to Sunday we had a frost. Sunday morning I could see in the low marsh there was a white frost. I thought right away of my corn. After breakfast, I and the boy went down and our corn was frozen down to the ground, and the ground was frozen as thick as a lead-pencil. We made up our minds that Monday we would drag it well and plant it again.

But the pathmaster saved us without knowing it. On Sunday he came and I told him that our corn was frozen in the marsh and we would have to replant it. He said he had to have us to work on the road with two teams for two days, and we had to go. When I came home from working on the road the first day I went down quickly to look at the corn and could see it coming nicely again. Next morning we went and examined it carefully and we could see plainly that every kernel was coming again. The corn grew very nicely and we took good care of it. It grew up to 10 and 12 feet high.

Then the boy began to talk silo. "A silo! What is that?" He explained to me what a silo was. All I needed then was the money. We finally got that and built the silo. It was the first silo between Madison and Lake Mills. That was 17 years ago. After the corn was ready to put in the silo we wanted to know how many tons of corn there was. So we went in the center of the corn field, measured off one square rod; cut the corn by hand and carried it on our shoulders out to the road; loaded it on the wagon; went home and put it on the scale and I tell you, my good friends, I had 24 tons and 700 pounds clean corn per acre. Our silo held 180 tons. We filled that silo and we had 36 to 40 shocks of corn left.

The same fall we plowed that piece again but put no fertilizer on it. In the spring we put corn in it again, and we grew a nice crop of corn but it was not as heavy as the first crop. Nevertheless we filled our silo with 10 acres of it.

Then we took another piece of marsh, 12 acres, and tiled it. At the same time took the pulverizer and pulverized that piece on which we had the second crop of corn, and put rye in it. We also put in 8 pounds of timothy seed and 1 pound red top per acre. The rye grew up nicely, and we harvested 22 bushels per acre, and I had a lot of straw that I could make into manure. A good manure pile is a farmer's bank. We had on the second tiling a good crop of corn too, but still we fertilized it with barnyard manure. After the rye was cut from the first tiling, the timothy, alsike clover, and red clover I put on in the spring grew up nicely, but some weeds came too. The middle of September we cut it and we got 10 good loads of hay. I saw it was a good hay crop. There were some weeds in it, but those little weeds cut no figure.

On the second tiling, the second year, we had a crop of corn and we had plenty of corn to fill our silo—good crop—and on our first tiling we had a wonderful crop of hay—timothy, alsike clover and red clover. I judge we had 2½ tons per acre, and we had a second crop with 1 ton per acre.

Then we went to work and tiled another 10 acres, and we went on this way until I got 70 acres tiled. I raised on that tiled ground, 2 years corn, 1 year rye, 3 crops of hay, and 2 years in pasture. That is an 8-year rotation. Furthermore, at the time when I had done no tiling I had on that farm 4 horses (some years we raised a colt); I had 25 to 28 head of cattle—cattle that were no better than common cattle; today I call them scrubs. After we had tiled that marsh and had it in the 8-year rotation, we had good feed and good feed makes good cattle. I started a thorough-bred Holstein herd. I still had a big debt on that farm, but I made up my mind to have good cattle, and as I told before "if you have a will you will find the way." We started in a slow way with a pure-bred sire. Later on when I had money, we bought a few pure bred females. Today you can come to my farm and find a herd of cattle between 50 and 60 in number that are worth from $13,000 to $15,000. While the marsh was wet my cattle were worth only from $700 to $800. I invite you to come to Deerfield to see for yourselves.

Furthermore, at the time that I bought that farm the buildings on it were all poor. Today you will see a dairy barn 90 feet long, cement floors, patented stanchions and a milking machine. You will see a separate horse barn which holds 11 horses; a house which cost me about $4,000.00. You may see all these things on our place. What brought us this? That *peat farm.*

Now, friends, I have explained to you what you can do with your peat land or with your marsh land. You all can do it, but you have to have drainage. Some of you gentlemen will say "If we drain our own marshes they may get too dry—they may then produce nothing." I don't agree with you. I have told you fully my own experience. Take a sponge, fill it with water and hang it up on a string. The water will run and run and run. At last it stops running and drops and drops. At last it stops dropping, but take hold of it and it is full of moisture. It is the same with your peat marsh. If you tile it, you will not get it too dry. By tiling the peat marsh, water will run out while there is too much in it, but peat will keep some moisture. I have farmed that peat marsh now for 17 years and I never had a crop failure. Of course on a dry year or a dry spell your crops don't grow, but I never get such a dry spell in my peat marsh. It never has gotten too dry and never got too wet. That is the success I have met raising crops on a peat marsh. All that is against me is sometimes a hail storm or, in the fall, an early frost.

You now have heard me talk about peat marsh. You can do the same thing today. You can do it better than I did it 20 years ago. I could not get the information from an agricultural school as you can today.

Now I have taken a lot of your time; and thank you for the attention you have given me.

Question. How long ago did you go on to your peat farm?

Mr. Foll. About 34 years ago.

Question. Haven't you, in more recent years, used some commercial fertilizer?

Mr. Foll. Yes. After I tiled and fertilized my marsh several years, I could see (especially in some years when my clover crop failed and I ran short of manure) that I took away too much manure from my upland. The crops and the yield got shorter on my upland. Now, what should I do? Really I didn't know. I wrote a letter to the Experiment Station, and I believe that letter came in the hands of Professor Whitson. Professor Whitson wrote me, "You can use potash on your marsh, but before you go to a big expense we will send you 200 pounds of potash for an experiment. You take the 200 pounds of potash, go in your marsh, in the center stake off an acre and sow it evenly on that acre of land. Around that acre for about 3 rods you put nothing. On the rest you can put barnyard manure. Then watch the result." I took his advice, and the potash I put on that acre was just as good a fertilizer as my barnyard manure.

The next year I bought a ton of potash from the local dealer in Lake Mills. I opened the bags, and it came to my mind that the potash didn't have the same color and looked not as clean as the potash I had the year before from the Experiment Station. So I went to work, took a cigar box, opened all the bags and took evenly from each bag a handful and filled that cigar box. There were some tags on those bags on which was a guarantee of potash from 48 to 50%. I took some of those tags and laid them in the top of that cigar box, and sent it to the Experiment Station for analyzing. The Experiment Station sent me a letter and told me, "The guarantee of your potash is from 48 to 50% but the analysis shows only 28%; but wait a week and we will go over it again." I received another letter which told me the first analysis was all right. "Go back to your dealer and explain to him. You paid too much money for your potash." I believe I paid $45.00 a ton. I went to my dealer and showed him the letters from the Experiment Station. He said, "We bought it in Chicago. We are not responsible for that." But I told him, "I bought it from you, and if you don't settle with me this thing will be reported to the state. You'll have to settle with the state." In four days a man from Chicago came to my farm and he made a settlement with me. I paid only $25.00 a ton. He paid me my money back and told me, "It is cheaper to settle with you than with the state."

Since I had poor potash, I bought some acid phosphate fertilizer. I mixed that with my potash, and I put 400 pounds per acre. I got just as good corn as I could wish. Mr. Jones came at the time I cut that corn, and saw it. So I say to you, if you have no barnyard manure you can use potash and phosphate.

How your peat is, I don't know. You will have to have it analyzed and the Experiment Station will tell you what fertilizer you need. Be not afraid to buy it. You will have results.

I had more experiments with that commercial fertilizer. The next year I bought potash and phosphate, mixed it together again, and put on only 300 pounds per acre on the same field, but I left one acre to see how it would turn out. Where I put on the 300 pounds there was a good crop of corn. It was just as good as I could wish, but not so on that one acre where I put nothing. The next year I put on rye, and in the spring I applied 100 pounds of potash and phosphate. I had a pretty good crop of rye,—18 bushels per acre. The one acre on which I put nothing was not worth cutting. The next year I had it in hay. I put on 75 pounds only per acre. I had a nice crop of hay; but where I put on nothing,—well, there was nothing, anyway not much. The next year I put on 75 pounds again and I got a good crop of hay. The next year I put on nothing, but still I got a fair crop of hay, and on the two years past I put on nothing but still it was good.

Question. Have you ever raised potatoes on your peat?

Mr. Foll. Yes. My peat is of two classes; one class is a loose peat mixed a little with sand; the other peat is a solid peat. I tried the two kinds of peat out in potatoes. On the loose peat I put on barnyard manure and raised a crop of corn. The next year I put it in potatoes, and I raised a nice crop of potatoes. My judgment says I had at least from 130 to 150 bushels of nice solid potatoes. They were not enormously big potatoes, but good sized potatoes, round, smooth, with shallow eyes, and a good taste.

I tried potatoes in the solid peat marsh, but there they didn't grow so well. I tried vegetables too. In the loose peat the vegetables (to my notion) didn't grow well. I didn't know how it was, but I found it was too loose for vegetables. But where I plowed the solid peat in the fall and gave it a coat of well rotted barnyard manure as a top dressing in the fall I pulverized it in the spring and put vegetables in it with good results. I had wonderful cabbage, splendid beets, and good rutabagas. Now remember if you plant them in clay ground they will get all kinds of forms (long heads), but if you raise them in the marsh they will be round like a bean, no long heads at all and have a very sweet taste. I had carrots in the marsh, 10 inches long with tops that measured 3 to 4 inches in diameter. I had onions as big as a coffee-cup, but still there were some smaller onions there too. Tomatoes grow large in the marsh, but you have a great time to get them ripe as there is too much moisture in the marsh.

TILING DEEP PEAT

O. R. Zeasman, County Representative, Green Lake, Wisconsin.

Before discussing the tiling of deep peat, let us decide what we shall call deep peat. The average man thinks of peat as something used for fuel in some European countries. If you were to ask the average marsh land owner in this state if he had any peat in his marsh, he would say, "No!" It is a brown or black muck, 4, 5 or 10 or more feet deep. Upon examination this so-called black muck nearly always proves to be peat.

Peat is the accumulation in old lake beds of partially decayed vegetation such as grasses and mosses. Color does not determine whether it is peat or muck. It may range in color from yellow or light brown to black. It may be fibrous, soft and spongey, tough as a felt boot, or loose and friable and well decayed. It is nevertheless peat in any of these stages of decay. For purposes of the present discussion, we will arbitrarily apply the term deep peat to beds over 4 feet in depth.

There are perhaps 1,000,000 acres of undrained deep peat in Wisconsin. How to reclaim this waste land is a live question. About half of it has an outlet, natural or artificial, and is waiting for supplementary drainage. The other one-half million acres require dredge ditches to give supplementary drains an outlet. On this matter of outlets there is agreement of opinion. But what sort of supplementary drains shall be installed? Some drainage engineers and other men experienced in drainage, say "tile"; others object to this and say "you cannot tile deep peat successfully." I propose to touch upon a few of the important points that should be considered in tiling deep peat.

The depth at which tile should be laid in peat is one of the much disputed points. Let us consider this question from several viewpoints. (1) Will water pass downward rapidly enough to permit of deep tiling? In all types the downward movement is more rapid than through clay. Tiling clay to a depth of 3 feet has proved very satisfactory. In fibrous peat, water will go downward nearly as fast as through sand. Partially decayed peat with an admixture of silt drains the slowest, but even in that type the drainage is rapid enough if the tile are 4 feet deep. In fibrous peat, tile may be laid 5 feet deep without material sacrifice in speed.

(2) Tile should be laid below the frost line when bedded in peat. When a perfectly dry soil freezes it does not heave. The heaving of a soil upon freezing is due to the expansion of the water in it. A peat when drained as dry as it will drain consists of from 50 to 75% by weight of water. This causes a peat soil to heave more upon freezing than any other soil. Hence it is important to get tile below the frost line or they may be heaved out of alignment and up to where the plow will catch them. On February 6 of this year, frost was down only about 12″ to 18″ in peat. Although this was a severe winter, there was a good covering of snow. I don't believe that frost in this state ever goes down over 4 feet in peat and usually not over 3 feet except under hard packed roads. Tile laid 4 feet deep in peat should not be damaged by freezing.

(3) The settling of peat should be considered in determining the depth to lay tile in deep peat. What causes the settling of peat? (1) The removal of water leaves spaces between the fibres that allow packing. (2) Working the land with implements, the tramping of stock at pasture, etc., packs the peat mechanically. (3) The vegetable matter forming the peat decays when exposed to air and cultivated. Undrained peat is waterlogged and does not decay nor settle. When drained, air gets in and bacteria are introduced in manure and decay of the peat begins.

Nearly everyone familiar with the drainage of peat recognizes that settling occurs, but upon the question of amount of settling there is great divergence of opinion. Personally I have taken elevations on one marsh, both before and after drainage. This observation consists of 4 elevations along each of 3 lines of tile laid 4 feet deep in peat, 5 to 6 feet deep. The averages of the 12 readings showed that the marsh had settled nearly .3 of a foot in the first year of drainage.

I have been unable to find records in this country of the settling of peat when drained. But in England, where they have for over 200 years drained peat very similar to that found in Wisconsin, they have authentic engineering records of the settling of peat. The following data were obtained from drainage records of the Lincolnshire Fens. In the East fen the peat shank from a depth of 6 feet, to 2 feet, or an amount of 4 feet in 80 years, or at the rate of $^3/_5$ of an inch per year. In Deeping fen, where the peat bed was 10 or more feet deep, the surface settled 24 inches in 25 years, or at the rate of about one inch per year. In Hilgay fen, peat settled 52 inches in 26 years, or at the rate of 2 inches per year. These long time averages vary from $^3/_5$ of an inch to 2 inches per year. The rate of settling is more rapid the first few years after drainage than later. In Whittlesea Mere the peat in the first 9 years of drainage settled at the average rate of 4.66 inches per year, and for the next 22 years at the rate of 4.18 inches. After this the rate was .02 inch per year. The rate and total amount of settling for the first 31 years seems excessive. I have been unable to find a detailed statement of the nature of the peat in Whittlesea Mere aside from the fact that the bog was originally a lake. I presume the peat was very raw and fibrous and that considerable of the settling resulted from mechanical packing. We need to collect data on the settling of peat in this country. This foreign material, however, points out the danger of tiling too shallow in deep peat. Tile deep unless you want to do it over in a few years. Lay the tile at least 4 feet deep, and 5 feet is none too deep in the fibrous raw material.

After making this statement you might well ask if I do not believe in *shallow tiling* of peat. I do not when it is possible to tile deep. However, I believe there are instances when it is justifiable to tile peat as shallow as 3 feet. I would advise tiling shallower than 4 feet rather than not tile at all under the following conditions. (1) When the peat is reasonably well decayed and settled as in old pastures. (2) When it is impossible to get an outlet to tile deeper. (3) When the tile system will drain the land thoroughly for a long enough period of years for the crops that can be grown to leave a good net profit on the investment.

After telling of the settling of peat you might reasonably be expected to ask "How can you tile peat successfully when it decays and settles? Does this decay and settling not disturb the alignment of the tile?" Remember that decay and settling occurs only where air gets into peat, and that air can get into it only where the water is drained off. Settling will then occur only above the tile in all marshes that are kept wet by seepage, and most of those located above limestone ledges. In a few flat marshes the water table may, during droughty summers, fall below the tile. Then undoubtedly there will be some decay and settling. If such marshes are tiled at all, the laterals should be given considerable fall, to reduce the danger of damage to the minimum, and the main should also be located where the peat is deepest. Any settling then will tend to give the laterals more fall.

In this connection it is well to remember that soft spots will be encountered in tiling deep peat. Here tile may get a little out of alignment. To guard against any considerable damage from these little irregularities, tile a little larger than seem necessary should be used. Five-inch tile are the smallest that should be laid in peat.

The cost of tiling peat to a good depth is reasonable. The most expensive portion of the digging is the first spading. Here are found logs, the roots of trees and brush and tough grass sod. The last 2½ feet of a 5 foot ditch will cost no more than the first 2½ feet. A tile drain laid 5 feet deep in raw peat will be more efficient from the very start than a shallow drain, and it will be more permanent.

Closely related to depth of tile in peat is the distance apart that the laterals may be placed. I have here a profile of a deep peat with tile laid 10 rods apart and 4 feet deep. Half way between the tile, water was somewhat over a foot higher than the water at the tile. From this and other observations I have been convinced that the water table in peat arises approximately one foot in every four rods. This means that if tile are laid only 3 feet deep in peat, they cannot be spaced much over 4 rods apart. If the tile are 4 feet or more deep, they will drain equally well at 8 rods apart. Thus by the extra depth of one foot, the cost of an entire line laid 3 feet deep is saved. All the fibrous and fairly raw deep peats will be drained readily by lines of tile 8 rods apart. In rare cases where the peat has reached a certain stage of decay and has an admixture of considerable silt, and in springy zones, tile sometimes need to be placed closer than 8 rods.

I have here a number of instances where deep peat has been tiled with good results. J. M. Stack near Fond du Lac tiled some raw peat that was from 6 to 7 feet in depth. The tile are laid 4 feet deep and 8 rods apart. The drainage is satisfactory and the system is in perfect condition.

C. H. Vine at Packwaukee tiled some deep peat in 1914. The tile, where bedded in peat, are in perfect working condition.

Fred Gunther at Babcock laid considerable tile ranging in size from 5 inches to 14 inches, in peat varying from 6 to 8 feet in depth. At first he used some home-made cement tile which fell down. These were replaced with clay tile which have stood the racket well. The system is in perfect condition. However, for first class drainage more laterals should be added to the system.

Philip Lehner at Princeton installed a tile drainage system on his farm in 1914. Some of the system is in deep peat. The tile are laid from 3½ to 4 feet deep and 8 rods apart. The drainage on this portion is satisfactory. On part of the main, however, where careless workmanship was done in sand, trouble has been caused by filling up of tile.

These instances which I have cited and others which might be enumerated show that deep peat can be tiled successfully. The most important point to remember in draining deep peat thoroughly, economically and permanently is to get your tile down deep, at least from 4 to 5 feet, if your outlet permits.

RAISING FIELD AND SEED CORN ON PEAT.

M. J. Vea, Manufacturer and Farmer, Stoughton, Wisconsin.

Having been brought up on a splendid black loam farm, overlooking the city of Stoughton, I had always thought that Dane was the most beautiful and productive county of the best state in the finest country in the world. You can perhaps imagine how I felt and what I said when Prof. George Huntington Williams, the great geologist at Johns Hopkins University, made the remark, after looking over the topographical map of Dane county,—"Why, your county is over half water and marsh. It must be a very desolate, malarial poor country in which to live!"

When I came back to Wisconsin I decided to buy a marsh farm and drain it. In 1907 I found one near Stoughton with ninety acres of marsh and only thirty acres upland, some of which was woodland pasture. I knew of no tiling being done in Dane county at that time, though undoubtedly the university had tiled some land. As a demonstration to the community, Mr. Jones of the Agricultural college laid out my drainage system and his students superintended the work during construction.

In so fine a dairy state as Wisconsin, with more high grade milch cows than any other state, except New York, it seems more appropriate to discuss the subject given, on a broader basis. I will not only discuss the raising of seed corn on peat but also the raising of common field corn as a part of a crop rotation for dairying, hog raising or the production of beef.

In the first place, a great deal of our peat land is not rich enough to produce seed corn without special treatment, and, secondly, only the choicest ears on the very best pieces of land will measure up to the high standards of the best seed corn.

Killing Off the Marsh Grasess. Before a drained marsh is fit for a cultivated crop like corn, it is necessary to kill off all grasses. This can perhaps be done best and cheapest by sowing buckwheat. This cereal will not only kill off all native vegetation by its vigorous dense foliage, but will also yield a good paying crop. A peat field on which buckwheat has been grown the previous year makes an ideal field for corn, as it is as free from vegetation and in as fine condition as any garden plot.

Plowing Peat Land for Crops. All peat lands that are to be put into field crops the next year, should be plowed the preceding fall. This is especially important for corn land as peat will not produce a corn crop unless the corn is planted *early*. Peat land is the last to thaw out in the spring and also the last to freeze up in the fall. The particles of soil are so fine that they are very impervious both to heat and to cold. Long after your up-land can be plowed to good advantage in the spring, the marsh soil will have frozen parts. On the other hand, you can plow peat land much later in the fall than you can upland. Even if a thin frosted coat forms, this soon disappears with a few warm days or a good rain in the fall. We have plowed our marsh lands as late as the later part of December and the first of January. It is however all-important that you plow it as early as possible in the fall as an early winter may set in and prevent any more work. A peat land farmer in my opinion is not doing his duty by his land if he does not plow it in the fall. Moreover he will also find it much easier work and he will be very thankful to have it out of the way in the spring. This is especially true, if the spring happens to be a very wet one.

The Seed. Any one intending to grow seed corn should get the best seed that can be procured in the state in which he lives,—seed preferably grown fairly close to home.

This seed should not only be a pure strain of seed, from one of the best yielding and most profitable varieties in the state, but should also be procured from a high grade grower, who has selected seed for years on the basis of early maturity and all the usual sterling qualities required of the best and choicest seed. This seed corn moreover should not only test 99% or better in germination but also must be of exceptional vitality. The vitality of seed corn is of greater importance on peat soils than on upland soils, as peat soils are the last ones on the farm to warm up in the spring. If the spring is a cold, wet one, it is necessary to have such good seed that every kernel will come up, even if the corn does not appear above the ground for two or three weeks after planting.

If the spring is favorable the corn will come up in a few days, and your strong vital seed will give you all the better and more vigorous corn.

Plant Your Corn Early. It is exceedingly important that corn should be planted very early on peat land. Marsh lands, as a rule, are a little lower than the surrounding country; early frosts accordingly strike the peat land crops first of all. If the

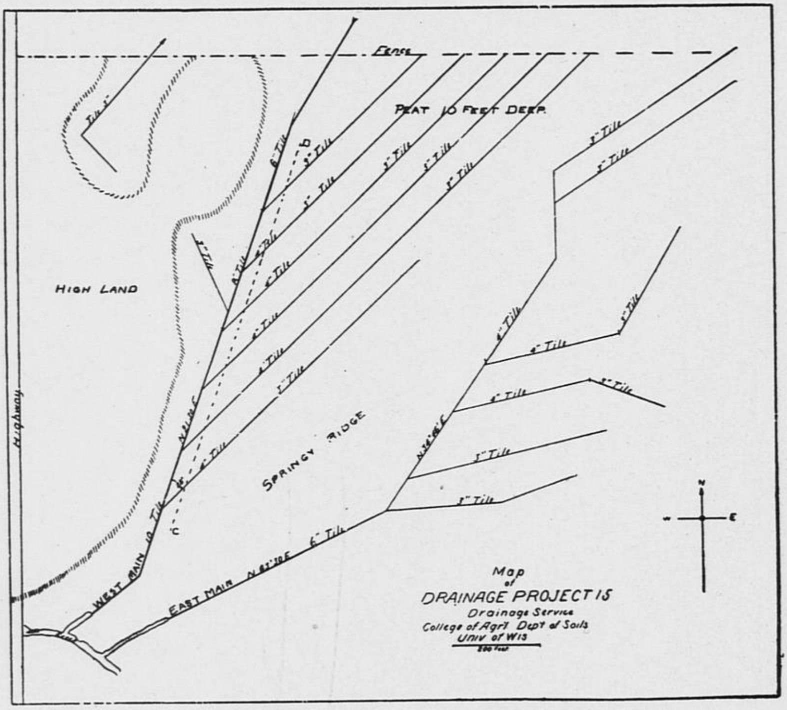


FIGURE 2. M. J. VEA'S DRAINAGE SYSTEM.

By tiling deep all around the springy ridge, the seepage water entering from the northeast was cut off and the wet, boggy, ridge underlaid with gravel was made dry without any tiling at all.

corn has been planted early, it will be matured before frost arrives. Corn should be planted between the 10th and the 25th of May. Even if the weather is not favorable, the corn roots get a chance to start, and the plant is ready for growth when the first favorable weather arrives. A very common sight in peat cornfields is to see the corn ten, twelve feet or more high in one field and a short distance away, corn that will not grow more than five to seven feet high. Invariably you will find that one of these fields was planted early, producing the best corn in the country, while the other was planted late and will only make a small quantity of inferior silage.

If your corn is far enough along by the time the hottest weather arrives, the corn will grow so rapidly and so large that it is a pleasure to watch it grow.

Planting Seed. Corn planted to produce seed corn should not be drilled in but planted with a check row planter as the corn gets the maximum amount of sunshine in this way and also can be kept more free from weeds.

Fertilizing the Corn. You cannot decide anything about the fertility and productiveness of peat land until you begin to raise crops on it.

The higher, more or less rolling pieces of ground are usually jet black, rich looking muck, while the lower spots and former swales are poor looking red peat soils. One naturally thinks that the black muck soils are rich and the red peat land is poor, while as a matter of fact, usually these higher spots, altho decomposed into muck by exposure to air, have been robbed of some essential soil elements, some of which may have been deposited in the lower peat lands. You cannot tell where to distribute your fertilizer until you see how crops grow on the peat. Corn is ideal for this purpose, showing not only by its size and vigor, where the soil is rich and strong, but also by the color of its leaves. Fertilizers can be applied as a top dressing from the time that the corn is about five inches high until it is knee high. The farm referred to in this paper has 90 acres of drained peat land to only 25 acres of upland fields. On a stock farm it is impossible to use all the manure produced on these few acres of upland. It has been the custom to fertilize the corn field the first year or two with common barn yard manure. Wherever the corn is ideal in size, vigor and color, no manure is applied. Wherever the corn is undersized, lacking in vigor and of a yellow sickly color, manure is applied, giving the poorest spots the heaviest coating of manure.

Another reason for preferring manure to any other fertilizer the first year or two is the fact that manure helps to inoculate the soil with valuable microbes. Peat soil has been soaked so long that upland microbes are absolutely lacking in the wet peat land and more or less so in the balance. Soil so dead that corn will not grow over four–five inches high and then turn white and die, will make a fair crop of corn if a good coating of manure is put on as a top dressing.

Study your Soil. It is exceedingly important that you have your peat soil analyzed. Experiment with different combinations of artificial fertilizers and manure so that you find out which elements are lacking. This should not be done on a large scale as it is too expensive. A series of tests conducted here at the university, demonstrated that our peat land near Stoughton is lacking in phosphorous. Rock phosphate is applied at the rate of 100 lbs. to the load with a dressing of approximately ten loads to the acre. If your test shows that manure is not economical and that other fertilizers should be used, I advocate that the same practice should be followed of applying the right kind of fertilizer as a top dressing. You will save nearly half of your fertilizer by following this practice.

Harvesting Seed Corn. The gathering of seed corn on a large commercial scale is quite an undertaking. The method finally adopted was to cut out each ninth row of standing corn, so that a team could drive between the rows of standing corn and gather the piles of seed. This row was cut by hand, two men preceding the corn cutter, who picked out the seed ears from this row of corn. The corn stalks secured in this manner, were spread on each side, between the next two rows, in such a manner that they made a clean bed for the seed corn.

Expert corn men would then pass thru the corn, selecting the choicest ears, and placing them on these beds. The haulers carted this corn to the seed house, where the seed is again selected. The choice seed ears are placed in a basket and hoisted into the seed house, while the other ears are thrown into another wagon placed alongside and hauled to the corn crib. An ideal corn field, with a hot dry summer, may yield up to 25 bushels of seed corn, with more than double that amount of crib corn.

Rotation of Crops. Rotation of crops in the peat fields is as valuable as on upland soils. A field planted to corn continuously is apt to breed corn pests. Peat soil is also so rich that weeds thrive wonderfully. It is necessary to have quite a portion of your land in hay and other crops, so that the corn acreage will not be too large for proper attention.

An ideal five year crop rotation is to raise corn two years, soy beans and amber cane, or millet, sweet clover and Canada field peas one year and hay two years. This is a very good rotation for any one who is feeding milch cows or raising beef.

Soy beans thrive wonderfully on peat land and with amber cane make an ideal combination to mix with corn in the silo and also the best possible kind of hay for milch cows or for making beef.

A mixture of millet and Canada field peas also thrive wonderfully and make a great quantity of valuable feed per acre.

The most successful hay crops have been secured from a combination of timothy and red top with the various legumes, alsike, red clover, sweet clover and alfalfa. When the various clovers are planted alone, they are not very successful, on account of the ground heaving too much in the spring. Timothy and red top help to make a sod that prevents this. A combination of various grasses of these kinds make a heavy crop of very nutritious, palatable feed. These grasses grow continuously all summer, never failing to give a good second crop of valuable hay.

A dairy farmer who wants to raise a crop with the maximum amount of protein per acre to make a balanced ration with his silage and a minimum amount of grain can do so by planting a mixture of quick growing legumes. In this mixture soy beans should predominate. With these soy beans you may sow yellow sweet clover, spring vetch, giant incarnate and a smaller proportion of Canadian field peas. From this mixture we have secured four to five tons per acre of exceedingly rich, palatable hay. Yellow sweet clover is better than white, on account of its more rapid growth and earlier maturity. Milch cows are eager for this hay. An upland farmer has no advantage in dairying over a peat or muck land farmer, if the peat farmer will see to it that his land is growing heavy crops of palatable feed, instead of loafing around with little or nothing planted on it.

A farm on which one-half of the land or more is peat, makes an ideal stock farm. It is however more essential to have a silo on such a farm than on any other, on account of the danger of early fall frosts. Peat lands naturally occupy the lowest places, where frosts first occur. You cannot be sure that your corn will be entirely matured when frost arrives. If you have a silo or silos you are always certain that you will have great quantities of ideal feed every year in the form of silage.

This rotation of crops will help you keep your land free from weeds and pests. If you will give your corn field ideal attention in every way, you will get splendid results. Hot dry summers will give you a larger crop of seed than you would think possible. A mild wet summer will give you only a moderate amount of seed. It accordingly is important that you do not depend on seed corn as your main crop. Dairying and stock raising will give you a sure, steady source of income. Sugar beets, onions, seed corn, celery and other crops which can be raised at a profit should be treated as additional sources of income. Some intensive farming of this kind will keep you interested in bringing all of your peat land up to the highest level of efficiency, and make you much more successful also with your other crops.

MANAGEMENT OF PEAT AND MUCK IN SOUTHERN WISCONSIN.

W. W. Weir, Assistant Professor of Soils, College of Agriculture, Madison, Wisconsin.

"Now that I have it, what can I do with it?" is a common question asked by farmers who have added to their inheritance some drained peat or muck. In taking hold of such a proposition some proceed almost with fear and trembling lest that used-to-be, water-soaked, frog-hatcher might possibly turn out to be a neighborhood joke. Others believe that it's all a matter of time in allowing the peat to get the habit of raising "civilized" crops. A lack of understanding of the possibilities of a peat or muck is largely responsible for many temporary and possibly a few permanent discouragements in Southern Wisconsin.

There is no reason whatever why a field of 10, 20 or 30 acres of peat should be looked upon as a "black sheep". It can without much difficulty be made to fit into the rotation systems practiced on the farm. To illustrate:

A dairy farm consisting of 120 acres is made up as following:

About 65 acres upland in crops
10 acres upland pasture (in rotation)
20 acres (permanent pasture)
20 acres marsh (mostly peat)
5 acres for yards, buildings, &c.

Before draining the marsh the farmer carried on his farming in the following manner:

28 to 39 acres were given to raising corn
19 to 20 acres for grain
17 to 18 acres for hay (Alfalfa about 8 acres)
10 acres for pasture in rotation
20 acres (permanent pasture)
20 acres Marsh—a poor to fair pasture for young stock.

Systematic crop rotation was practiced,—not a simple three or four-year rotation fitted to the whole farm, for the conditions forced him to dovetail four systems of rotation, viz.:

1.) A 3-year rotation of corn, grain, clover (for hay)
2.) A 3-year rotation of corn, grain, pasture
3.) A 4-year rotation of corn, grain, clover, pasture
4.) An alfalfa rotation,—alfalfa (3–4 years), corn, grain, clover.

Tho a few irregularities crept in, this farmer was able to raise each year the amount of crops required to feed his stock.

Cultivating the Marsh. After the marsh (peat) was drained, corn was successfully grown on it. This affected the rotation systems but little. A few more irregularities resulted than before, especially during the first three years, because corn was grown three years in succession on the peat. The cropping acreage having been increased, the farmer increased the size of his herd, and raised each year:

37 to 40 acres of corn
20 to 30 acres of grain
20 to 30 acres of hay (10 acres alfalfa)
10 acres of pasture in rotation
20 acres of permanent pasture.

On the upland practically the same rotation was continued on each field as was in operation before the marsh was cultivated.

Thinking Thru the Peat Problem. To place a crop of corn as the first crop on a southern Wisconsin peat is a simple thing requiring no real thot; but to think thru the problem of successful peat and muck management is quite a different proposition.

There are two ways of starting out,—a wrong and a right way. If he has never cropped a peat, then the farmer has before him a new experience. He can start out in his own way giving no or little heed to what others have done, or he can resign himself to the teachings of science and give a listening ear to the experiences of others.

A student in a college laboratory would, if he had any wits at all, study thru the details of an experiment before attempting the experiment. That is the only way whereby he can direct his energies to the best advantage. What successful business man, engineer, teacher or lawyer is there who does not follow the same principle? Why can't the farmer apply this rule of success to his hog-raising, cow-feeding and marsh management? He should, therefore, think beyond the mere decision of putting corn on that peat. He should drive his thinking down into the soil itself.

Some Points to Think About. What are some of the points that the farmer should think about? If he has done any reading at all, the following questions would surely confront him,—"When should I plow the marsh? What is a good first crop? Shall I use lime? Shall I use any manure? What about commercial fertilizers,—if needed, what kind and how should they be applied for most profitable returns? Is it necessary to rotate crops on a peat?"

It would be well to formulate these questions and have them answered if possible months before the plow turns a single furrow. Some of these questions would prove difficult and almost impossible to answer were the farmer to make the attempt without aid. He has at his disposal bulletins of the Experiment Station, and best of all, he is able to come in direct contact with the College of Agriculture thru the State Soils Laboratory. Thru this service, the College sends a man to look over the land in question and take samples if necessary for analyses. A full report with recommendations concerning his particular problems follows. To get this aid the farmer must apply for it and pay a fee for the services rendered. Let us consider the above questions in a general way as applied to peats and mucks of southern Wisconsin.

When to Plow the Marsh. The best time to plow to decompose the tough sod, is during the summer; but this is seldom done because of the summer's work. Hence the plowing is usually done in spring or fall. Which is the better I am unable to say. In some cases spring plowing seems better, perhaps because the weeds are given a greater set-back.

What is a Good First Crop? For general farming, corn,—especially if the marsh has been pastured before drainage and plowing. On tough, unpastured sods, buckwheat and flax are recommended, even corn does very well. Checking the corn frequently facilitates in controlling and killing the smart-weeds.

Should Lime be Used? No, Southern Wisconsin low lands generally are not acid. I know of only one peat-bed (a small one) in Southern Wisconsin that has developed a high degree of acidity.

Should Manure be Used? For general and permanent improvement it is good practice for first treatment to apply four to six loads of horse manure per acre. Use mixed farm manure if horse manure is not available. This treatment is beneficial not so much in adding soluble plant-food elements as in inoculating the peat with helpful soil organisms in order to unlock the vast store of nitrogen in these soils.

Four years ago a heavy application of muriate of potash and acid phosphate on a well-drained peat in Rock county failed to grow corn, while on a manured strip the corn grew very well. On a drained and twice-plowed peat near Whitewater last summer an application of manure gave better results than muriate of potash and phosphate,—even tho the commercial fertilizers added more soluble plant-food material than the manure. Generally, fertilizers give much better results when the peat or muck has at some time received a dressing of manure. It is believed that this superior effect of manure is caused largely by the organisms which it carries.

Except for first application on peats, manure gives greater and more profitable returns when applied to upland.

What About Commercial Fertilizers? Use them, because they are the most profitable fertilizers, provided the proper kinds are selected.. Here the State Soils Laboratory can be of the most help. When I began Soil Extension work in Southern Wisconsin, I started out assuming that potash fertilizers were the first great need of all marshes; but soon a marsh was found on which a liberal potash application gave only 4 $^1/_5$ tons increase of corn, and where acid phosphate was mixed with the potash the increase was 12½ tons. Here the acid phosphate was responsible for an increase of 8⅓ tons.

A pot fertilizer test on a peat from Waukesha county showed as much response to acid phosphate as to potash. A field demonstration substantiated the preliminary test.

A peat taken from near Kansasville showed a phosphorous content so low that it failed in a pot fertilizer test to respond to potash alone, but gave a very positive response to phosphates alone. Potash with the phosphate gave a little better growth than the phosphate alone.

Again, on a well-decomposed peat from South Madison, potash alone gave the positive results, and phosphate with the potash gave a little more growth than the potash alone.

When we consider, therefore, the first fertilizer needs of Southern Wisconsin marsh soils, we find that we may have peats that are in need of potash more than phosphates, some that need phosphates more than potash, others that are in need of the one fertilizer as much as the other, and still others, especially mucks, that prove productive even without manure and fertilizers. This being true, it is all the more necessary that the farmer should ask himself this question,—"What about the fertilizer needs of my own particular peat or muck?"

The Potash Fertilizers. Muriate of potash applied broadcast at the rate of 100 lbs. per acre per year is considered best for most crops. Sulfate of potash in heavier applications may prove better for onions, cabbage and sugar beets.

The Phosphate Fertilizers. The common of these are acid phosphate, rock phosphate and ground steamed bone meal. The latter may be used with marked success on truck crops. The main objection to rock phosphate is its insolubility. Acid phosphate is more generally used because of its quick results. During the first few years of marsh improvement, undoubtedly acid phosphate will prove the most profitable; in time, however, rock phosphate may be considered for the maintenance of the phosphorous supply. This should be tested out, however, before the change to rock phosphate is made.

The following are the results on a marsh near Evansville on which a test of acid and rock phosphates was made:

Treatment, 1913, (per acre)	Yield of green corn per acre, 1913	Yield of oats per acre, 1914
200 lbs. potash, 400 lbs. acid phosphate	14.5 tons...	48.3 bu.
200 lbs. potash, 800 lbs. rock phosphate	12.3 tons...	49.0 bu.
20 loads manure	15.8 tons...	49.5 bu.

This shows an equal money value of rock phosphate giving a little less yield than the acid phosphate.

Fertilizers Applied Broadcast vs. in Drill with Seed. This is a question requiring further study. Since so many farmers are now purchasing fertilizer attachments for their corn planters, this method of applying commercial fertilizers appeals to them. The fertilizer should never be dropped on the seed in the hill, but rather below the seed or to one side. In either case some soil should come in between the seed and the fertilizer. This is possible only when the proper adjustments are made. Two hundred pounds per acre should be the maximum to apply in this manner. In case of potash much less should be used. Much depends upon the soil and crop requirements in determining the kind and amount of fertilizers that should be used. Some condemn hill application of fertilizers on marsh soils. This method certainly places the plant-food material in a position where the young plants can easily get it at the most critical time in their growth. This can be observed in actual practice.

On a well-drained peat at Palmyra, a yearly application of 125 to 130 lbs. of muriate of potash and acid phosphate (mixed in proportions of 1 to 1) in the hill gave two tons less green corn per acre than was produced by a broadcast application of 400 lbs. muriate of potash and 600 lbs. of acid phosphate (applied once in three years). These results are surprising, and they speak well for hill application as a most efficient use of fertilizers on this particular field. It would be folly to draw final and general conclusions from this one experiment. For general and permanent soil improvement it is conceded that broadcast or application of fertilizers in narrow drills is the better practice.

Is Crop Rotation Necessary on Peat? Yes, if best results are desired. The prime object of crop rotation is to maintain and increase if possible profitable crop production. It is as necessary on peats as on upland. Rotation enables the farmer to solve some of his soil and crop problems in the best possible way. Rotation greatly aids in avoiding diseases and insects which develop most favorably in soils kept continuously in the same crop. Rotation permits the addition of more easily decomposed organic matter.

It sounds very much like "carrying coals to Newcastle" to recommend the plowing under of clover sod on a peat which in itself is practically all organic matter, yet it is recognized as excellent practice, especially when potatoes, cabbage, sugar beets and onions are raised. The use of proper fertilizers combined with crop rotation containing clover and timothy is a safe and wise rule to follow.

Some have observed the beneficial effect on a corn crop following the plowing under of a green rape crop on peat (rape sown broadcast in the last cultivation of the preceding corn crop). Others endeavor to seed to alsike clover and timothy as soon as possible so that a clover-timothy sod may be plowed under.

The placing of a hay crop in the rotation necessitates the growing of a grain crop which is a less desirable crop for this kind of soil because of the tendency towards lodging. If corn or some other cultivated crop is raised the first three years and the soil treated with the proper mineral fertilizers during this time grain may be grown very successfully, provided, too, a lesser amount of grain be sown per acre than on upland. If the grain grows too rank even at this time it would be well to cut it for hay to save the seeding.

If a farmer has 30 acres of peat, for example, and desires to grow cabbage and sugar beets as cash crops, this field may be divided into four equal strips and cropped each year respectively to sugar beets, cabbage, grain and hay (alsike clover and timothy). Thus on each strip there would be practiced a four-year rotation of hay, oats, cabbage and grain. On a dairy farm, two or three corn crops may be grown in succession, and followed by grain, seeded to alsike clover and timothy. The hay may be cut the first year and pastured the second. Thus, we see a great many variations may be thrown into the crop rotation on peat.

In conclusion, it may be said that sufficient information has been accumulated and can still be secured to transform every drainable peat and muck area in Southern Wisconsin into respectable and profitable fields. Through the application of thought and good judgment on the part of the farmer, these lands could be made to throw off the too common popular opinion that "nothing good can be said about them," and receive a baptism of a more favorable opinion that "nothing bad can be said against them."

CROPS ON DRAINED PEAT.

William H. Bowden, Babcock, Wisconsin.

I have been farming 18 acres of drained marsh lands for about 9 years just outside of the Remington Drainage District in Wood county, Wisconsin. My soil is a peat and muck and varies in depth from one foot to four feet underlaid with a sand subsoil.

I have grown hay, oats and corn on my drained marsh land. The corn was grown in 1914 which was an exceedingly wet unfavorable season and on five acres I grew at the rate of 35 bushels per acre. On the same five acres in 1915 I grew 309½ bushels of oats.

The rest of the time I have grown on my marsh land tame hay (timothy and alsike clover mixed) averaging from 1¾ to 3 tons per acre. The smallest crop was this last year when the season was very unfavorable, being extremely wet in the spring and very dry and hot immediately following the wet time. I have never used on my marsh land any fertilizer except stable manure. One light coat of stable manure was put upon the five acres of land on which the corn and oats grew. None of the rest of my drained marsh land has been manured.

For the entire seven years that this drained land has been seeded it has averaged 2¼ tons or better of tame hay to the acre.

Anton Brost, Babcock, Wisconsin.

I own a farm of 320 acres of drained marsh in the town of Remington, Wood county, Wisconsin, in the Cranberry Creek Drainage District. I moved on this farm in 1895, several years before it was drained by artificial ditches. The years 1893, 1894 and 1895 were extremely dry years and the soil water level was four to six feet below the surface of the ground in this land. My land is very flat there being only occasionally a little higher place locally known as islands. My surface soil is well decomposed peat and my subsoil is quite sandy. After 1896 the years were wetter and the ground gradually filled with water. As it became too wet for farming I dug shallow ditches but they gave me little relief. In the year 1908 the first drainage district ditches were dug in that district. They gave me some drainage but were too small and too shallow and too far apart to give perfect drainage and they were not enlarged to give me perfect drainage on all of my farm until 1915.

I have always practiced mixed farming raising live stock as well as farm and garden crops for sale. Live stock have always done well for me.

During the dry seasons of 1895 and 1896 I grew oats on 23 acres of these marsh lands at the rate of 70 bushels per acre. I also had a heavy potato crop. From that time on my lands were too wet for successful farming until 1908. From 1908 my land along the ditches was sufficiently drained for cropping but farther away from the ditches it was too wet. In 1908 I grew on $\frac{1}{3}$ of an acre 250 bushels of Red Weathersfield and Yellow Danvers onions, well ripened besides many that were bunched and sold in that way. Also that year I grew and shipped celery which was pronounced equal to or better than the Kalamazoo celery. This was planted 4 inches apart in rows 3 feet apart. It was all salable. Much of it was 30 inches high, with stalks 3 inches in diameter. I have grown on the drained marsh celery, onions and cabbage in a small way very successfully each year since any part of my farm was drained. The season of 1916 on $^1/_5$ of an acre I grew something over three tons of good cabbage. I have grown cabbages on drained marsh lands that weighed over 20 pounds. In 1911 I grew 6 acres of potatoes which yielded over 1200 bushels and from which I sold $800.00 worth and had enough left for my family use and for the next year's seed.

Ever since my land has been drained in 1908 I have grown an excellent crop of potatoes on the drained marsh each year except the year 1916. I have grown as high as 250 bushels of potatoes per acre on drained peat.

In 1912 on the same piece of land where I grew the large crop of potatoes in 1911 I grew and ripened Wisconsin No. 8 corn which yielded 71 bushels to the acre. Of carrots I have grown on this drained muck 75 bushels on 9 square rods. Of rutabagas I have grown at the rate of more than 1000 bushels per acre. One year I grew a few sugar beets, as an experiment and while the stand was thin, the beets were of good size and of exceedingly high sugar test as shown by the test made at the Agricultural Experiment Station.

These drained marsh lands grow excellent crops of tame hay especially if alsike clover is sowed with the timothy or red top. On my land I have grown tame hay five feet tall and have often seen it produce at the rate of from two to three tons per acre. I have always had a good crop of oats when they were on land that was sufficiently drained and they have yielded from 55 to 70 bushels per acre.

I have usually grown a heavy crop of corn for silage but on drained muck corn ripens about two weeks later than on higher land and is often injured by frost.

On none of these crops on which I have reported did I use commercial fertilizer. I have experimented in a limited way with commercial fertilizer as against stable manure and I find that the stable manure gives much better results than any commercial fertilizer that I have used. However commercial fertilizer is an improvement on no fertilizer.

We can go upon and work our drained lands in the spring from a week to ten days earlier than the higher lands can be worked. In fact we can work our drained lands as soon as the frost is out of the ground. Some of my lands have been cropped continuously since 1895 and with only moderate applications of manure and since drained from year to year produced better rather than poorer crops. There is no sign of their running out that I can see.

I have laid no tile, but my land has a sandy subsoil and drains directly into open ditches eight feet deep and generally not over half a mile apart. Practically every forty is adjacent to such a ditch since the supplemental drains have been constructed.

Frank Rasmussen, Babcock, Wisconsin.

I came here in the early spring of 1911 expecting that the dredges would finish that summer but owing to weather conditions and soft marsh it was dragged out for 3 years before the work was entirely finished. The first year the water was at least 2 feet deep on the land in places and for 2 weeks we could not get away from my buildings with a team. The spring of 1911 was dry and the ground was all burned over. I sowed 125 acres to timothy. It all drowned out in May and June. The following year I did nothing but sow 40 acres to buckwheat. That surely looked fine till the rain started in the fall of 1912. Then it got so wet that I had to leave it for the prairie chickens. I guess they appreciated it too. At times there were between 800 and 1000 chickens there. Ed. Dano from Tomah waded in water to his knees in the buckwheat.

The timothy I sowed the year before came to life. I cut about 50 tons of inferior hay, but I got $14.00 a ton on the cars at Daly for it. By fall in 1912 the ditches were nearly completed, all but a rock ledge which held the water level only 3 feet below my land. I sowed timothy in my buckwheat in 1912 on 11 acres along the ditch. In 1913 I cut 17 tons of good timothy on it. I got $14.00 a ton for that also but hay was cheaper than in 1912.

Since the drainage was completed I have had oats go 50 bushels per acre on an average in a 22 acre piece; 300 bushels of potatoes per acre. Filled 30 foot silo on 9 acres of corn. Buckwheat has gone 35 bushels per acre and rye about 24. I own 276 acres and have about 150 acres under the plow.

E. A. Witte, Sprague, Wisconsin.

My brothers and I came to Wisconsin from Iowa in April, 1913, having purchased a half section three miles west of Sprague, Juneau county, in the Little Yellow Drainage District. Our land was practically all marsh.

We did not have much success the first year, owing to the fact that our drainage ditches were too small and shallow to drain the land thoroughly. However, the work of draining this land was well under way the next season and things began to look different. Since that time we have had very good success with every crop we have planted.

The average yield of oats the past three years was 45 bushels per acre. We had some last year that went 75 bushels per acre, on *new breaking.*

Barley is a very good crop on this marsh land—30 to 40 bushels per acre.

Potatoes do as well here as anywhere in Wisconsin and are of just as good quality.

We have not had very good luck with corn on account of early frost. About 50% of it got ripe this season. The growth is always rank and heavy, and makes excellent silage. Both fall and spring rye will produce a good crop.

We have had great success growing onions for three years, with better results every year. Six hundred bushels per acre is our average yield. Last year we had 21 acres and the average sale price was 65 cents per bushel, on track at Sprague. This year we sold at $1.25 per bushel. It costs us about 15 cents per bushel to grow and market these onions. So you can see what the possibilities are for raising onions on this marsh land.

There is absolutely no question as to whether it pays to drain marsh land here in Wisconsin. We can produce as much per acre as they do on any other soil of the state, and I think at considerable less expense. Our soil is very easy to cultivate and we have very few weeds.

LEVELLING THE SPOIL BANKS.

A. P. Nelson, Drainage Commissioner, Racine, Wisconsin.

(Racine Convention)

Some of you intend to visit my farm tomorrow to see the spoil banks that I have levelled.

We did not level them when the ditch was first constructed. We let the banks get mellow for a year or two and then went at them with a plow and road grader. We stopped as soon as we had the bank spread out enough to raise a crop on it. We raise good crops there now.

It took three men and three teams one day to fix up 80 rods on one side of the ditch. That meant about 20 cents a rod.

The spoil bank was originally about 20 feet wide at the bottom. It was rough and about five feet high. We levelled it to about half that height.

The black soil on my marsh was more muck than peat. But the mixture of the clay of the subsoil with even the muck is beneficial.

I have never tried to level the spoil banks with a team and scraper. It seemed easier with a road grader.

I am better at handling a plow than I am at talking. Nevertheless I shall answer all of your questions tomorrow when you can see my ditch and levelled spoil banks.

CONCRETE DRAIN TILE

H. A. Le Roy, with American Concrete Pipe Association, Chicago, Ill.

Drainage is a subject for consideration when land increases beyond a certain value and with this consideration comes the choice and merits of the material to be used. The problems now confronting you, gentlemen of Wisconsin, are the same that farmers of other states are meeting and one that still others, who have low, wet, unproductive land must meet in a few years, when tiling will produce cheaper and better land than can be purchased on the market. Fortunately, however, your difficultices have been met and overcome by farmers in adjoining states and their failures and successes during the past should be the aid and guide for your present work; it will save time, trouble, litigation and money.

The progress and development of drainage is in the nature of an evolution. First the old plow ditches easily and cheaply constructed suffice to carry off the surface water but the constant attention and inadequacy to furnish proper drainage causes them to be surplanted with small drain tile and with the introduction of drain tile the value of lands have usually increased to the point where drainage systems are adopted for large areas. With the advent of these districts comes the open ditch outlet with its multitudes of disadvantages and these later are replaced by the large 42, 48, 60 and 72-inch tile. As you are just beginning drainage in Wisconsin it is inappropriate that we talk of these larger sizes of pipe at the present. Time will show you the advantages of these over the open ditches.

As the drainage develops—sections, townships and whole counties sometimes become involved. This necessitates adequate and equitable laws. It requires the expenditure of vast sums of money and the material used should be the most permanent for once the work is designed by a competent engineer it should be everlasting.

Geologists tell us that glaciers were the cause of our present drainage troubles, therefore it would seem unfair if in return for this damage we were not recompensed in some manner. Fortunately this has been the case. When those fields of ice which plowed their way through Iowa, Minnesota, Illinois and Wisconsin finally melted, it had lain bare immense ledges of lime-rock and had piled high huge hills of sand and gravel for man to use when the occasion arose.

In Europe it was discovered by crushing lime-rock to a fineness of flour and mixing with it a proper proportion of argillaceous substances, then burned and later reground, that a material was produced which when water was added made a substance hard as rock. Experiments later proved that when this material was proportioned with sand, gravel and rock, an even harder substance occurred. This happened about the year 1824 and was the origin of Portland cement and the origin of concrete. The use of this material to replace heavy stone foundations proved such a success on account of its low cost that it was heralded throughout Europe as a wonderful building material. Its adaptability for building soon found this material used in almost every variety of form for which stone and other building material had previously been used.

Germany, England and France were among the first to use concrete for sewers in the larger sizes. Later it was made into concrete pipe which was also used for sewers. So popular had

Portland cement come into use that it was shipped throughout the United States and records show that cement shipped from England was used in the manufacture of concrete sewer pipe in Milwaukee 43 years ago. The ingenious Americans readily saw the opportunity in future for this material and were not slow in building mills, the first of which was built in the year of 1866. With the manufacture of cement in the United States, the cost was reduced and consequently there was a greater demand for concrete. Since concrete becomes more hard and durable by being brought into contact with water, it is natural that its use would be applied to drainage work. Manufacturers were quick to see that here was a field without a competitor and throughout the United States machines were patented and developed for the manufacture of concrete tile. These manufacturers were expert machinists but they were *not engineers* or authorities on concrete and in their enthusiasm to place these machines on the market, they gave some very erroneous information relative to the manufacture of concrete tile. Had they gone back and studied the records of how pipe was produced in Germany, England or France, they would have found that the pipe as recommended 40 or 50 years ago should be made impervious. This fact they overlooked entirely and their boast of the concrete made by their machines was, that it allowed water to percolate through it freely. This idea was obtained, no doubt, from the other material which was universally used for drainage, although failures of this material had occurred time upon time and it had never occured that the material was at fault for at that time nothing else was available for this class of work.

When one contemplated the manufacture of concrete tile, nothing was said regarding material. If a man possessed a gravel bank they advised him to purchase a machine and manufacture tile regardless of whether the material was clean or dirty. The results of this sort of work are obvious. Concrete tile manufactured this way was *bound* to fail. It violated every principle which correct usage had taught. Naturally, all the concrete pipe manufactured in this country eight to ten years ago was *not* a success. The fact that some of this pipe was good and some poor although made by the same machine led manufacturers to believe that some radical wrong existed. Immediately investigations and experiments were carried out which showed the aggregate used must be absolutely clean. It also showed that instead of a loose, porous pipe which they previously advocated, a dense impervious pipe was needed. These failures led the engineers and colleges throughout the country to make experiments and tests not only on concrete pipe but also on the other material used for drainage which clearly showed that competitors of concrete pipe were also violating certain principles which heretofore had been ignored. With the successful manufacture of concrete a strong rivalry existed between it and other materials which made itself manifest by bitter remarks and untruthful statements regarding both materials. This led the manufacturers to unite with engineers and colleges to carry on and formulate a standard specification for all classes of material to be used for drainage. So many wrongs had been done not only to the manufacturer but the purchaser as well that it was agreed that experiments should be carried out to protect all persons interested in the manufacture and purchase of drain tile. These experiments have been carried out for a number of years and their proceedings published from time to time so the manufacturers could profit by their tests.

Probably no other material carries its brand of *quality* as good concrete pipe and for that reason a brief discussion as to the manufacture at this time will be of valuable assistance to those contemplating its use. The first thing to bear in mind regarding concrete tile is this—its process of hardening and becoming better is purely chemical. The only human factor which enters into the process of this manufacture is the mixing of the materials. The elimination of the human and mechanical element always tends towards a higher product. The laws of nature are working with concrete drain tile under the conditions to which it is subjected rather than tending to tear down and destroy it.

The comparative strengths of the different consistencies of concrete is a question which arises in the layman's mind who inspects the manufacture of concrete pipe. Concrete work as generally seen by farmers is made a wet—while concrete tile is a dry mix. Naturally the question arises whether the unfamiliar dry concrete gives results similar to the other. Experiments and tests have shown wet mixtures in the early period are of lower strength than dry concrete but the difference becomes less with the lapse of time and a fairly soft plastic concrete will acquire the same strength as a dry concrete within three or four months. A very wet concrete will continue to be weaker than one containing less water.

George W. Rafter at the Watertown Aresnal had some tests made showing the mean comparative strength of concrete aged 20 months. The dry mixtures as used in concrete tile were only a little more moist than damp earth and required much ramming; the plastic mixtures require a moderate amount of ramming to bring the water to the surface; the wet mixtures quake like liver under moderate ramming. The relative strength of Dry, Plastic and Wet mixtures are 2348, 2203 and 2129 respectively.

These tests although practically the same, show the dry mix to be slightly higher for strength but one must bear in mind the fact that it requires considerable ramming and by ramming is meant packing the aggregate as firmly as possible. Later in my paper I will show how this ramming is done but before going into that matter I wish to discuss the subject of aggregates. There is a very erroneous idea prevalent that the failure of concrete pipe is due *principally* to the lack of cement when in reality the failures are due principally to dirty and organic matter in the material, and by far the most important feature of the manufacture of concrete tile is that the sand and gravel shall be absolutely clean. Fortunately Wisconsin has many such gravel pits but where gravel is not clean and contains any percentage of clay or loam, it is necessary that such material shall be washed. To illustrate this point, I will cite a case that came to my attention in Florida. It is a situation which I would not recommend but it was such a freak and illustrates the point so clearly that this is my only object in presenting it to you.

An engineer while constructing the abutments for a highway bridge ran short of cement but the material he had at his disposal was an excellent grade of clean, sharp sand. It was necessary that this work be completed and securing of additional cement would have been a matter of several weeks so he used the material at hand in the proportion of 1 to 20 and the abutments are still standing and are in use at the present time. This is an unusual case but it illustrates what can be done with a clean aggregate.

The recommended mixtures for concrete tile are usually 1 part cement to 3 or 4 parts sand and gravel for the smaller size tile. Where large drain tile are used the mixture is in the proportion 1 : 2 : 4. There are various kinds of tile machines on the market for the manufacture of pipe and the majority of them are very good. The necessary requirements of a good machine is one that will subject the concrete mixture to high pressure, making the mass dense and compact. This is what is referred to by Mr. Rafter as ramming. Pipe manufactured in this way upon being removed from the moulds will retain their shape when placed in the curing room.

Experiments and tests have demonstrated that concrete hardens more rapidly and more advantageously at a high temperature in the presence of moisture. That is to say that concrete at 70 degrees with occasional sprinklings of water will cure in a shorter time than at 35 or 40 degrees. It has been found that if a temperature is maintained at about 50 degrees and sufficient moisture is brought in contact with concrete that the best results are obtained.

There are several methods of curing or hardening pipe. Probably the best method is the steam curing whereby the heat in the room is kept at a high temperature and steam admitted to give the necessary moisture to harden pipe. This is an artificial means of aging and pipe will harden in this manner in 48 hours. However, an excellent quality of pipe can be made if the tile is sprinkled daily but this requires a greater length of time, usually 28 to 30 days.

Since in discussing in detail the component parts of concrete tile, a brief outline of the manufacture may prove of interest to those not familiar with the process. Cement is added to the right proportion of a clean, well-graded aggregate and thoroughly mixed, with water added, making it the consistency of damp earth. This is elevated to a machine and while it runs in the moulds it is tamped so thoroughly water is forced to the tile's outer surface and on removing the moulds web-like water marks are plainly visible. The enormous pressure to which these tile have been subjected allow the moulds to be removed and the tile carried to the curing chamber without the least injury. On being placed in this room where a temperature of 150 F. is maintained, the tile are kept damp either by water, spray or steam. The latter is the more usual way of hardening. The tile remains here for 48 hours and are then removed to the storage yard ready for shipment.

In the first part of the paper it was stated that "probably no other material carries this brand of quality as good concrete pipe." This brand, if it may be termed such, is the web water lines on the surface of the tile for it indicates where a dry mixture concrete is used that sufficient pressure or tamping necessary for this work has been applied. It must be understood, however, that clean aggregate is to be used in connection with this. Fortunately Wisconsin possesses some of the cleanest and best gravel in the world. It seems to have been nature's recompense to man for the damage done by the glaciers and for this reason Wisconsin should be the logical leader of all states not only in the use of concrete tile but concrete work in general. How true this is becoming may be seen in the work that Milwaukee county is doing on its roads which at the present time stand out as eminent leaders in the United States.

When Mr. Jones presented his paper to the American Concrete Pipe Association, "What Wisconsin Farmers Want to Know About Cement Tile," he stated the unusual hauls made transportation very difficult to some of the regions which are badly in need of drainage and he wished to know if it was possible to manufacture tile on a small scale thereby eliminating the troubles of hauling. Experience has taught that small temporary tile plants are not advisable. It has been found that a central plant shipping in a radius of 150 miles is the most adequate way to manufacture pipe. The idea of farmers manufacturing their own tile is to be discouraged. Personally I do not believe in the small portable tile plants unless they are operated by competent manufacturers who have gained a reputation for their products. Wisconsin is just in its infancy in the matter of drainage. As near as could be learned, 1200 carloads of tile were used in the entire state last year for drainage purposes. When I state to you that this would about constitute one day's run for one large concrete tile plant, you may realize the drainage work done by other states.

Should these portable plants be introduced in Wisconsin, there might arise the same condition which was experienced several years ago and for that reason if Wisconsin follows the policy of the other states on its drainage matters the centrally located plant with its efficient arrangement will be the means of giving farmers an excellent quality of pipe at a reasonable price.

THE ADVANTAGES OF CLAY TILE OVER CEMENT TILE

E. H. Haeger, with Haeger Brick and Tile Co., Dundee, Illinois.

The assigning of this seemingly dry subject to a tile man may appear somewhat peculiar, for tile men usually prefer wet fields. You can see how easily one drifts into the vernacular of his particular business, especially when he is so saturated with it that his ideas must have an outlet.

I am not like the Irishman in the story, who being invited by three men to join a friendly conversation, answered, "No thanks, I haven't me club with me." Let me explain that I am very glad to join in this friendly discussion with the added assurance that I carry no bias or prejudice against Portland cement. It is one of the indispensable building materials which have played an important part in the advancement of the welfare and comfort of all peoples. Used in the right place cement serves admirably.

Put yourself for a few moments in the place of a farmer trying to decide whether to use clay or cement tile. Clay tile have been in use for many years, while cement tile in most localities are new and untried. Consequently you begin to question how the cement tile are made, by wet or dry process, machine made or poured, water-cured or steam-cured? How can you tell if the tile are aged enough to use, and when is a cement tile properly aged? Will cement tile in the ditch make proper joints? Is there danger that the tile will cement together at the ends? Does freezing affect cement tile more seriously than it affects clay tile? Will cement tile bear as heavy pressure as clay tile after being laid? Will cement tile resist the action of running water and its possible constituents?

Let us take up these questions and apply them to both cement and clay tile bearing in mind that a fair comparison can be had only by considering representative samples of each kind.

In the process of making cement tile there are several matters of prime importance. Was the gravel or aggregate clean, or was a loamy gravel used? Did the various batches of concrete run uniform as to the proportion of cement used? Some of the larger cement tile factories are using measuring devices, but there is a large number of smaller plants where the mixing is done by hand. While the instructions of the Portland Cement Association give hand-mixing the preference, yet it is subject to mistake through carelessness or some other distraction. In cases where the tile are made right on the farm, the chances for poor mixing are much greater; not to mention the temptation to use unclean gravel just because it is handy. The Portland Cement Association has laid down twenty-five rules for cement tile making.

Here we have 25 rules which must for the greater part depend upon the judgment of a workman if they are to be observed. And, mind you, this workman has but few mechanical devices to check his work.

What appears to be one of the most serious defects in making small cement tile is the fact that speed in making necessitates running the concrete rather dry. If it is run too wet, the tile will not stand up after the mold is removed. It is common knowledge that the best cement work is obtained by running the mixture wet. Quoting from page 15 of Bulletin No. 31, Iowa State College, in reporting on a failure of cement tile:—"It was all along noticeable that the tile which had been made the wettest were the strongest." The setting of concrete is a chemical action of crystallization caused by the uniting of lime and water; and unless enough water be added, there will remain uncombined lime and the tile will be correspondingly weaker. Lack of water will prevent uniformity in cement tile. Tests of cement tile have developed the fact that the addition of water has strengthened the tile when dry. We shall see later how too much water affects the same tile.

The curing of cement tile whether by steam or open air process invites the chance for lack of sufficient moisture. The steam may dry too quickly, or the open air cure may not be assisted with necessary sprinkling of water. Here again are chances of failure to make good tile, as there is no check on the careless or forgetful workman.

How is one to know whether a cement tile is sufficiently aged to be safely used? This question is not readily answered by the ordinary man, for tests have shown that the strength of cement tile will vary from time to time. Certain samples tested at different times showed variations in strength even after 18 months from the time they left the factory. This shows that a chemical action may be taking place long after the tile are supposedly ready for use. Here is another chance which the purchaser must assume, for he is in no position to make definite tests.

Compare for a moment this fallible method of cement tile making with the systematic manufacture of clay tile. Once the clay reaches the pug-mills it can be handled with a precision that bars chances of human errors. Mechanical apparatus protects the processes of drying and burning. Recording pyrometers and heat measuring devices make it unnecessary to rely upon human skill for these important stages. When the various parts of a kiln show uniform required heat, one may be positive that the tile are evenly burned.

Now I am not going to say that all clay tile are perfect, but I simply wish to establish the point that the manufacture of clay tile can be, and is, more reliably controlled mechanically than can the making of cement tile. When clay tile are taken from the kiln, one may be sure that they are ready for use. The color and ring of a clay tile are always patent evidences of the quality, and the average purchaser may make his own tests.

Cement tile makers claim to make a more perfectly shaped tile with smooth ends. Is there not danger then in some soils the smaller sizes of tile will fit too closely at the joints and reduce the flow of water into the tile? Then again in other soils where the bottom of the ditch is gravel, the cement tile are too straight to form satisfactory joints, which in the case of clay tile can be obtained by twisting the tile into position. I have the following letter from a tiler:—

"As to cement tile from the standpoint of a tiler, it is the same as that of a farmer. The faults as I see them are that the tile are perfectly straight and same length both sides making it hard to get a tight joint on top at all times. The main fault is that owing to poor mixing, or poor and dirty sand every 100 or so of tile includes one poor tile.''

About two years ago a tiler told me of a peculiar circumstance in connection with taking up some cement tile. He found in many places that five or six lengths of tile were cemented end to end so firmly as to form single pipes. This raises the question of whether this may not occur frequently, and with the resultant loss of drainage. It also proves the foregoing statement that one cannot be certain when cement tile are chemically complete.

We come now to the question of which kind of tile is more seriously affected by freezing. This action is perhaps the most severe which tile are called upon to stand; for both before and after being laid, the tile may be subjected to frost which in many cases will set up a spalling action. The extent of this action will depend very largely upon the porosity of the tile, for a tile which absorbs the larger amount of water will be subjected to the greater expansion.

The Engineering Department of the Iowa State College has for several years been conducting experiments to determine accurate tests which may be adopted in the Standard Specifications for Drain Tile. This work has recently been completed at Ames, Iowa, and the American Society for Testing Materials has approved the report. By addressing the Engineering Experiment Station, Ames, Iowa, copies of the specifications can be obtained.

Among the experiments conducted at Ames were freezing and absorption tests. The tabulated report shows cement tile to be from two to three times as porous as hard clay tile. The porosity of cement tile and the softest clay tile was found to be the same. This was explained by the engineers by the fact that they had purposely selected the softest clay tile they could find and had picked tile from two kilns which were in the course of firing when the supply of fuel oil gave out. A fair average comparison of Ames tests shows conclusively that the porosity of cement tile is 10% and that of clay tile is 5%. You can judge for yourself that the cement tile when frozen wet will be subject to greater pressure.

Natural freezing tests were conducted upon both cement and clay tile with the result that after 41 tests the clay tile showed much greater frost resistance than did the cement tile. Clay tile were also treated with a solution of sodium sulphate as a substitute for freezing. Quoting from page 652 of the 1916 volume of the American Ceramic Society, "Up to 75 treatments no clay tile with less than 7% absorption was noticeably affected."

From the foregoing tests for porosity and freezing one may logically draw the conclusion that good clay tile resist frost more certainly than do cement tile because of the former's lower porosity.

Turning now to the matter of crushing strength we find ample data. Hundreds of strength tests were made at Ames upon both cement and clay tile. Taking five of the highest tests on similar sizes we find that the clay tile of 24″ diameter showed 8½% more strength than 24″ cement tile. The 16″ clay tile showed 32% more strength than the 16″ cement tile and the 8″ clay tile showed 45% greater strength than 8″ cement tile.

Thinking that an average of the tests on each size and kind would be interesting I have made up the following table:

Clay Tile			Cement Tile		
Size	No. Tests	Pressure	Size	No. Tests	Pressure
24″	92	4516 lbs.	24″	100	4807
16″	89	4737 lbs.	16″	100	3610 lbs.
8″	98	3310 lbs.	8″	99	2000 lbs.

The 24″ clay tile tested showed a lower average strength than the cement tile due to the fact of including soft clay tile which under proper inspection by an engineer would be excluded. In fact a comparison of the tests of 16″ and 24″ clay tile shows that contrary to expectation and usual practice the 24″ tile withstood less pressure. This would indicate that some of the 24″ clay tile were not up to standard; and I believe that the adoption of standard specifications will bar the use of non-vitrifying surface clays for making the biggest sizes of tile.

If we carried the comparison of the tests on the 24″ tile further we would find that the loss of strength due to wetting would make the clay tile show 3387 lbs. as against 3028 lbs. for the cement tile, leaving a margin of 10% in favor of the clay tile.

The 16″ clay tile in average test proved to be 31% stronger than the 16″ cement tile and the 8″ clay tile proved to be 65% stronger than the 8″ cement tile. Computing the loss of strength after wetting, the 8″ clay tile would show 90% more strength than 8″ cement tile.

The loss of strength in cement tile by wetting is really a determining factor. While some cement tile when dry may show about the same crushing strength as clay tile, tests have proved conclusively that wet cement tile have a much lower crushing strength than have wet clay tile. In other words, the wetting of cement tile causes a greater loss of strength than does the wetting of clay tile. Cement tile lying in an inch or two of water have been found to become wet all around after laying. Consequently there is a reduction in the strength of cement tile at the time they are laid in the ditch. As long as the tile remain wet throughout there can be no increase in strength. Clay tile owing to lower absorption maintain a more uniform strength whether wet or dry.

The effect of moisture on cement tile was called to the attention of engineers who were investigating tile which had failed in the ditch. This fact prompted them to make tests as shown on page 159 of Ames Bulletin No. 31.

TESTS OF THE EFFECT OF MOISTURE ON THE STRENGTH OF CEMENT AND CLAY TILE.

Bearing strength of 6 in. cement tile, dry	1360 lbs. per lin. ft.
Bearing strength of 6 in. cement tile, wet 30 days	930 lbs. per lin. ft.
Bearing strength of 12 in. cement tile, dry	940 lbs. per lin. ft.
Bearing strength of 12 in. cement tile, wet 4 days	1090 lbs. per lin. ft.
Bearing strength of 12 in. cement tile, wet 30 days	680 lbs. per lin. ft.
Bearing strength of 6 in. clay tile, dry	2160 lbs. per lin. ft.
Bearing strength of 6 in. clay tile, wet 30 days	1610 lbs. per lin. ft.
Bearing strength of 12 in. clay tile, dry	2810 lbs. per lin. ft.
Bearing strength of 12 in. clay tile, wet 21 days	2730 lbs. per lin. ft.
Bearing strength of 16 in. clay tile, dry	1700 lbs. per lin. ft.
Bearing strength of 16 in. clay tile, wet 5 hours	1700 lbs. per lin. ft.

In this connection I wish to read paragraphs from an engineer's letter published in the same Bulletin on page 15, for they substantiate the fact that cement tile are affected in strength by moisture.

"Some tile were tested while lying by the ditch on dry ground, by placing a plank across them and having a number of men stand on it. They held up more weight in that manner than was over the broken ones in the ditch. This made it look as though they were much weaker when wet, and it was also apparent that the tile which broke down absorbed the most water; or it might be stated the other way, that the tile which absorbed the most water were the ones which broke down."

Excerpt from Cement and Engineering News.

"To learn whether or not this is the explanation, experiments were begun in the testing laboratory of the College of Applied Science, State University of Iowa, about a year ago. It was soon proved that a 1-3 portland cement mortar cured in air under conditions similar to those commonly obtained in the manufacture of cement drain tile, was weakened from 40 to 50 per cent by being soaked in water. It was further proved that this weakening resulted at once, that is, the full weakening effect came about just as soon as the specimens were saturated with water. This fact seemed to indicate that the cause was physical and not chemical.

"The mere fact, however, that a dry mortar may be weakened 50 per cent by the introduction of pure water seems of sufficient importance to warrant its publication at this time."

We come now to what is considered as the most damaging indictment against cement tile, namely, their inability to resist the action of alkaline soils and of water. This statement has been the target of many shots from cement companies, but up to the present time they have not disproved it. The one result of the discussion has been to set cement chemists on the search for a preventative or coating which will stop the action of water on cement tile.

While the action of alkaline soils on cement tile is not so pertinent to us in this part of the country, it is interesting to note Bulletin No. 69 issued by the Montana Agricultural Experiment Station. Investigations covering three years and some 5000 tests proved beyond doubt that alkaline soils do destroy cement tile. Whether the action is chemical or physical is a mooted subject, but the fact of destruction remains unchanged.

Although the occurrence of alkaline soils is more usually found in the West, we have on the other hand soils which show a strong acidity. Take our sour swamp lands and determine how much lime is required to neutralize the acid. Some land requires 30 to 40 tons of lime per acre to neutralize the acidity to the depth of eight inches. What chance has cement, whose main constituent is lime, to resist the action of acid when laid in $3\frac{1}{2}$ to 4 feet of such soils?

Perhaps a glance into the chemistry of the action of acid on lime will be interesting. We have been told that carbon dioxide is very common in occurrence and is formed largely from the decomposition of vegetable and animal matter. It is a gas which combines readily with equal volumes of water. This solution has an acid reaction and readily affects the calcium hydroxide as shown by the formula

$$Ca(OH)_2 + CO_2 = CaCO_3 + H_2O.$$

In Portland cement the hardened mass is permeated with crystals of calcium hydroxide. The addition of carbon dioxide precipitates or throws down calcium carbonate with the attendant loss of lime. Once start to break the chemical affinity and it is only a question of time until a cement tile will be washed away. Chemical analysis of cement tile can gauge very closely the rapidity with which the calcium carbonate would be precipitated.

The action of carbon dioxide upon calcium hydroxide is verified by text books and chemists and is as firmly established as other chemical and natural laws which are unchanging. Letters from professors of chemistry at Ames, Iowa, and Mt. Vernon, Iowa, and reports from the University of Illinois, all tell of chemical tests with the same result,—disintegration. Cement tile taken up have been found pitted and eaten out. In some cases the water has cut entirely through the lower side.

I have this letter from a Wisconsin tiler:

"In answer to your letter at hand, my experience with cement tile has been this. I have laid but a very few cement tile. After I put those tile in the water, having had to step on the tile to make my joint and moving around, I find they split through the center. I have found where cement tile come in contact with water running a steady stream, it seems to take the cement out of them. I have taken up cement culverts one and one-half inches thick where they have been all rotten. I know of a job of cement tiling done at Palmyra, Wisconsin, and all the tile had to be taken up. After the first winter they all went to pieces."

Also this letter from a chemist and ceramic engineer:

"Our experiments with cement drain tile quite clearly showed that cement gradually disintegrates under the continued action of water and finally crumbles. The friends of cement asserted that we were working with poor specimens of that product; but as nearly as I could judge, the specimens were quite typical.

"Incident to some other work, we have found that water contains a considerable amount of soluble salt which has a tendency to cause disintegration of cement pipe."

An excerpt from Engineering and Contracting, May 21, 1913, page 570, says:

"The decomposition of concrete mortars by rain water and other causes was fully recognized in Europe and England many hundreds of years ago, and various additions were made to the concrete, all designed to counteract this destruction; bullock's blood, rye-dough, barley water, beer, eggs, buttermilk and earth being added with various results. The accounts of the repairs to the steeple of Newark Church in 1571 has this entry: '6 strike of malt to make mortar to blend with the lyme, and temper the same, and 350 eggs to mix with it.' On the continent in 1840, Mr. Fred Kuhlmann exploited silica of soda and cement, and silicate of potash."

As for the action of acid upon clay tile, tests and examinations of used tile have proved conclusively that there is no deteriorating action. Step into a chemical laboratory or drug store and see how the strongest acids are handled in clay casseroles with no ill results to the containers. If acids affected clay tile at all, the effects would be noticeable upon tile which have been taken up. Clay tile in use for over thirty years have been found in perfect condition, and many of the older tile companies have letters from customers reporting such experiences.

Aside from the actual merits of the two kinds of tile under discussion, there is the important matter of the reliability and responsibility of tile manufacturers. While this is of importance in the matter of private drainage work, it is frequently vital in the case of county and township drains.

The equipping of a cement tile plant involves a relatively small amount of money, whereas a clay tile factory requires from $25,000.00 to $125,000.00. Many of the large tile makers have investments ranging up to one million dollars. Drainage contracts frequently amount to five to ten times the capital invested in cement tile plants which submit bids. What recourse would drainage commissioners have in case of tile failure which involved a larger amount of money than the value of the factory which furnished the tile. While the dollar mark fortunately is no criterion, yet the size and financial responsibility of a manufacturer gives assurance of the ability to fulfill contracts and redeem them if necessary.

To sum up briefly, cement tile offer you "ifs" and "chances". If the various rules of making are followed, if the gravel is right and clean, if the various batches of mixing are uniform in proportion and water, if the tile are properly cured, if the ditch pressure is not too heavy, if there are no soluble salts or carbon dioxide in the soil water, then cement tile will be all right.

On the other hand clay tile offer you assurances as to care and exactness of manufacture, greater resistance to freezing, greater strength, more uniformity, and a record of years of active service which removes them from the list of experiments. Numerous tests both physical and chemical have proved beyond a doubt that the advantages all point indisputably to clay tile, the logical drain tile.

THE SUPPLEMENTAL BENEFIT LAW.

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Briefly stated, supplemental drainage and the usually accompanying assessment of supplemental benefits are necessary because the drainage work first laid out and confirmed is not sufficient, to drain the district thoroughly.

When the general drainage district law (Ch. 419, Laws of 1905) was passed it was believed by the committee that drafted that law, that the last part of sec. 10 of that Act (now sec. 1379—20 of the statutes) was sufficient to authorize all necessary supplemental work.

In 1907 the Remington Drainage District, finding its drainage insufficient and that new ditches were necessary and old ditches must be enlarged, sought to obtain from the court an order authorizing necessary supplemental drainage. It was found that the confirmed benefits were not enough to authorize the raising of the money required to do the proposed new work.

But it was also found that the confirmed benefits were not nearly as high as the actual benefits. The district therefore sought to have the court increase the confirmed benefits, so that they were equal to the actual benefits, that had been caused by the work already done, (that was thought to be very conservative) and to have the court authorize the supplemental work required to give the needed drainage. The circuit court made an order confirming those increased benefits and authorizing the proposed supplemental work.

Attorneys who would pass on the drainage bonds doubted that this order was valid. Appeal was taken to the supreme court, and that court, in the case of "Remington Drainage District, 138 Wis. 621" decided that the circuit court had no power under that statute to increase the benefits already confirmed.

The district then turned to the legislature and Chapter 270, Laws of 1909 (now sections 1379—30a to 1379—30d) was passed. These sections include all that was originally included in the supplemental drainage law. That law authorized necessary supplemental work and authorized necessary supplemental assessments for benefits arising from such supplemental work, and that was as far as that act went.

No attempt was then made to correct in any way injustices that might exist by reason of errors in the first confirmed benefits. Under these provisions, without doubt the supplemental benefits assessable to any tract were confined to those benefits which would be especially caused to that tract by the supplemental work.

But there were so many glaring inequalities and injustices in assessments made under the drainage district law, due in part to inherent difficulties in the making the first assessment, and in part to commissioners' ignorance of the real problems involved in assessing benefits, that between 1909 and 1911 drainage commissioners and owners of drainage lands were casting about for some means of relief from these inequitable assessments. They finally seized upon the supplemental drainage law as one through which many of these unjust assessments could be corrected. In an attempt to enable this correction of assessments, Ch. 633 of the Laws of 1913 (now section 1379—30bm of the statutes) was passed.

When this was drawn it was recognized that the previous benefits assessed by the commissioners and confirmed by the court, should not be changed, in fact could not be changed to the detriment of the holder of any bonds or other money obligations issued by the district. And in order that this proposition be placed beyond possible doubt, so that bond-buyers could not seize upon any supposed authority to cut down assessments, as an excuse for bidding low upon drainage bonds, the previous provision of law bearing on that question (section 1379—30c) was not repealed. That provides that

"No assessment of supplemental benefits . . . shall change the apportionment of assessments for construction previously confirmed by the court, but . . . such previously confirmed assessments for construction shall remain liens upon the same lands and easements . . . in the same amounts as when first assessed and recorded"

And as paragraph fifth of section 1379—18 of the statutes requires the assessment for construction against the lands of the district to be "in proportion to the benefits" there is no doubt that the commissioners are powerless to disturb in any way the benefits already assessed and confirmed by the court. So far as the holders of securities against the district are concerned these confirmed first benefits cannot be cut down as those benefits are the foundation on which those securities rest.

Practical Application of the New Sections.

But all lands in the district should be required to pay a sum total for the construction of the drainage proportional to the actual benefits that they received. That is justice. Then in what way can the commissioners so apportion the supplemental benefits as to correct errors made in assessing the original benefits?

Let us take a few concrete illustrations.

The ---------- drainage district made its original assessment of benefits on the assumption that all lands would be sufficiently drained for general farming by the ditches then confirmed.

There are four forties practically alike in section 16 in that district. They lie in a row. Between the east two runs a ditch giving to the east two forties ample drainage, but giving to the west two forties only partial drainage. A new ditch between the west two forties is necessary to complete the drainage so all will be equal. It will cost $980.00.

Two conditions might confront the commissioners at this point.

1. They might have enough confirmed benefits to cover the cost of the construction of the necessary new ditch. In which event if the original assessment was equal, as the new ditch will only give the wetter land a drainage equal to the sufficiently drained forties, all four tracts should, under section 1379—30bm be assessed an equal share of the cost of construction of the new ditch. As the cost of construction must be in proportion to the benefits this works out that way.

2. The second condition that may confront the commissioners is when the benefits confirmed by the court are not enough to cover the cost of construction of the new ditch. If the proposed work warrants it the commissioners may now assess supplemental benefits. They find that in fact the total benefit to each forty from the old and new work will be $800.00. Four hundred dollars of that has been already assessed. As the law read prior to 1913 those supplemental benefits must be such "as were warranted by the proposed work" (Par. 6, sec. 1379—30a). If that were strictly followed the NE¼ of NE¼ and NW¼ of NE¼ of said section 16 could be assessed very little supplemental benefits, because they were drained enough by the first ditch and the second ditch would benefit them little if any.

Yet the undrained forties (NE¼ of NW¼ and NW¼ of NW¼) of said section paid half the cost of draining the drained forties and it is no more than just that the drained forties should now pay half the cost of the ditch necessary to give the last described forties equally good drainage.

Here is where section 1379—30bm comes in. It provides in substance that whenever it shall be necessary to assess supplemental benefits against lands of any district such supplemental benefits shall be so apportioned and assessed as to, so far as practicable, correct any errors made in assessing all prior benefits for such drainage so that all lands in said district shall be required to pay a sum total for the construction of all of the drainage proportional to the actual benefits received by said land from the total drainage.

This would seem to be in the interest of justice and their assessment would be as follows:

Description	Original benefits	Assessed for const.	Damages	Suppl. benefits	Suppl. assts. for const.	Suppl. damages.
NE¼ NE¼ 16.......	$400.00	$250.00	$10	$400.00	$250.00	....
NW¼ NE¼ 16,......	400.00	250.00	10	400.00	250.00	....
NE¼ NW¼ 16.......	400.00	250.00	....	400.00	250.00	$10
NW¼ NW¼ 16......	400 00	250.00	....	400.00	250.00	10

While the commissioners can not either cut down or raise the benefits previously assessed and confirmed, because those benefits are a judgment of the court, and to insure the credit of the district this judgment must not be disturbed, those commissioners can in fact so spread the supplemental assessment of benefits as to make the sum total of benefits (old and new) as nearly just as possible.

Take the illustration already given. The ditch already put in cost $980.00 and for it there was assessed against each forty $250.00 as cost of construction. The necessary new ditch will cost $980.00. The commissioners will have to report to the court under paragraph five (5) of section 1379—30a that the cost of construction already assessed together with the cost of construction by them proposed for the new ditch will exceed the benefits already assessed and confirmed by the court. They will further report (if the facts warrant) that the benefits from the original and supplemental work will be $800.00 to each forty and they will place a supplemental benefit of $400.00 against each forty. That gives all forties equal drainage and equal assessments.

So far I have only considered a case where there was a flat assessment of benefits.

Now let us take from another roll an illustration where the original benefits were graded by distance from drain. The four forties were practically alike. The cost of the original ditch was $800.00. The cost of the supplemental ditch will be $950.00.

The original benefits are not high enough to cover the total cost of construction of the two ditches.

The commissioners find that the total benefits from the two ditches to each of these four forties is $1,000.00. They therefore spread enough supplemental benefits on these several forties so that each is assessed altogether $1,000.00 benefits. The benefits against the forties are then equal. They then assess against the four forties such sum as will raise $950.00 plus the supplemental damages and give all of the four forties equal total assessments for construction. The assessment then is as follows:

Description	Original benefits	Original asst for const.	Damages	Suppl. benefits	Suppl. asst. for const.	Suppl. damages
NE NE............	$500.00	$300.00	$12.50	$500.00	$150.00	....
SE NE	500.00	300.00	12.50	500.00	150.00	....
NE SE	250.00	150.00	....	750.00	300.00	$12.50
SE SE............	125.00	75.00	....	875.00	375.00	12.50

Another illustration will cover another case that the commissioners may likely meet. In the illustrations already given complete justice is done by the supplemental assessment. But occasionally assessments of benefits have been so spread that complete justice cannot be done through supplemental assessments. I will assume a possible case (and I know of some even worse than the one assumed). The original assessments and awards assumed are on the left of the illustration below:

Description	Original benefits	Original asst for const.	Damages	Suppl. benefits	Suppl. asst. for const.	Suppl. damages
SW SW 1.........	$500.00	$250.00	....	$500.00	$204.00	$10.00
SE SW 1..........	500.00	250.00	....	....	....	....
NE SE 1..........	500.00	250.00	$10.00	500.00	204.00	....
SW SE 1..........	500.00	250.00	10.00	500.00	204.00	.. ..
SE SE 1........ .	500.00	250.00	10.00	500.00	204.00	....
SE SE	500.00	250.00	... .	500.00	240.00	10.00

The SE¼ of the SW¼ of section 1 is all high land and complete drainage will not benefit it more than $300.00, and it will receive very slight benefit from the supplemental work.

The original assessment of $500.00 benefits against the SE¼ of SW¼ cannot be cut down. Under section 1379—30bm it is evident that no assessment of supplemental benefits can be made against that forty as it is already assessed beyond the benefits that it will ever receive from drainage.

The ditch necessary to give the SW¼ of SW¼ of section 1 and the SE¼ of SE¼ of section 2 drainage equal to the other low lands in the district will cost say $1,000.00. How shall that be assessed? There are $20.00 supplemental damage making the total sum to be raised $1020.00. As this is to be divided between the other five forties (assessed each $1,000.00 benefits) and as the former assessment for construction is equal this supplemental assessment for construction will be equal or $204.00 against each of those five forties. (See table above.)

Now let us take another instance from an actual assessment roll:

Description	Original benefits	Original assts. for const.	Original damages	Suppl. benefits	Suppl. assts. for const.	Suppl. damages
NE NE...........	$600.00	$240.00	....	$600.00	$480.00	$15.00
NW NE..........	420.00	168.00	....	780.00	552.00	15.00
SW NE..........	450.00	180.00	$15.00	750.00	540.00	....
SE NE...........	....	....	....	1,200.00	720.00	15.00

The SE of NE was omitted from the original assessment of benefits and assessment for construction by mistake of the commissioner who computed the assessments. The first ditch only went to the center of the quarter section. To give necessary drainage this ditch had to be enlarged and extended to the north line of that quarter at an expense of $2.247.00. The commissioners determined that the benefits to the totally drained land will be practically equal and will be $1,200.00 per forty. The commissioners comply with the statute (1379—30bm) and their supplemental assessments and awards are as given above.

I have used in these illustrations only a small part of the district in each case. In making computations on the entire district the same principles would be applied.

In making supplemental assessments commissioners are likely in a single district to run across problems quite like all of these illustrations.

I believe my examples correctly illustrate the principle to be applied in making supplemental assessments and although the supreme court has never passed on sec. 1379—30bm I believe that that court will approve such an equalizing supplemental assessment.

Commissioners should not forget the spirit of that statute which is expressed as follows:

"It being the purpose and intent of this act to require the commissioners to so apportion said supplemental benefits as to correct, so far as practicable, any errors made in assessing the original and all prior supplemental assessed benefits for such drainage so that all lands in said district assessed benefits shall be required to pay a sum total for the construction of said work proportional to the actual benefits received by said land from the total drainage."

ASSESSMENT OF BENEFITS IN DRAINAGE DISTRICTS

James L. English, Drainage Commissioner
Waterford, Wis.

(Racine Convention)

I am going to speak from the standpoint of the farmer. Benefits consist of increased production or increased market value or both. Direct drainage, indirect drainage, the right to cross the lands of others to reach an outlet, and benefits to highways, constructed or prepared, are elements of benefits.

I shall point out cases of benefits I have observed.

A particular forty could have been bought in 1906 for $800.00. A district canal was put through its center. Its sub-soil was gravel, and the ditch gave this forty enough direct drainage that supplementary drainage was unnecessary. Five years later Mr. Jensen, the Yorkville, blacksmith, bought this forty for seventy-five dollars an acre. Within a year he was offered $125.00 an acre for it. He refused it and is growing cabbage, beets and onions on it today. There is not a building on the forty.

I knew another forty that was all a cat-tail bog, fit only for a duck hunter. It is now at the side of a district ditch. Recently, Mr. Zimmerman, our county superintendent, offered seventy-five dollars an acre for it and could not get it.

Tomorrow when you see the cornfield on the peat marsh of the Wheeler farm in the Hoosier Creek Drainage district, you can judge for yourselves what the land is worth. Before drainage it was about worthless.

Form for Rating Benefits

Parcel No. ____________________ No. Acres ______________
Owner ____
Town of ______________________________ Sec. __________
Fall to ditch No. ________________________________ Feet
Acres wet ___________ Medium ___________ Dry __________
Soil ____
Present value per acre wet ________________ __________
Improved value per acre wet ________________ __________
Present value per acre medium ________________ __________
Improved value per acre medium ________________ __________
Total improved value wet ________________ __________
Total present value wet ________________ __________
Gross benefits wet land ________________ __________
Allow for tiling ______________ __________
Allow for outlet ______________ __________
Allow for ______________ __________
Net benefits to wet land ________________ __________
Total improved value medium ________________ __________
Total present value medium ________________ __________
Gross benefits medium land ________________ __________
Allow for tiling ______________ __________
Allow for outlet ______________ __________
Allow for ______________ __________
Net benefits to medium land ________________ __________
Special benefits to dry land ______________________________
Nature of benefits ______________________________________

SUMMARY

Net benefits to wet land____________________	___________
Net benefits to medium land_________________	___________
Special benefits to dry land_________________	___________
Add for distance from main outlet___________	___________
Add for tile in place of open ditch___________	___________
Add for ________________________________	___________
Total assessed benefits to parcel_____________	___________

DAMAGES

Square rods taken for main ditch____________	___________
Square rods taken for lateral ditch___________	___________
Cost of levelling spoil bank_________________	___________
Value of land taken_______________________	___________
Rental value spoil bank________yrs.__________	___________
Allow for cutting fields____________________	___________
Allow for________bridges _________________	___________
Allow for _______________________________	___________
Total damages to parcel____________________	___________

REMARKS

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Mr. George Waller, attorney for the Hoosier Creek District, has worked out a good form for assessing benefits, shown above,

In this locality most forties have some high, some medium, and some lowland. The engineer must determine the amount of each.

Suppose that the present value of ten acres is one hundred dollars. Imagine it to be perfectly drained and it is worth 1000 dollars. The benefit of drainage is 900 dollars, or 90 dollars an acre.

But its costs say 20 dollars an acre to tile it after the district has put in the outlet ditch. Deduct this 20 dollars from 90 dollars and we have 70 dollars an acre as the benefit of the outlet ditch.

Discussion

Mr. Jones: Aren't you a little bit hoggish with your district benefits when you say that perhaps ten dollars an acre spent for the outlet drain yields 70 dollars in benefit, while the twenty dollars spent for the supplementary tile yields only twenty dollars in benefits?

Mr. English: I never thought of it in that light.

Mr. Jones: A better way is to combine the cost of the outlet drain and the supplementary drains—ten dollars plus twenty dollars in this case, or thirty dollars which is the total cost of perfect drainage. The benefits you say are 90 dollars an acre, or three times the cost. Logically then, the benefits of the outlet ditch are three times ten or thirty dollars an acre and the benefits of the supplementary tile are three times twenty or sixty dollars an acre. But the sixty dollars does not need to appear in your assessment roll, since the district does not put in the supplementary drains. Merely put down thirty dollars benefit for the outlet drains, and fix your values before and after drainage so that by subtracting you will get thirty dollars as the benefit.

Mr. Lucas: You are trying to reduce to a mathematical certainty a thing that depends on the opinions of the commissioners. You and I would put different values on the same field of land. Value depends somewhat on sentiment. Assessments are largely pure guesses.

Mr. Jones: Yes, but it is better to base that guess on the cost of drainage, than to base it on sentiment. Some forties can be drained more easily than others, and they should be given credit for it.

If a piece of land is ten feet higher than the surface of the ground at the ditch, eighty rods away, it should not be taxed as much as the low land next to the ditch, even though one is just as wet as the other.

Mr. Lucas: Elevation has no bearing on it whatever. The higher land could not be drained upon or through the lower land unless a district were organized, no matter how much fall it has. The lower owner may object.

Mr. Jones: Carrying your idea to its ultimate conclusion, you would tax the higher piece of land as much as the lower and to satisfy the objections of the owners of lands below the outlet of the district you would carry the water all the way to the Gulf of Mexico or to the Atlantic Ocean. That may be law, but it is not common sense. The upper owner must have some rights by virtue of the elevation of his land.

Mr. Thorne: Jones is right absolutely. If a forty can be drained easily its tax should be correspondingly less. Furthermore, when you do not give a distant forty a lateral to connect it with the outlet ditch you should deduct the cost of this lateral from the tax against the distant forty, and not from its benefits.

Mr. Vaughan: It is best to put in a lateral for each distant wet forty and levy the tax accordingly, but if the lateral is omitted, it is the tax and not the benefits that should be decreased by the cost of the lateral. But I want to ask Mr. English what crops he has observed on peat lands.

Mr. English: I knew them to be good generally. Last year on some peat of my own I got six bushels of potatoes from a row thirty-seven rods long, without fertilizer.

EXPERIENCE WITH PEAT

Irving G. Wheeler, Burlington, Wis.

(Racine Convention)

It is getting late, so I will not take up much of your time. I think about 1911 Mr. Peter Myers thought we ought to have a drainage district out our way, and someway or another it fell on me to promote the project. Mr. Waller and some of you know, it took a couple of years before we got down to business. I had about 120 acres of marsh land in the district. To make the story short, we finally got a good outlet, and drained it by putting a twelve inch tile to connect with the district ditch. We used three inch tile to drain into this big tile. We put them four rods apart across the whole of the marsh. This was completed two years ago this fall, about this time (Oct. 10) and we at once plowed up about one hundred acres of the marsh. Last year we planted it to corn and flax, and as you all know it was an exceedingly wet year, and we had an early frost in August, which took all our corn. Just as our flax was ready to cut we had a hard hail storm which threshed out about half of it, so we hardly got our seed back.

This year we went at it again and planted fifty-five acres to corn. We were all ready to plant about the 10th of June but in this part of the country we had rain continuously for forty hours. That threw us away back in our plan. We could not get on the land for almost two weeks, so we did not start planting until the 25th of June. We used commercial fertilizer. And while we have not got very much corn, the growth of the fodder is wonderful. I do not think there is a stalk in the field less than eight feet, and there was some of it ten and twelve; more ten and twelve than there was eight.

President Coddington: What variety of corn was that?

Mr. Wheeler: Common Dent corn. I just used common yellow and white Dent.

President Coddington: What kind of fertilizer?

Mr. Wheeler: Potash, such as I could get, but I could not get very much potash this year.

President Coddington: What was your subsoil?

Mr. Wheeler: We had a good deal of peat, with blue clay subsoil.

Mr. J. F. Mayer: How far down?

Mr. Wheeler: All the way from a foot and a half to four feet, but where we had most of our peat I put no more potash. and I cannot see but what we have got just as good a crop out there as where the clay was nearer the surface.

Mr. Anton Brost: Have you used any barnyard manure?

Mr. Wheeler: Yes, sir, we used some sheep manure, and also a little horse manure.

Mr. B. M. Vaughan: What is the result?

Mr. Wheeler: In the first place, we put commercial fertilizer all over the whole marsh where we put the corn. About three hundred pounds to the acre. Then we added some sheep manure on about fifteen acres, I cannot tell you just how many pounds. Of course, where we put sheep manure the corn grew much faster than where we put the fertilizer; but as the season went on the part we put more potash seemed to catch up with the part where we put on the sheep manure, and as the fall ended I could not see that there was any difference.

Mr. Vaughan: What percentage of phosphoric acid did your fertilizer contain?

Mr. Wheeler: I could not tell you. I paid more attention to the potash than to anything else.

Mr. Vaughan: Maybe it was the phosphoric acid that did the business.

Mr. Wheeler: It might have been.

Mr. Vaughan: Did you put your barnyard manure on the surface?

Mr. Wheeler: Yes, sir, and the fertilizer I put over the corn after it was planted. Some of the corn was about three inches before I put on the fertilizer. You see we drilled this corn, and I drilled the fertilizer right over the corn. Now, on the part of the corn where the most peat is, I put on the most potash. I put on as much as forty-nine pounds per acre of potash—mixed it in with the rest of the fertilizer.

Mr. Frank W. Lucas: What does that cost you?

Mr. Wheeler: Sixty dollars a ton the way I get it. I got some fertilizer with a smaller percentage of potash, and that cost me only $28 a ton. Then I got two hundred pounds of what I supposed was pure potash, and I mixed in eight pounds to the one hundred, on twenty-five hundred pounds.

Mr. Lucas: How many acres did you fertilize in that way?

Mr. Wheeler: We fertilized fifty acres, putting this two hundred pounds of potash over ten acres. That is, I mixed two hundred pounds in with twenty-five hundred pounds of other fertilizer and put two hundred and fifty pounds to the acre;

Mr. A. W. Dibble: In my spoil banks this year, where tile were laid, the blue clay was thrown on top of the ground, and the sugar beets are at least 30 per cent better than they are out where the clay did not reach them.

President Coddington: How long has your land been tiled?

Mr. Dibble: This year.

TILE REPLACES OPEN DITCH

M. W. Loving, Chicago, Ill.

The original plans of the Bridgeman District of Cheneville, Illinois, provided for an open ditch throughout the entire length of main channal. The width of ditch, including spoil banks, would average around 100 feet.

The engineer's attention was called to the fact that land in this locality is worth $200. per acre at a minimum. Figuring on a length of 10 miles of ditch, 100 feet wide, we have 120 acres; at $200. per acre the waste due to this cause alone is $24,000.

A 40 inch reinforced concrete tile in the lower section of the district, 36 inches in its central section and 30 inches in the upper end, had sufficient capacity to carry the stream under maximum flood conditions. The maximum depth of grade line was 10 feet; the minimum around 7 feet.

The engineer and commissioners were favorably impressed with this method and have installed the tile as above mentioned throughout the entire length of the ditch. They realized that the grade line of the tile never changes, hence more complete drainage can be obtained at all times. The open ditch would have to be cleaned out from time to time, and hence be a source of expense for the future. The tile ditch offers less resistance to the flow of water than an open channel and hence a smaller sectional area of tile is required to carry a given volume of water. Under certain conditions, hydro-static pressure is applied to advantage. In modern drainage district the large tile replaces the open ditch whenever possible. Long headed engineers and drainage commissioners have realized that an immense saving is accomplished in the long run.

DRAINAGE ENGINEERING IN SOUTHERN WISCONSIN

P. J. Hurtgen, Drainage Engineer, Burlington, Wis.

(Racine Convention)

I shall attempt to give you a brief outline of the course pursued by me in the conducting of drainage investigations.

The Preliminary Survey.—My usual procedure, after given authority by the interested land owners, or their attorney, is to consult the township maps, which invariable show the approximate location of all streams of any size and then proceed to run levels along the main ditch and laterals to determine whether or not there is fall enough to insure proper drainage.

The boundary line of the district to be embraced within the drainage area is then determined. This I usually do by driving around the watershed, with a township map, making the boundary line in all cases, follow some subdivision line.

After noting the boundary line of the district, I always verify it by comparing it with a topographical map. These topographical maps are issued and can be procured from the Director of the United States Geological survey, Washington, D. C., and they can also be procured from large book stores in the cities. I find these maps of great assistance in drainage work, as they are reasonably accurate. The contour lines on the maps are drawn at twenty foot intervals.

The location of the boundary line is of great importance, for if land of any extent is excluded from the district, that must be taken in later, the most carefully designed system of drainage may prove inadequate. In this section of Wisconsin, the border of the watershed is quite prominent, and can usually be determined by driving or walking around the border of the district, or a combination of both. Where the eye can not detect the border line, levels must be taken to determine its location.

Then follows a survey to determine the amount of low wet land in the district. The fall available, the cost of the work. and the area of land reclaimed are the prominent features which determine whether or not the reclamation project is warranted.

I have invariably sketched the border of the wet land by pacing from some known fixed corners. This can be done with a reasonable degree of accuracy in this section for the reason that most farms are divided into fields not to exceed 10 or 20 acres. The outside boundary of the low land requiring drainage is easily determined by the vegetation found upon it. In addition to this the points where the topography changes are usually well marked, thus making it a simple matter to determine the boundary of the low and high land. I believe the attorneys and commissioners with whom I have worked will support my contention that we have obtained very good results at less cost for the district by adopting this method in preference to an extensive topographical survey of the entire area.

It must be borne in mind that in practically all of our drainage districts, we not only construct the main ditches, but also laterals, thus providing an outlet for practically all the low land in the district. This makes it necessary to run levels along the main ditch, and also the laterals. When these elevations are taken observations are made over the area of low lands to verify the judgment exercised in making the preliminary survey. While this might be called a topographical survey it is not conducted on such an elaborate scale as is sometimes advocated by the writers of text books on land drainage.

It must also be remembered that this wet land survey is also verified by three commissioners when viewing the lands for assessment purposes.

Cases do arise on some areas in all districts where the topography is such that an actual topographical survey is necessary to determine the natural drainage of the area. I therefore employ a combination of methods, dependent on conditions.

During the time the preliminary survey is made, enough data is procured to outline the approximate extent and cost of the work necessary to drain adequately the lands within the area of the district. If after the appointment of the Commissioners and all other necessary legal steps have been taken, the commissioners find that after a thorough investigation the work should proceed. then a thorough survey is made by running a line of levels and taking an elevation every 100 feet along the line of the proposed work. While doing this, notes are recorded in the level book, locating all angle points, by referring them to, or tieing in to some fixed points such as trees, or property lines, or such other available permanent points as may be within a reasonable distance from such angle. This is done to facilitate the work of making the actual survey of the exact location of the ditches and branches. By making a survey of all the branches, as well as the main ditch, and noting the relative elevation of adjoining lands you practically have a topographical survey. At any rate, from this survey, together with the preliminary survey and the investigations made by the Commissioners is determined the classification of the land within the district.

But, to return to the preliminary survey. After this survey is completed and the watershed boundary line of the various branches is procured, preliminary profiles are made of the main ditch and branches, and a grade line established. In fixing the grade line of the profile, certain points are arbitrarily fixed, such as the outlet, and the necessary depths of the lowest depressions, and the minimum fall permissible. These elevations from the basis of the adjustment of intermediate portions of the grade line.

The Design.—In fixing the grade line, I find it convenient to commence on the upper end and work down stream, and fix the grade line and width of ditch so that the velocity in each down stream section will increase. The reason for this is that a decrease in velocity during flood time, when the water carries more or less silt, will cause the suspended matter to drop in the ditch, and form schoals. On the other hand a large increase in velocity will cause eddies, thus producing the same result. Another frequent cause of eddies, and consequently silt deposits, is to allow laterals and sub-drains to intersect with the ditch at a large angle. This should be avoided, as much as possible, and the lateral or sub-drain curved just before it enters the main so that the direction of flow in the two waterways are almost the same.

The various factors that govern the design of drainage systems are so dependent on watershed formations, soil composition, and available fall, that absolute rules of procedure are almost impossible. However, general standards for average conditions may be applied, and the duty of the drainage engineer is to become familiar with these standards, and their value in relation to each drainage system under consideration.

The design of a drainage system resolves itself into the folowing division: (1) The location and depth of the drains, (2) the adjustment of the grade line, and (3) the determination of the size of the main drain and branches. The adjustment of these details is sometimes a difficult problem, which not only demands true information and trained judgment, but also considerable experience.

If a satisfactory outlet is available, the governing points are (1) the size and shape of the tract, (2) the surface slope of the lands, and (3) the structure of the soil. If the area to be drained is comparatively level the mains should be located in the course of natural depressions, maintaining as straight a line as possible, in order to provide direct drainage throughout the length of the drain. By following the natural watercourse, the necessary depth of excavation is less.

In the case of tile drain, the sizes should be designed to remove surface overflow and sub-soil waters with such rapidity that crops will not be injured. In estimating the amount of water to be removed, the rate of removal necessary is so varied by the watershed, topography, and soil composition, that tile size formulas cannot be evolved that would be applicable, except in a general way.

It is a question in my mind whether it is economy to design tile lines large enough to completely protect farm lands from excessive rains, which may occur only at intervals of ten or more years. For average soil conditions, with due regard for the topography of the water-shed, the removal of one-quarter of an inch in twenty-four hours, I believe to be sufficient, and for large areas with favorable soil conditions this I believe can be reduced to one-eighth of an inch in twenty-four hours. Tile outlets should be located to one side of the natural water course, because of the tendency of overflow water to wash channels through the loose soil over the tile.

Under certain conditions, it is advisable to construct overflow depressions in connection with tile drains. However, I am not enthusiastically in favor of these depressions except in cases where they extend through individual farms, or where the surface slope is uniform. It is true, that if properly maintained they will permit of a material reduction in the size of tile, and consequently a proportionate reduction in the cost, but if they are constructed through the lands of several land owners, and unless close inspection is maintained by the Commissioners, these depressions will gradually fill in. Individuals will farm across them, especially during dry years. With the overflow ditch partially closed, and the tile too small to carry the water, serious losses will result to the land owners when a wet season comes—and it is sure to come.

Again, in this section of Wisconsin ,where the land is more or less rolling, it frequently becomes necessary to construct these depressions across long ridges, where it becomes necessary to construct a ditch of considerable depth. This may necessitate both bridging and fencing. Where the grade line of the surface run can be constructed practically parallel to the surface of the ground, and then seeded, and properly maintained, this objection would be removed.

In the specifications for the construction of all of the outlet ditches, I have planned, I have specified a one to one slope. A number of small ditches have been constructed in this section through peat marshes with a ¾ to 1 slope. This section of the state, being within the glacial area, has a surface soil of glacial drift, aluvial deposits, variable stability. In the construction of our ditches, we may find several hundred feet of hard, tight, clay soil, where a slope of one to one will stand up well, while the adjoining section may have pockets of sand or gravel, and still another section may be clay for a depth of four to six feet, underlaid with a strata of sand and gravel from six to twelve inches in depth. Where we encounter this sand or gravel in well defined layers from four to six feet below the surface of the ground, and where it covers a considerable area, the water will seep through the sand and water carrying with it enough sand to cause the banks to break and cave into the ditch, making it necessary to go over the work several times. However, the areas where this condition exists are usually small, and after the water has drained from these areas little further trouble is encountered, except from frost and erosion.

These forces of nature tend to fill open ditches, especially the first year after construction when the waste banks, berms and slopes are still in a loose, unsettled condition, and easily affected by the weathering action of frost and water. I have come to the conclusion that it would be economy to construct all of our ditches, except through peat soil, with a side slope of 1½ horizontal to 1 vertical. While this would increase the cost of the work considerably, there would be a substantial saving in the cost of maintenance.

However, I fear that this additional cost would discourage a large per cent of our drainage projects. For example, the amount of excavation in the Root River Drainage District, by substituting a 1½ to 1 slope, would have increased 25%, thus making the assessment considerably more. I am afraid our Commissioners would be in the position that Pat was. Pat and Mike were standing on the bank of the ditch where a large floating dredge was at work.

Mike said to Pat, "How would you like to be working on that boat?"

"Fine" replied Pat. "I'd like the job, but I'd hate like the devil to be one of the fellows under water that's filling up the scoop." The Commissioners would hate to be the ones levying the assessment.

It is my opinion that a great saving could be brought about by establishing a patrol system on both open ditches and tile drains. I made this suggestion at our meeting at Grand Rapids last winter, and I wish to emphasize it again here, that this is very important, and newly constructed ditches could be maintained at a much lower cost if proper provisions were made for frequent inspection.

The drains in the district could be divided into three sections, and each Commissioner make an inspection of his section about every thirty days during the growing season. While doing this he could make a notation of the particular points where the ditch needs attention. The Commissioners then could report to one of their number, who should keep a record of the portions of the drains that require attention. This Commissioner then could procure the services of a good reliable man, to remedy the particular defects noted on the record.

The very fact that frequent regular inspections are made by the commissioners will have a tendency to make land owners more careful about placing obstructions in the ditch, and when they see the commissioner on the job at regular intervals they will be reminded of the value of a clean ditch, and will assist the commissioners in keeping it clean.

A man with an ordinary long handled dung fork, with tines close together could cover several miles of ditch in a day, and by pulling out pieces of sod, lumps of dirt, boards, grass, weeds, and other debris could maintain an unobstructed channel, thereby providing a free flow for the water.

You, commissioners and land owners, have observed the obstructions above mentioned and know what the results are, if they are permitted to exist for a long period of time. You know that if these obstructions occur in a section of ditch with low or flat grade that the silt will settle at these points, and in a short time the ditch bottom will be anywhere from a foot to several feet above grade, with the result that tile outlets will be below the bottom of the open ditch instead of several feet above as they should be.

I have seen land owners permit their stock to enter the ditch for water, and force large pieces of earth or sod into the center of the ditch. I have seen land owners during dry periods, actully construct dams across the ditch to hold back enough water to supply their stock. I have found a large roll of fence wire, three feet high inbedded in the ditch and covered with silt half its height. Under a patrol system these obstructions would not be tolerated.

Another thing which I deem of great importance is the matter of small ditch outlets into the Main ditch. As stated before, it has been common practice in this section of the state, to construct lateral drains. Where this is not done, the surface water washes and erodes the banks of the ditch carrying huge pieces of earth into the ditch.

I would recommend that where laterals are not constructed, their entire length, that at least two or three hundred feet be constructed from the outlet up-stream to reduce this trouble to a minimum.

When to Make the Final Survey.—I believe it is a waste of time to stake out or measure the angles in the ditch lines during the preliminary survey. This belongs to the final survey and should be postponed until the commissioners are making their assessments and final report.

The Final Survey and Inspection.—In staking out open ditches, laths are driven every hundred feet, about twenty feet from the center of the ditch, and each lath properly marked with the number of the station. An elevation is then taken on the ground adjoining the lath, and a typewritten copy of the cuts is furnished to the contractor, and the original copy kept in the office.

In staking out tile drains, hub stakes marked by a lath are driven at intervals of one hundred feet on tangents, and fifty feet on curves. The elevation is then taken on the hub stake, which is driven practically flush with the ground, and a typewritten copy of the cuts is furnished the contractor laying the tile, and a copy retained in the office.

Our work, both tile and open ditch is checked for accuracy as to the grade line. In case of tile drains practically all our soils except peat cave badly, and in some cases fill the trench nearly half full. In order to check the grade of the tile I use a rod six feet long, made of ½ inch round iron. This rod is provided with a clamp which can easily be clamped 3 or more feet above the bottom. This rod is forced through the loose earth on the tile, and the leveling rod held on the clamp, and a reading taken. On tile work readings are taken at intervals of twenty-five feet.

The open ditches are checked by taking rod readings on the bottom of the ditch.

On ditches where floating dredges are used, the elevation of the water is procured at a point directly back of the dredge, and then with the aid of a boat the depth of the water is measured, and the bottom elevation is thus procured.

Local Notes.—On one branch in the Mount Pleasant and Somers district it was necessary to change the route of the ditch on account of encountering a peat marsh, which is underlaid with a very light marl mixed with snail shells. The marl was from five to six feet from the surface of the ground. The peat marsh forms a reservoir for the runoff from a considerable area of adjoining lands. and is consequently composed of a semi-fluid soil, which slushed into the ditch from both the sides and the bottom. By changing the course of the ditch and following the border of the marsh a good ditch was constructed except a section of one hundred feet on the upper end where the peat slushed into the ditch, and at this point the ditch is about three feet above grade.

In this section of Wisconsin some difficulty is met with in the construction of the tile drains on account of the caving in of the sides of the trenches. This is especially true on the border-line of our marshes where we encounter more or less wet sand and in some cases quicksand. This condition makes it necessary to brace the sides of the trenches at such points. While this condition has inconvenienced the contractors to some extent it has not increased the cost of the work to the drainage district in the same proportion.

The Root River Drainage District, which is west of the Mount Pleasant and Somers Drainage District, let contracts recently for the construction of fifteen miles of open ditches, ranging from two to thirty foot bottom widths. About four miles of this work drains to the South, and eventually empties into the Des Plaines river. This so-called South ditch is constructed with a four foot bottom, and affords drainage for about 3300 acres of land, and has a fall of three feet per mile on the grade line.

The North ditch drains north into Root River, and is being constructed with a thirty foot bottom at the outlet, and a four foot bottom at the upper end. This ditch drains about 14,700 acres within the Root River District, and connects with the Yorkville Raymond drainage ditch, from which point to the outlet the ditch is constructed with a thirty-foot bottom. The thirty foot bottom section of the ditch receives the run-off from practically 26,000 acres of land.

The total fall on the eleven miles of ditch which drains north into Root River is ninety-four feet. The minimum fall on the grade line is thirteen inches per mile, which is confined entirely to the lower section with a thirty-foot bottom. The minimum fall on any other section is thirty-eight inches per mile.

The main ditch and one open ditch lateral in this district is to be constructed through a peat marsh, for a distance of about one mile. While these sections may be difficult to construct with a dry land machine, I anticipate no trouble in maintaining these sections after they are constructed, because of the adequate fall through, and on either side of the marsh. The estimated amount of excavation required in the Root River district is 362,000 cubic yards. The lower section of this ditch, or 135,000 cubic yards, is being excavated with a two yard drag line, for which the contractor receives 12¼ cents per cubic yard.

The balance of the open work is being constructed with two dry land machines, one a Powell, and the other a Bay City, both being practically the same type of machine, and are operated with gasoline engines. The contract price for the section of ditch constructed with these machines is 9.9 cents per cubic yard. Cole Bros. of Napanee, Indiana, have the contract for all the excavating.

The contract for fourteen and a quarter miles of tile drains in this district was procured by James Reeves, representing the Streator Tile Company, of Streator, Ill., who was the lowest bitter. Their contract provides for the furnishing of first class shale tile, and the construction of the drains, including the bulkheads at the outlets. The tile drains in this contract range in size from six to twenty-inches, and are to be constructed to an average depth of 5½ to 6 feet.

With the kind permission of Mr. Reeves, I will give you an analysis of his bid per foot on the various sizes of tile. These prices include the cost of the tile, hauling, digging the trench, filling and the construction of the bulkheads at the outlets. The depths range from 4 to 7 feet.

20″ tile drain, complete @	64	cts. per lin. ft.
18″ tile drain, complete @	58	cts. per lin. ft.
16″ tile drain, complete @	45	cts. per lin. ft.
15″ tile drain, complete @	43	cts. per lin. ft.
14″ tile drain, complete @	37	cts. per lin. ft.
12″ tile drain, complete @	28	cts. per lin. ft.
10″ tile drain, complete @	22	cts. per lin. ft.
6″ tile drain, complete @	10	cts. per lin. ft.

We have on some of our other work, had more favorable prices from Mr. Reeves, but considering the present labor conditions, we consider this a good fair bid.

The Yorkville and Raymond Drainage District, as before stated has a common outlet with the Root River Drainage District. This ditch was originally constructed in 1906, with a floating dredge, and reconstructed in 1914. The cleaning out of this ditch was also done with a floating dredge, by Henry Johnson of Sterling, Ill. The main ditch is ten miles long, and has a uniform fall of two feet per mile, with the exception of a short section on the upper end, which has a much greater fall. Considerable difficulty was encountered on this work on account of the unstable condition of the soil, which consisted of clay underlaid in many cases with sand and gravel. Hardpan and large boulders were also encountered on the various sections, which caused considerable delay to the contractor. The area within this district consists of 6700 acres. Provisions, however, had to be made in planning the size of the ditch for an additional 4000 acres which was outside of the drainage district. The bottom width of the ditch varies from thirty feet at the outlet to four feet on the upper end. The depth at no point is less than eight and one-half feet, except near the lower end where the grade line intersects the grade line of the outlet. The excavation on the Main ditch amounted to 111,000 cubic yards. There were three miles of tile drain constructed, ranging in size from four inches to eighteen inches in diameter. The four inch tile were constructed on each side of a highway, which was badly in need of drainage. The contract price for the tile drains in this district were somewhat lower than the Root River District, owing to more favorable labor conditions, and the use of surface clay tile from a factory at Union Grove, which was in close proximity to the work.

The Norway and Dover Drainage District, is the largest drainage project in this section of the state. The original plans for this work were designed by Mr. Wm. Powrie of Waukesha, who rightly deserves the title of veteran drainage engineer of southeastern Wisconsin. The early history of the organization of this district is a long, long story, and can best be related by Mr. Myers, the attorney for the district, who through the persistent appeal of interested land owners sucessfully overcame many obstacles which were encountered before and after the organization of the district. Over 17,000 acres of land comprise the drainage area of this district, and it receives the run off from nearly 35,000 acres additional. Considerable difficulty was encountered on portions of the big marsh in constructing and maintaining the ditches to the grade line, because of encountering stretches of deep humus and partially formed peat. The entire marsh had been a reservoir for the water which flowed down from the higher lands for centuries, and consequently was extremely wet. The result was that on some sections of ditches, not only did the sides of the ditches cave in, or rather run in, but the bottom forced its way up also. Some of this work had to be gone over a second and a third time, and special efforts were made to overcome the difficulty, but it appeared that the more this semi-liquid soil was agitated, and the more weight added to the spoil banks the worse were the results. The water in the ditches was dammed up, in order to float the boat, and just how these particular sections would behave when the ditches were completed, and all the channels opened up was a question that kept us all guessing. Mr. Myers, the commissioners, and Mr. Bracken, who represents the firm of McWilliams, all participated in the guessing contest. However, we were satisfied that the dredge contractor, by skillful manipulation of the dredging machinery, had accomplished all that could be accomplished with the dredge. After the ditches were completed and the outlet provided we found that these bad sections were anywhere from two to four feet above grade. Considerable of the deposit was silt that had washed into the ditch by following the underground water, and being very light, was transported through the underground crevices, and into the ditch. We realize that if these deposits could be flushed into the Wind Lake Canal, that they would be carried down the canal, and into the Fox river. During this time we had a dry period with only light rains, so that the water available from natural drainage was not sufficient to clean the ditch of these deposits. In the meantime, the deposits were becoming firmer and grass and weeds began to grow on them, all of which tended to hold, or rather tie them more firmly to the points where they had lodged. Several remedies to relieve the situation suggested themselves. One was to divert the water from Wind Lake by constructing a channel to connect Wind Lake with these ditches. This plan necessitated the construction of a dyke at the present dam at the outlet of Wind Lake, and also the raising of the dam itself, and the construction of another dam across the newly constructed channel to control the water so it could be carried through either channel. This plan could be carried out only at a great expense to the drainage district. Another plan that was suggested was to install a small suction pump, and convey the slush far enough from the ditch so that the weight of the spoil bank would not break the berm and force additional slush into the ditches. Another plan suggested was to construct a drag that could be dragged down the center of the channel, and loosen the light deposits so that they would float down and out of the ditches.

We realized by this time, that whatever method was adopted, that these deposits had to be worked down gradually and slowly, thus giving the adjoining land an opportunity to drain out and carry with it the deposits that was causing the trouble. We finally procured a row boat, and attached a motor to it, and after opening a channel with hand labor, through the worst sections the motor boat was propelled back and forth through the ditches. The loosened deposits of silt, when mixed with the water in the ditches, floated down the stream and into Fox river, with the result that we now have a reasonably good channel through these troublesome sections. It is probable that this will have to be continued from time to time until the marsh settles, and becomes firm.

The Hoosier Creek Drainage District, comprises an area of nearly 15,000 acres, and contained practically 3,000 acres of low, wet land. The outlet of the Main ditch in this district is in the Fox river about three and one-half miles southeast of Burlington, from which point it extends easterly through the towns of Burlington, Dover and Brighton, in Racine and Kenosha counties. The length of the Main ditch is nine miles, and ranges from a twenty foot bottom at the outlet to a three foot bottom on the upper end, with an average fall of 4½ feet per mile. The original contract was let for twenty-one and one-half miles of open ditches, and eight and one-half miles of tile drain, ranging from six to twelve inches. The policy adopted by the Commissioners was to construct an open ditch wherever a twelve inch tile was not large enough to accommodate the area to be drained. The contract price of a twelve inch tile drain, was practically the same as an open ditch, with a two foot bottom. However, the land owners on any lateral had the option of substituting tile large enough to accommodate their drainage area by paying the difference between the cost of the open ditch as originally planned and the cost of the larger tile. Many of the land owners, knowing the advantages of tile drains, as compared to open ditches, arranged with the commissioners to substitute the larger tile. The amount of the original tile contract which was procured by the National Drain Tile Co., was approximately $7600. Enough tile drains were substituted for open ditches to increase this amount to $12,000. My first experience in large land drainage projects was procured in this district.

The Main ditch was planned and designed with a depth of from six to seven feet in the low lands, and the laterals from five to seven feet. The work was started at the outlet with an old Type R, Austin machine, and considerable difficulty was encountered with the original contractor, who lacked the necessary capital and equipment to prosecute the work at a rate of speed that would insure its completion within a reasonable time. As a result the attorney and commissioners prevailed upon the contractor's bondsmen to complete the work. The bonding company lost considerable time in procuring another contractor to complete the work. The balance of the work was completed with a Bucyrus drag line, with caterpillar tractors, and the contractors were making good progress until finally their steam boiler caused them so much trouble that the firm manufacturing the machine concluded that to properly equip the outfit, a new type of boiler would have to be built. This occurred late in the fall, and as a result operations were suspended until the following spring. Late fall, and early spring rains washed dirt and other debris into the ditch, with the result that the ditch was considerably above the grade. As a result, partly due to these conditions, and partly to shallow design, several of the laterals are not affording the best of drainage. Considerable difficulty was encountered in completing two of the lateral ditches. The upper end of one lateral passed through a peat marsh; another passes through a peat marsh underlaid with a light marl, and a mixture of small shells, neither of which would support the large sixty ton drag line machine, with the result that other means had to be employed. Dynamite was tried on these sections, but the soil was so completely filled with water, that the results were anything but satisfactory. These sections of ditches were finally completed by hand digging this year.

I am pointing out these bad conditions which were partly due to shallow design in order that other engineers may profit by it and make proper allowance in their plans for enough additional depth to provide for similar situations.

I do not want you to infer from what I have said that this drainage system is a failure, for it is not, but is a fair example of the average ditch. When we visit this district tomorrow, you will see some of the best crops ever produced in this or any other section of the state, on land that before drainage produced nothing but a poor grade of coarse slough hay, which could be used only for bedding.

In this section of Wisconsin, the low wet land lies in small scattered areas over the entire drainage district, thus making it necessary to construct long lines of drains, in order to provide an outlet for all the owners of wet land. This fact makes it necessary to design the drains as economically as possible, which sometimes, leads to the adoption of a plan with a very low factor of safety with little or no allowance for such conditions just mentioned.

I have taken up a great deal of your time, and before we part, let me add, "Get your drains deep enough, and wide enough, and don't do as one engineer did." When he discovered that a certain contractor had dug the ditch deeper than the specifications provided, he called the contractor to task. The contractor, who was a large-hearted, generous German was surprised and hurt at the lack of appreciation of his generosity, and he set up this defense, "I make de deepinings and de videnings yust like de paper call for, only a little bit deeper."

DRAINAGE ENGINEERING IN NORTHERN WISCONSIN.

Warren Moore, Drainage Engineer, Ladysmith, Wisconsin.

Being located as we are, on the great glacial drift of the north part of the state, we have none of the big problems of the more level lands of the central and southern parts of the state, but what our problems lack in size, they make up in number.

The glacial action left us with such a variety of soils and topography that it is only with the most careful investigation that we can determine what really is needed to drain the land sufficiently for agricultural purposes.

We have flat land that is dry, and hilly land that is wet, and the thing that makes it most difficult to determine the most economical system that will answer the purpose, is, that the nature of the surface soil does not seem to make very much difference. It took me a number of years to determine why it was that lands of the same surface quality situated only a comparatively short distance apart would differ so much in regard to natural drainage. I know now that the subsoil is more to be reckoned with than the surface soil.

With only a few exceptions our marshes and swamps have sufficient fall so that about the only engineering problem is to determine what system will give the best drainage for the least money.

Most of our marshes and swamps containing five hundred or more acres have more than one outlet. The Deer Tail District has eight distinct outlets. Many of our drainage projects consist of several small marshes more or less connected. Sometimes these small marshes in the same general drainage proposition will differ greatly in the nature of their subsoil and if the greatest care is not exercised, there will be a needless expense incurred by putting too much tile in some places while the same amount in an adjoining piece will not give sufficient drainage.

Money spent in a thorough survey before making the plans, and especially in subsoil survey, is money well spent. Fortunately one dense growth of brush does not interfere seriously with a subsoil survey. It does interfere with the topographic survey.

For the preliminary survey, the first thing I do is to take a pocket compass and hand level and go over the project making a rough sketch of its boundaries, water-sheds, etc. With this map for a guide I can plan how to get enough levels to enable me to arrive at a very close conclusion as to what will be needed to put in an adequate drainage system. In most cases I can get the necessary levels by following roads and other open ground and hitting the wet lands at controlling points, without cutting very many brush.

If the proposition is being backed by some one that is paying the bills as we go on, I do all of this work before the petition is prepared, but if I am doing it to promote a proposition for parties who feel that they cannot put much into it, I make only the sketch of the project at first and run the levels after the petition is out and enough signers secured to indicate that it will be a going proposition.

In many cases I go out and make the preliminary examination without making any charges; simply having the understanding that if it develops I will have the job of completing the preliminary work.

In this way there have been projects started that would otherwise have died for the lack of someone to put up the money for the first examinations.

Of course I don't base any real plans on anything short of actual knowledge but in most cases I am able to give them a very good idea of what will have to be done with only the information gained with the pocket compass and the hand level; in fact, I am often surprised at the accuracy of some of these preliminary estimates.

I am getting the best results on final surveys by first running a line of Check levels to establish a good set of benches.

Then I start at some convenient point, preferably near the outlet, and run a traverse line and take enough elevations to give me data for a fairly accurate contour map of the whole project. By using two rods and making all the measurements with the stadia, I get very accurate results with a minimum of expense.

On the open marsh lands, I have one rodman work on each side and when I want to move ahead on the main traverse line, I have the rodman who happens to be located most conveniently set the hub and guard-stakes. These, when well set, make a basis for the location lines for the tile without having to run any extra lines.

I also get the aid of property owners as the work is carried on and by locating these corners on the map can fill in the property lines with very little work; thereby getting a good map from which to figure acreage in making up the estimates. In our country very few of the property lines are marked and we have to pick up the old government sections and quarter corners and use them as a basis for the property lines.

Where it is brushy I have got the best results by having a good man take a couple of good axemen and cut out lines along the margin of the wet lands, keeping as close to the margin of the benefited land as is practicable without making too many angles. The better engineer I can get to look after this work the better the results. In fact, I would attend to all of this cutting myself if possible as the proper locating of these lines will greatly reduce the subsequent work. Then I follow up the brush cutting with the transit and stadia as I would in the open marsh; taking advantage of the openings and high points as much as possible to get topography.

In this way I can keep the transit at work on the open ground while the brush is being cut. This saves considerable time that would be wasted if the transit had to wait for the brush cutters.

At first I had considerable difficulty in keeping the notes of both the traverse lines and the levels in one book and have them in shape to plat up handy, but I have worked out the form of notes shown in the table.

TRANSIT NOTES

From	To	Bearings.	Stadia Distance	Vertical Angle	H. I.	F. S.	Elev.	Remarks.
0	a.	S.89° 00′ W.	5.60	....	39.97	5.30	34.67	W. Side marsh.
0	b.	S.80° 26′ W.	4.00	....	....	4.80	35.17	E. Side marsh.
0	c.	S.89° 00′ W.	1.75	....	....	5.60	34.37	S. W. " "
0	d.	S.00° 35′ W.	1.10	....	....	7.43	32.54	W. L. in creek.
0	1.	S.01° 40′ W.	2.41	....	....	4.13	35.84	Turning point.
1	2.	S.00° 35′ W.	1.18	....	38.66	4.26	34.40	
2	a.	S.16° 30′ W.	3.20	....	....	4.30	34.36	End of circuit.

The book used for these notes is the standard field book and by carrying the elevations on a separate sheet of paper it makes room enough for all the items required; if I were depending on one set of notes I wouldn't like the idea of carrying the elevations on loose sheets, but I have bench marks of the check level survey to keep checked up on, and I consider the time used in running the check levels and establishing benches ahead of the work well spent. It doesn't take long to run a mile of check levels and it furnishes a means of double checking all of the level work which is really the main thing in a drainage survey.

The traverse notes on the left page can be platted in the usual way by latitude and departure. You will notice that there is no column for corrected distance. This is omitted because there is so little need for making corrections of horizontal distance for vertical angles on this kind of work and by omitting this and the space generally used to carry the elevations in the usual way, it leaves plenty of room for the remarks column which is very important on this kind of work.

As a rule I prefer not to set the final stakes for the ditch or tile lines until the contractor is ready to use them. Where there is clearing to be done I find that nine-tenths of the mistakes in the field are caused by the stakes being moved after they have been set.

In establishing the grades for tile work, I set hubs and reference stakes, and run levels on the hubs I mark the stakes merely with their consecutive number. In the office I compute the depth of cutting below the hub at each station and furnish the contractor with these figures in loose-leaf form.

Our first problem after the survey is made is an equable assessment and in our work we have not considered any half way measures. We start in with the idea that every piece of land will ultimately be fitted for any kind of crop. On the first district we organized we were fortunate enough to get a man with years of experience in railroad construction and contracting, and thanks to him, we have organized a plan to take care of the problem of making assessments that is mathematically sound. We borrow the idea from the railroads that commissioners are not supposed to do the detail work of making assessments but should supervise the work of having it done correctly. This eliminates the mistakes made by making offhand assessments. It is apparent that the only way to do this is to reduce it to a mathematical basis, and it is also apparent that the engineer is the only one who has the data to work from and the office equipment to work it up with.

After the final survey and plans are made and the cost ascertained, the commissioners go over the district with the engineer and appraise the value of the various kinds of land in both an undrained and a completely drained condition without regard to property lines or ownership. The engineer makes notes of these appraised values and uses the Nye Jordan form. (See Second Annual Report.) He enters in the first three columns the number of acres of high, low, and wet lands—this he has already ascertained by his survey. In Columns 4, 5 and 6 he enters the appraised value in the present or undrained condition. This gives him the undrained value of the whole tract which he enters in Column 7. Then he enters the appraised value of what this land would be worth if it were thoroughly tiled in Columns 8, 9 and 10, and the total value in Column 11. This minus the undrained value gives the gross benefit for column 12. Then he figures the cost of a complete tile system suitable to drain the land sufficiently for any crop, together with any sub-mains necessary to reach the main outlet as planned. This he enters in Column 13. This subtracted from the gross benefit gives us the net benefit for Column 14.

This eliminates the much discussed problem of making equable assessments on forties that are not touched by the main outlet. And by the way, I don't think we should ever plan a system of mains that does not give every forty a direct outlet.

After the engineer has completed these assessments, the commissioners go over the whole proposition with him, picking out various forties and checking the results of his computations. This fully accords with the law requiring commissioners to make the assessments, and gives them a thorough check on the fairness of the work of the engineer.

There has been a question in the minds of some of our people as to whether tile would benefit the clay soils of Northern Wisconsin. Our experience has been limited but I believe from what I have observed that we have no clay in the glacial drift that is too tight to be benefited by tile. For instance, tile layed on the Shaw farm in the fall of 1915 in clay discharged water all summer in 1916 and dried the whole area thoroughly. Tile layed on the Decker farm in clay that was slightly wet on the surface and comparatively dry in the bottom of the tile ditch was discharging water at the outlet in ten days from the time it was laid with no rain in the mean time. I also notice that you in Southern Wisconsin are tiling successfully in soil where you can dig out a pit and have water in it all summer for stock. I can assure you that there is no place in our county where soil is that tight.

Discussion

Mr. Vaughan. You should subtract the cost of the tile from the cost of construction and not from the gross benefits.

Mr. Jones. Yes, or else multiply the cost of the supplementary tile by the ratio of benefits to get the "tile benefits" and subtract this product from the "total benefits" to get the "district benefits".

Mr. Vaughan. That is very ingenious and I believe it is sound.

STANDARD TESTS FOR DRAIN TILE.

E. R. Jones, Associate Professor of Soils,

Madison, Wis.

For years engineers, farmers, and tile manufacturers have been asking for a set of standards for drain tile. At last such standards have been established by a reliable authority. Committee C—6 of the American Society for Testing Materials has standarized the tests, and the Iowa Engineering Experiment Station has published the results. Dean Marston was kind enough to send me fifty copies of the report of the committee and I have them for distribution among the members of this association asking for them.

I shall speak of a few of the more important tests in the light of the committee's report.

Classes. The committee appointed for this work recognized clay, shale and concrete tile and have recognized three grades of each: (1) farm drain tile for private drainage work on farms for moderate sizes and depths; (2) standard drain tile for ordinary district land drainage at moderate depths; and (3) extra quality drain tile for district land drainage for considerable depths where an extra quality is desired. The purchaser should specify the class of tile he desires before holding the manufacturer to a particular standard.

PHYSICAL-TEST REQUIREMENTS FOR DIFFERENT CLASSES OF DRAIN TILE—TABLE I

Internal Diameter Inches	Maximum Absorbtion of Water Permissible—Per Cent									Minimum Average Ordinary Breaking Strength Lbs. per Linear Foot		
	Farm Drain Tile			Standard Drain Tile			Extra-Quality Tile					
	Shale	Clay	Con-crete	Shale	Clay	Con-crete	Shale	Clay	Con-crete	Farm	Stand-ard	Extra
4......	11	14	12	9	13	11	7	11	10	800	1,200	1,600
6......	11	14	12	9	13	11	7	11	10	800	1,200	1,600
8......	11	14	12	9	13	11	7	11	10	800	1,200	1,600
10......	11	14	12	9	13	11	7	11	10	800	1,200	1,600
12......	11	14	12	9	13	11	7	11	10	800	1,200	1,600
14......	11	14	12	9	13	11	7	11	10	900	1,200	1,600
16......	11	14	12	9	13	11	7	11	10	1,000	1,300	1,600
20......				9	13	11	7	11	10	....	1,500	2,000
30......	Not advisable			9	13	11	7	11	10	....	2,000	3,000
40......				9	13	11	7	11	10	....	2 500	4,000

Porosity. Too much porosity, and hence capacity for absorbing water into the walls is undesirable in tile of any material or any size. Highly porous tile contain so much water in their walls that repeated freezing and thawing injures them. Many farmers believe that porosity is an advantage. They believe that porous tile will make a soil dry more quickly than more impervious tile. My experiments lead me to believe that 98 per cent of the water enters from the soil through the crack between the tile, and I do not care much how that little 2 per cent does get in. The best tile we have are the vitrified tile, but they cost twice as much as common tile and are not to be considered except in unusual places.

PRESSURE ON TILE—TABLE II
Wet Clay—Pounds per Foot.

Feet Above Tile	Width of Trench		Add for each 1 inch of width
	1 Foot	2 Feet	
2..	280	635	30
4..	450	1120	58
6..	545	1500	86
8..	605	1790	110
10..	640	2010	133

Just the other day a tile manufacturer called at my office to tell of the good qualities of his tile. He said that his 4″ tile weighed 5.7 pounds when dry, and boasted that after they had stood in water for 24 hours, and wiped dry, they weighed 6.7 pounds. That is an increase of about 18 per cent. His jaw dropped about two inches when I showed him that 14 per cent is the highest per cent tolerated even for ordinary farm clay drain tile. Observing the table you will see that only 7 per cent is allowed for extra-quality shale tile. The lower percentage is required in shale and concrete tile first because it is more easily obtainable and second because it is necessary. A shale tile with more than 11 per cent pore space is apt to have so much space between the layers in its walls, due to its laminated structure, that it will go all to pieces with repeated sudden freezing. A concrete tile with more than 12 per cent porosity is unsafe not only because of its freezing, but also because the action of water moving through its walls may weaken the tile.

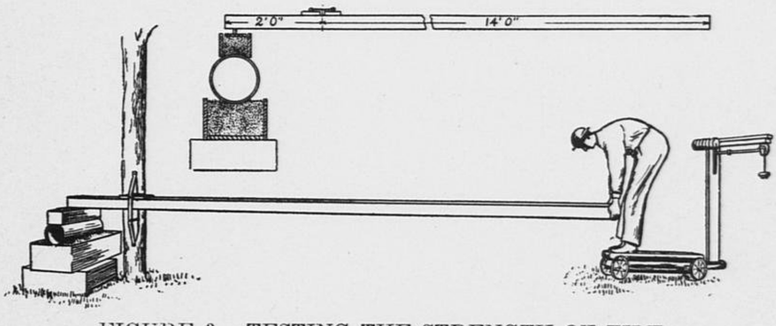

FIGURE 3. TESTING THE STRENGTH OF TILE.

The tile is placed on the sand in a box. A bottomless box is placed on the tile so that it will hold sand. A lid is then placed on the sand in the upper box. The lid rests on the sand and not on the sides of the upper box. Pressure is applied to this lid by means of the lever. It is measured by the scales.

A simple freezing test can be made by letting a tile lie on wet ground for a winter. If it has not begun to peal off by spring it is a good tile. Even if it has pealed off slightly it may be satisfactory, because on the surface of the ground where it freezes every night and thaws every day it was subjected to more abuse in a single winter than it would meet in 100 years under 3 feet of earth. There it would freeze but once each winter and thaw but once, and if it is empty when it freezes the injury is negligible.

Strength Tests. Twelve inch tile, of the farm class, and all of smaller diameter, are required to bear 800 pounds per linear foot without breaking. If they qualify for the standard class they must be able to bear 1200 pounds per linear foot, and the extra quality must be able to bear 1600 pounds. The requirements increase with diameter and class until extra quality tile, 40 inches in diameter, must be able to bear 2 tons per linear foot without breaking.

BREAKING STRENGTH OF TILE—TABLE III
Pounds per foot length—Sand Bearing

Size	Kind	Weight per foot	Walls Thickness	Minimum	Average
8"	Clay	22 lbs.	.78" to .85"	1210*	1940
8"	Conc.	22 "	.65" to .90	1160	1660
16"	Clay	64 "	1.15" to 1.20"	1700	2310
16"	Conc.	85 "	1.60" to 1.90"	1640	2140
24"	Clay	120 "	1.50" to 1.75"	1460	2190
24"	Conc.	200 "	2.30" to 2.50"	1790	2240

* Cracked.

Table II shows the actual number of pounds of pressure that tile, laid in trenches of different depths and widths, is called upon to support. Contrary to the general belief, the pressure is greater under a wet clay than it is under ordinary sand. An 8 inch tile laid 4 feet deep has to bear about 450 pounds per linear foot; a 16 inch tile laid 10 feet deep has to bear about one ton.

In Iowa, considerable data has been collected showing that a great many lines of tile more than 12 inches in diameter have been broken by the actual pressure. It will be noted that farm drain tile, though qualifying in its class, is not strong enough to bear the actual weight in a trench, 2 feet wide and 10 feet deep. The tile may be protected somewhat if the trench up to the top of the tile is made only wide enough to receive the tile. This leaves the undisturbed earth on either side of the tile to aid the tile in supporting the weight of the loose earth above it.

While it is seldom that a five inch tile is required to bear a weight of 800 pounds under actual conditions, it seems highly desirable to have it strong enough to bear that weight as an indication of the good quality of the tile. In the larger tile, the greater strength is actually necessary in order to bear the overlying weight in a deep trench.

Tables I, II and III are extracted from the report of the committee referred to.

The breaking test is commonly made in a laboratory equipped with apparatus for applying pressure conveniently. For the convenience of the farmer, or the drainage commissioner, or engineer, who wants to make a test for his own satisfaction on the ground, a lever device has been devised by the Soils Department of the College of Agriculture. This method involves the use of the sand bearing originally used at the Illinois Experiment Station, but the pressure is applied by a lever 16 feet long with a fulcrum 2 feet from the end where pressure is applied to the tile. By standing on a platform scales the weight of the lever arm and of the man operating it may be found. By applying weights to the scales, the number of pounds exerted by the man lifting on the lever can be measured. Subtracting from this, the weight of the man and the lever, the net lift on the lever can be measured. This multiplied by 7 gives the number of pounds of pressure exerted upon the tile. This is a device which any farmer can use, and should use in many cases to satisfy himself as to the quality of the tile.

Good cement tile are probably as good as good clay tile, but we have found more poor cement tile in Wisconsin in 10 years than of clay tile in 50 years. In every case, however, the poor cement tile were made by the farmer himself. Cement tile made in a well equipped factory seem to be satisfactory, but in every case the safest way is to apply the test of porosity and strength.

LEGAL PROBLEMS PECULIAR TO DRAINAGE IN SOUTHERN WISCONSIN AND THE REMEDY

Peters J. Myers, Racine, Wisconsin.

Attorney at Law, Chairman of Committee on Legislation of the Wisconsin State Drainage Association.

(Racine Convention.)

Mr. President, Members of the Wisconsin Drainage Association, and Friends:—

In addition to the welcome which has been extended to you by the others who have preceded me, I take personal pleasure in welcoming you to our city and to the drainage districts which we will inspect, on tomorrow. I wish that in going over the work which you will see that you would carefully observe what has been done, and then at our next meeting, which will be held in Madison, freely criticise what you have seen.

The subject which has been assigned to me by our Secretary is "Legal Problems Peculiar to Drainage in Southern Wisconsin." I have seen fit in this paper to extend the subject so as to point out the remedy for the legal difficulties which we have not been able to successfully overcome.

In so far as my observation goes, we have no legal problems in this section of the state which do not also apply to the state at large. It is true that some of our drainage districts are located in a section of the state where land is of great value and is devoted to intensified farming and market gardening. This fact does not raise any question peculiar to this locality except, perhaps, that we allow more damages for mutilation and for farm bridges than is customary in the sections of the state where the land is less valuable. The same general rules however apply. It is also true that in this section of the state we have adopted the plan of putting in large tile for laterals whenever the same will be large enough to afford a perfect outlet. We have however not gone as far in this locality as they are going in the neighboring states of Iowa and Illinois. Our largest tile laterals have not exceeded a 24 inch diameter. The putting in of the tile drains does not raise any legal difficulties peculiar to this section of the state. In fact this character of work rather eliminates the question of damages to the premises through which it passes.

My talk to you therefore, will be along general lines and not confined to this particular locality.

I think that we can be justly proud of the results which we have accomplished in all but one of the five drainage districts which you will have an opportunity to inspect. In the one in which we have not accomplished all that is necessary to give complete outlet drainage we have been prevented from so doing because of a legal obstruction which prevents us from removing an actual obstruction,—a mill dam in a so-called navigable stream about one-half mile below the outlet of our main ditch, which dam forms a barrier five feet in height to the natural flow of the stream.

As we expect to show you a portion of this drainage district I am going to give you a brief history of the proceedings which have heretofore been had relating to this work.

The district to which I refer is the Norway and Dover Drainage District, comprising portions of the towns of Norway and Dover in the western part of this county. The original work in this district was commenced in 1889 under a special act of the legislature of 1887 authorizing proceedings to be had in the circuit court of this county for the lowering of the level of Wind and Muskego Lakes and reclaiming marsh and overflowed lands in Racine and Waukesha counties.

Deep dredge ditches were dug, which lowered the level of Wind Lake, which is located near the upper end of the district and above the general marsh area, about five feet, and resulted in the draining and complete reclamation of about 5000 acres of very good land.

This was the first large drainage work ever undertaken in this state. No provision was made in the law however, for a permanent organization and for the maintenance of the work after the same was constructed and the commissioners were discharged by the court after the work of the actual digging of the ditches was completed. The ditches were not cared for, and, owing to the character of some of the soil, gradually began to fill up and the land owners saw the necessity for a permanent organization, and at their instance a bill which practically embodied the then existing Illinois drainage district law was presented to the legislature of 1895. This bill finally became a law and we had our first general drainage law in the State of Wisconsin.

The State of Wisconsin is indebted to the pioneers of the Town of Norway, Racine County, for the adoption of this law. Senator Adam Apple, Hans Jacobson and Ole Hanson were the leaders of the movement, and their sons are today continuing the work of perfecting the drainage laws so as to overcome the legal difficulty presented in this district.

I wish to point out to you that there is an area of low marsh land at the lower end of this district, comprising about 1000 acres, which does not now nor has it ever received complete drainage, and that there is another area of about 3500 acres about seven miles above the outlet which lies at an elevation of from 5 to 6 feet above the low water at the outlet which does not now nor has it ever received complete drainage.

Subsequent to the doing of the original work many town ditches were dug leading into the main canals.

During the year 1905 the land owners in the original area decided to organize the entire area into a drainge district for the purpose of enlarging and maintaining the ditches theretofore dug, and the owners of a large area lying to the south in the Town of Dover petitioned to be made parties to the proceeding, which petitions were presented to the court. The commissioners appointed after making their preliminary report and securing the legal organization of the district, decided that it was necessary to lower the mill dam in the Fox River at Rochester about three feet so as to give the necessary fall to the ditches and to completely drain the area of 4500 acres to which I have referred.

At that time I made a careful examination of the law as it existed, and advised the commissioners that while there was grave doubt about the matter it was my opinion that the district had the right under Chapter 419 of the Laws of 1905 to condemn the water power, rights of flowage and riparian rights and to lower or remove the dam. The commissioners accordingly adopted plans and made their final report to the court providing for the acquiring by the district of the water power and the lowering of the dam three feet. This plan, if it had been carried out, would have resulted in the complete reclamation of the entire area of 17,000 acres of land within the boundaries of the district.

At the time this report was filed the appeal in the Horicon case was pending in the supreme court, and between the time of the filing of the report and the date set for hearing thereon the supreme court handed down its decision in that case, and we met our first legal difficulty, from which we have not been able to get any permanent relief up to the present time.

After the decision in the Horicon case the work proposed in this district lay dormant for nearly two years when, at the demand of land owners, it was again revived and the report referred back to the commissioners with directions to amend the same and omit all work in the so-called navigable Fox River. They proceeded accordingly to modify their plan and late in the year 1913 the court confirmed a report providing for the work which has just been completed and which has resulted in the complete drainage of all of the low lands in the district excepting the 4,500 acres referred to, which area however was materially benefitted.

Within a year after the passage of the Water Power Act the land owners in this district instituted a proceeding before the Railroad Commission for the fixing of a high and low water level in the mill pond above the dam, and for the placing of bench marks fixing the height of the present dam. Pending the hearing upon this petition the district entered into a contract with the owners of the dam for a lease of the water power from April first to November first of each year, and in addition thereto secured an option on the dam. With this arrangement perfected the Railroad Commission made a finding to the effect that the low water in the pond above the dam could be maintained at a height of thirty inches below the crest of the dam without in any manner materially effecting the navigability of the River above the dam. After the decision was rendered the riparian owners along the river above the dam appeared upon the scene with a threatened appeal to the courts. Those of you who are familiar with the Water Power Act realize that the Act is not very clear in defining the powers of the commission other than to fix levels. Pending negotiations with the riparian owners looking toward an adjustment of the difference with them, the Railroad Commission, at our request, has vacated its order in this matter so as to enable those riparian owners to still perfect their appeal in the event that the negotiations should fail. The matter has rested at this point for nearly a year. Under the ruling in the Horicon and Shephard cases courts will not recognize the right of drainage districts to acquire by condemnation water powers, rights of flowage and riparian rights in navigable streams. In this case the drainage district is absolutely at the mercy of the owners of the water power and of the riparian rights even though we have a finding by the Railroad Commission that the lowering of the water level will not effect the navigability of the river above the dam. In fact the option which the drainage district holds upon this water power is at a figure which is about twice the actual fair market value of the property sought to be acquired.

In the bill which your legislative committee presented to the last legislature and which is now in the hands of the special committee of the legislature for ratification, amendment and report to the 1917 session, we have provided a remedy for this situation in so far as the constitutional inhibition may permit, and in my judgment this bill provides the only remedy which can be devised.

I believe that the navigable waters problem is the greatest problem which confronts us in successfully draining and reclaiming the swamp lands in this state. In no other state of the Union have the courts ruled as in this state, and in no other state are the public rights of navigation so jealously guarded and protected. Of course the position of our supreme court is well founded, and is based upon the trust created under the ordinance of 1787 which provides that the waters leading into the Mississippi and St. Lawrence and the carrying places between the same shall forever be free to the people of the United States as well as to the people of this state. Our court has construed this trust as of equal binding force with the ordinary trust created in an individual by a written instrument.

I have gone over this whole proposition in other papers which I have presented before other meetings of this Association, and have discussed the same before committees of the legislature, and I do not wish to repeat unnecessarily to you anything that I have heretofore said, but I wish to urge upon you, and upon the members of the special committee of the legislature, the great importance of this feature to the drainage laws of our state, and the great necessity for the amendment proposed.

I know that it is the opinion of a great many land owners, commissioners and even members of the legislature, that our drainage laws are entirely too complicated and should be simplified. I wish to say that from the standpoint of a lawyer who has had fifteen years or more of experience with the actual operation of the drainage district law, that in order to have a proceeding which is valid and binding and enable us to find a market for the bonds to be issued in payment for the improvement, we have got to have a law drafted with some idea towards complying with the legal necessities of notice to all persons interested, and the full protection of the interests of the land owners.

Chapter 419 of the laws of 1905 was drafted by lawyers who appreciated the necessity for these steps. Our present law consists of amendments to Chapter 419 made by the legislature from time to time. We must have a law which clearly and definitely outlines each step to be taken, and it is going to be impossible to have upon our statute books a valid drainage law unless these steps are so defined. The drainage law is a special act and is an entire departure from the common law. The rights and powers of drainage districts are strictly construed, and a drainage district has no rights or powers not specifically granted by the act. In this respect it differs from the ordinary municipal corporation. It is impossible to draft a drainage bill comprising three or four sheets of legal cap, such as has been frequently suggested to me by members of the legislature.

There is another legal difficulty in the organization of drainage districts which has caused the districts and land owners in the district great expense and has resulted in much injustice, hardship and inequality in the assessment of benefits and for cost of construction. I refer to the question of a jury trial on the assessment of benefits.

This legal difficulty is not peculiar to southern Wisconsin, but, I am informed, is a difficulty which has been met with in the organization of nearly every drainage district in this state.

Usually we find some energetic land owner who feels that the assessment for benefits and cost of construction levied by the commissioners in their report against his lands is too high. This energetic land owner usually retains an energetic young lawyer who hasn't very much legal business, who files a remonstrance setting up the fact that the law upon which the proceedings are had is unconstitutional and void in spite of the fact that the supreme court has in numerous decisions declared it to be constitutional; that the court is without jurisdiction and also that the assessment of benfits is too high and that the award of damages is too low. This energetic young lawyer usually advises his client that it would be advisable to get other land owners to file similar remonstrances and usually the land owner accompanied by his attorney makes a canvass of all the owners of lands in the proposed district, and they are usually successful in getting a dozen or twenty land owners to file remonstrances who would not othewise file, although, they might feel that they are somewhat aggrieved by the assessments.

Here in southern Wisconsin we have a situation which does not prevail in the larger marsh areas of the northern and central parts of the state. Our marsh lands are usually owned by individual farmers, who are also the owners of the higher lands surrounding the marshes. Thus we have a great number of land owners instead of a corporation or a few individuals owning the bulk of the marsh lands. I have yet to find the farmer whose lands are assessed for benefits and cost of construction in a drainage district who does not feel that his assessments are too high and the assessments against the lands of his neighbor are too low, and the land owner who is soliciting remonstrances to help him out on his individual fight has no great difficulty in promoting additional remonstrators. His energetic young lawyer, who probably has never had any experience in the organization of drainage districts, reads the statute and at once concludes that he must have a jury trial for his client, and he proceeds to file a demand for a jury trial on the question of assessment of benefits and award of damages.

I have absolutely no objection to trying the issues on the question of whether or not the award of damages is ample before a jury, because, in my opinion, the question of damages is particularly a question for the jury to pass upon in a drainage case as well as in a condemnation case, or any other case where damages are to be awarded. The award of damages in a drainage case is in its nature a condemnation case for the reason that private property is being taken for a public purpose. But as to the trial of the question of the assessment of benefits I submit that it is entirely impossible to bring before the jury all of the facts bearing upon the question of benefits to the lands of an individual owner in the course of a short jury trial lasting at most from three days to a week. By the assessment of benefits in a drainage district we mean the probable increase in the reasonable fair market value of the land of an individual owner by reason of the carrying out and completion of the drainage scheme. In other words the commissioners must fix the present value of the land and then fix such improved value of the land which in their opinion will result by reason of the work. The difference between the present value and the improved value constitutes the assessment of benefits which is the basis upon which the cost of construction is apportioned. When I speak of value I mean the reasonable fair market value at private sale between the owner of the land who wants to sell and a prospective purchaser who is ready to pay the full, fair market value thereof.

Many considerations must enter into the fixing of the improved value by the commissioners. They usually, in the larger districts comprising upwards of ten thousand acres of land, make a very thorough study of present conditions, the market value of the surrounding high land; they study the results accomplished on other similar districts; they take into consideration the character and fertility of the soil; the location of the particular tract of land to be assessed as to the outlet ditches; the necessity for underdraining the same, which is always a difficult problem. In this section of the state no marsh land can be made fit for cultivation unless it is first thoroughly under-drained, the subsoil being clay. The cost of underdraining is always a serious problem and one to be dealt with by men who have had experience in the underdraining of lands. Some lands require the tile drains to be close together, while in other lands they can be from six to eight rods apart, depending entirely upon the porosity of the soil.

The commissioners must also take into consideration the relative proportion of the various assessments of benefits. All of the questions go to make up the issue to be tried by jury, and it is not to be wondered at that the results of jury trials have never been satisfactory. I have known commissioners in large projects to spend a year in arriving at their conclusion as to assessment of benefits, and yet it is expected that a jury of twelve men can make an intelligent assessment in three days or a week. This issue should be tried by the court without the aid and assistance of a jury, and all questions relating to the assessment of benefits in any one drainage district should be submitted to the court upon the same trial. In other words, all of the parties plaintiff should be obliged to present their case before the court at one hearing, and the drainage district should present its case as to all of the several tracts of land upon the same hearing. This would eliminate the long-drawn-out trials. In one case that I have in mind in particular, being the case of Ward against Babcock which was decided by our supreme court last March and the opinion being incorporated as a part of our proceedings at the last meeting, the jury reduced the assessment of benefits from $7,000 down to $1,300. The trial court however committed several errors in the exclusion of evidence offered by the commissioners, and we were obliged to take the case to the supreme court, where it was reversed and sent back for a re-trial. In that case if all of the assessments of benefits had been reduced in the same proportion as the Ward assessment there would not have been money enough to go ahead with the work. We deemed it wise to delay the trial of other remonstrances until after the decision in the Ward case. The Ward case came up for re-trial last June and after the jury was empanneled and had viewed the premises and the drainage district generally, it was agreed that the assessment of benefits should be reduced fifty per cent and that Ward should pay the cost of the appeal to the supreme court. We did this rather than to take the chances of another jury trial with the uncertainty as to results. In this settlement we took care of those whom we believed to be the principal remonstrators. There were a few scattered remonstrances left which we did not consider to be at all serious, but we later discovered that we had a new crop,—some of whom are demanding exhorbitant reductions. In any event we feel that in making settlement of these remonstrances we are saving money to the land owners, but these settlements have resulted in gross inequalities in the assessment of benefits as between the land owners who bear their full and just burden of the cost of the work, and the remonstrating land owner who has secured an unreasonable reduction in the assessment of benefits because of the threat of a jury trial.

It is true that where the commissioners and their attorney are good diplomats many difficulties can be avoided, and sometimes the difficulties of a jury trial may be eliminated by making a small reduction in assessments of benefits or small increases in the awards of damages. This, of course, is always desirable but it involves a great deal of labor and careful work on the part of the commissioners and their attorney. This was recently done in the organization of the Root River Drainage District in this county. The actual cost of the work in this district is a little over $80,000, according to the contracts let. We secured the disposition of the remonstrances excepting two or three, which were not serious and which are still pending, at an expense to the district as a whole of not exceeding $3,000. Many of the reductions made in the assessment of benefits and increases in the awards of damages were just, and only a few were made for the purpose of avoiding protracted litigation. The final report of the commissioners in this district was made in the month of February of this year and on the day set for hearing we secured the confirmation of the report except as to the land upon which remonstrances had been filed. We proceeded to advertise for bids and before letting we had disposed of the majority of the other remonstrances. We now have one large drag line machine and two Bay City machines on the work, with several miles of ditch completed, and we are also putting in several tile laterals at the present time. All of this was careful diplomatic work, and for weeks I did nothing but keep in touch with the situation and met land owners and adjusted differences both in the office and in the field. I had the hearty support of the petitioning land owners and of the commissioners. If we had gone into court and tried the main issues presented either before the court or with a jury, we would still be trying cases with the result of an expense far exceeding the amount of the reductions given and a delay of the construction of the work two or three years, which would also result in great financial loss to the land owners because of being deprived of the use of the low land.

However, we did not have the energetic land owner or the energetic young attorney to contend with except in the lower end of the district, where one of the land owners employed some Milwaukee attorneys, who successfully promoted some fifteen or twenty remonstrances located along the line of a large tile lateral. We brought them into court, had the jury empanneled ready to try the case, when we made them a proposition to eliminate the construction of the lateral from the plans and reduce the assessment for benefits and cost of construction to an amount equal to the estimated cost of construction of this lateral. They finally took the bait offered and their lateral has been eliminated from the work of the district for the time being and their assessments reduced without any loss resulting to the other land owners in the district. I was recently informed that as soon as the main ditch is completed below the outlet on this lateral a land owner whose land lies at the head of the proposed lateral will file an affidavit with the commissioners requesting that the lateral be constructed. This, of course, means that the entire cost of the lateral with an additional overhead charge will have to be assessed against the lands of these remonstrators, and they will finally be required to pay more toward the construction of the lateral to the main ditch than they would have paid had they not remonstrated. However, attorneys and commissioners should not be required to be diplomats, and it should not be necessary to make such settlements.

The energetic land owner with his energetic young lawyer who has worked up the opposition goes into court and faces the jury and presents his side of the case. The evidence presented is usually as follows: The land owner takes the witness stand and swears that he has been the owner of the land assessed for a number of years; that he has raised crops of wild hay upon the land; some of the hay is blue joint and is very desirable for feeding purposes; that it is better than upland hay; that the land is great pasture land and that he has an abundant supply of pasturage during dry seasons; that he once plowed up a ten acre plot and got one hundred baskets of corn to the acre; that his marsh land in its present condition is of greater value than the surrounding high land; that he does not believe in under-draining; that he has never done any under-draining of his own land; that he knows of a certain tract of land some three or four miles away which was under-drained and a large amount of tile put into the same; that this land has not produced good crops since being underdrained; that the construction of the proposed drainage ditches will damage his land twenty dollars per acre.

He calls as witnesses a number of the promoted remonstrators who verify his statements. These witnesses are probably subjected to a severe cross-examination. They do not know anything about the market value of the wild hay, the cost of harvesting the same, and are unable to understand that the actual cost of harvesting and marketing wild marsh hay exceeds the market value of it.''

The commissioners in their defense testify as to the various elements which have gone to make up the assessment of benefits. You probably call in to their assistance some of the best farmers in your county, or in adjoining counties, who have had experience with drained lands, and will probably call as witnesses some of the soil men from the college of agriculture to show the character of the soil of the particular tract and that if thoroughly drained it will produce any and all crops grown in that given locality. The case goes to the jury under the instruction of the court that the assessment of benefits is made up of the difference between the fair market value of the land on the day of the filing of the final report of the commissioners and the improved value which will result because of the construction of the proposed drains and ditches. The jury attempt to arrive at a verdict and in nine cases out of ten their verdict will be a compromise of perhaps fifty per cent or a little more of the amount assessed by the commissioners for benefits. This statement is based upon my experience, and the result has been so unsatisfactory and unfair that I believe that we are fully warranted in asking the legislature to eliminate the jury trial upon the question of benefits and make this a question of fact for the court. We have made this provision in the bill which we presented to the legislature during the last session, and this matter is going to receive serious consideration at the hands of the special committee of the legislature. The chairman of our legislative committee presented to the joint judiciary committee of the senate and assembly at the time our drainage bill was under consideration a very able brief on the constitutionality of an amendment to the law eliminating the jury trial. This brief has been incorporated in the proceedings of our last meeting and is available to all of you. Both Mr. Vaughan and myself are thoroughly satisfied that such a provisions is constitutional, and a similar provision has been sustained in both Indiana and Illinois.

BUSINESS MEETING.

Officers were elected as follows:

President, B. M. Vaughan; vice-president, A. P. Nelson; A. C. Willard and E. R. Jones were elected treasurer and secretary respectively.

It was moved and carried that two new committees be created, one on Methods and Results, and the other on Clean-Out Machinery.

The following financial statement from January 20, 1916, to March 27, 1917, was read and accepted.

Classified Receipts.

Balance on hand Jan. 20, 1916	$57.50	
Membership fees for 1916–1917	200.00	
Membership fees for 1917–1918	70.00	
Contributing membership fees	16.00	
Sale of proceedings	.20	
Advertisers in 1915 proceedings	20.00	
Advertisers in 1916 proceedings	617.00	
Borrowed from secretary	11.66	
Total		$991.36

CLASSIFIED EXPENDITURES.

Postage	$125.49
Stenographer	176.50
Printing	591.25
Telephone	2.49
Supplies	6.55
Miscellaneous	9.19
John Raymond, traveling expenses	25.00
A. L. Webster, traveling expenses	20.00
Engraving	14.89
B. M. Vaughan, traveling expenses	20.00
Total expenditures	$991.36

Respectfully submitted,

A. C. WILLARD, Treasurer.

E. R. JONES, Secretary.

Examined and found correct:

H. C. WEBSTER,

NYE JORDAN,

Auditing Committee.

At the closing session the president announced the appointment of the following committees:

Legislation—Peter J. Myers, Chairman, Racine; Frank W. Lucas, Madison; G. T. Thorn, Oshkosh; Percival Brooks Coffin, 39 S. La Salle St., Chicago, Ill.; J. F. Mayer, Richfield; E. R. Jones, Madison.

Standards—J. L. English, Chairman, Waterford; J. Q. Daniels, Babcock; C. F. Liens, West Bend; Warren Moore, Ladysmith; A. E. Matheson, Janesville; A. B. Larson, Tomah.

Methods and Results—O. R. Zeasman, Chairman, Madison; P. J. Hurtgen, Burlington; G. E. Brown, Madison; Anton Brost, Babcock; A. P. Nelson, Racine; W. B. Coddington, Plover; A. W. Dibble, Madison; W. J. Hansche, Racine; C. H. Pratt, Plainfield; P. C. Frederickson, Necedah; Carl Foll, Deerfield; E. R. Jones, Madison.

Clean-Out Machinery—C. F. Leins, Chairman, West Bend; E. R. Jones, Madison; J. Q. Daniels, Babcock; E. I. Philleo, Grand Rapids; R. F. Roberts, Randolph; W. B. Coddington, Plover.

Auditing—Nye Jordan, Chairman, Mauston; H. C. Webster, Milwaukee; A. W. Dibble, Madison.

Mr. Carl Foll was elected to honorary membership in the association as a recognition of the valuable service he has rendered to the cause of drainage.

After appointing A. P. Nelson, W. B. Coddington and E. R. Jones, a committee to make arrangements for a summer meeting, the president declared the convention adjourned.

WISCONSIN STATE DRAINAGE ASSOCIATION

LIST OF MEMBERS—1917

Albrecht, Fred, Ohio, Illinois.
Allen, C. L., Eau Claire.
American Concrete Pipe Ass'n,
210 S. La Salle St., Chicago, Ill.
Ames, F. M., Brooklyn.
Arends, A. H., Cleveland.
Arpin, E. P., Grand Rapids.
Atwell, V. P., Stevens Point.

Bangs, J. W., Kingston.
Binnie, John, Poynette.
Bodenheimer, M., Green Bay.
Boston, H. D., Stevens Point.
Bovee, A., Ladysmith.
Bowden, Wm. H., Babcock.
Boye, A. J., Plainfield.
Brann, Geo. W., R. 20, Peru, Ill.
Brost, Anton, Babcock.
Brown, G. E., Madison.
Bruins, H. A., Brandon.
Brusewitz, A. G., Appleton.
Buboly, Fred, Reedsville, R. 2.
Butterfield, Geo. W., Baraboo, R. 2.

Carlson, Ed., Taylor.
Carswell, N. L., Lone Rock.
Channing, Adam, Whitewater.
Chase, J. B., Oconto.
Choak, Charles, Kansasville.
Clark, J. J., Berlin, R. 1.
Clark, W. W., Grand Rapids.
Class, L. B., Cambria.
Clousing, Louis, Thiensville.
Coddington, W. B., Plover.
Coffin, P. B.,
Room 308, N. Y. Life Bldg., Chicago, Ill.
Comstock, H. G., Milwaukee.
Corning, C. E., Portage.
Cragoe, T. J., Oakfield.
Cull, Arthur J., Hartland.

Dale, D. P., Storm Lake, Iowa.
Dalton, Frank E., Poynette.
Daniels, J. Q., Babcock.
Daniels, Dr. J. S., Omro.
Davis, F. M., Rapatee. Illinois.
Day, Jerod W., Ashland.
Dean, Seth, Glenwood, Iowa.
Day, Seth, Glenwood, Iowa.
Delta Land Co., Trempealeau.
Dettinger, Stanley, Hixton.
Dibble, A. W., Madison.
Dietz, George, Greenville.
Dodge, McL., Madison.
Donohue, Jerry, Sheboygan.
Drill, A. E., Hebron, Illinois.
Durbin, H. A., Waukegan, Illinois.

Edwards, B. F., Wales.
English, J. H., Waterford.
Fedderson, P., Davenport, Iowa.
Foll, Carl, Deerfield.
Frederickson, P. C., Necedah.
Froehlich, W. H., Jackson.
Finucane & Avery, Antigo.

Gallagher, D. J., Babcock.
Gault, J. H., Milwaukee.
Gaulke, Wm., Grand Rapids.
Giddings, C. C., Racine.
Goldsworthy, C. R., Vesper.
Green, E. H., Benson, Minnesota.
Green, Howard T., Genesee.
Gunderson, H. A., Portage.
Gunther, Fred, Babcock.

Haeger, E. H., Dundee, Illinois.
Hahn, F. J., Tomah.
Hales, G. S.,
3112 Monroe St., Madison
Hall, W. B., Oconto.
Hansen, H. N., Nestbrook, Minn.
Harness, J. H., Oakfield.
Harrington, Myron, Waupaca.
Harrison, A. P., Reedsburg.
Hart, M. E.,
1149 Farwell Ave., Chicago, Ill.
Hay, Townsend, Elkhart Lake.
Hay, W. J., Oshkosh.
Hereid, John, Sun Prairie.
Hines, Edward, Farm Land Co.,
2431 S. Lincoln St., Chicago, Ill.
Hinze, P. H., Madison.
Hirsch, August C., Reedsville, R. 3.
Holcomb, A. E., Grand Rapids.
Holland, J., Necedah.
Holmes, V. C., Evansville.
Holway, O. G., Merrillan.
Hubert, D., Cedar Grove.
Hurtgen, P. J., Burlington.
Hyne, Ed., Evansville.

Jacobson, James, Waterford, R. 23.
James, S. D., Wales.
Jawart, J. Will, Jr., Manawa.
Jensen, J. Albert, Clinton.
Johns, H. A., Randolph.
Johnson, Easton, Whitewater.
Johnson, John G., Blair.
Jones, Dave W., Wales.
Jones, E. R., Madison.
Jones, Howard Murray, Auburndale.
Jordan, Nye, Mauston.
Judd, Geo., Footville.
Jung Brothers, Randolph.

Kamper, J. H., Franksville.
Kastenson, H. E., Franksville.
Kelly, J. W., Brodhead.
Kieher, Louis G., Thiensville.
Kiekhaefer, Henry, Thiensville.
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Klefstad, Iver, Prairie Farm.
Klitzman, Carl, Marshall.
Knoke, Hugo, Readfield.
Koelsch, Andrew, Hales Corners.
Kolb, J. A., Berlin.
Kolb, W. F., Berlin.
Kraft, Arnold, Watertown.
Krause, J. L., Beaver Dam.
Kuechenmeister, G. A., West Bend.

Larsen, A. B., Tomah.
Lein, Lars, Sr., Edgerton.
Leins, C. F., West Bend.
Lindas, M., Deerfield.
Litch, Geo. H., Oregon.
Livingston, E. C., Randolph.
Lockman, Frank, Columbia.
Lucas, F. W., Madison.
Luedke, Aug., Lena.

McComb, J. A., Milton.
McKay, Geo., Doylestown.
Maas, Chas., Marshfield.
Mach, M., Shiocton.
Mahnke, Otto, Reedsville, R. 3.
Marsden, L. W., Edgerton.
Matheson, Alex. E., Janesville.
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Morgan, W. W., Ladysmith.
Morse, Dr. E. A., Appleton.
Mortenson, C., Camp Douglas.
Myers, P. J., Racine.

Neitzel, C. J., Watertown.
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Nichols, E. G., Elkhart Lake.

Olson, Ole C., Larson.
Olson, N. E., Tomah.

Peddie, A. F., Cedar Rapids, Iowa.
Philleo, E. I., Grand Rapids.
Phillips, J. A., Neillsville.
Pierce, Edwin, Merrillan.
Post, L. D., Weyauwega.
Pratt, C. H., Plainfield.
Pratt, D. H., Plainfield.
Prout, G. L., Vesper.

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Reindahl, A. K., Madison.
Reitbrock, A. C., Milwaukee.
Renak, E., Racine.
Reynolds, T. F., Oconto Falls.
Rice, Ernest, Ogdensburg.
Richards, Thos., Whitewater.
Rocque, Fred, Lena.
Rowlands, M. J., Cambria.
Rush, A. H., Reedsville.

Salsich, H. E., Hartland.
Sanborn, Q. W., Pardeeville.
Sawle, Wm., Arena.
Scanlon, D. J., Oregon.
Schaefer, George J., Sherwood.
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Shepard, L. G., Waterloo.
Sherwood, H. H., Elkhart Lake.
Shilling, E. C., Abbotsford.
Skeen, W. J. Antioch, Illinois.
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Smith, J. M., Shell Lake.
Smith, K. S.,
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Smith, W. J., Plainfield.
Spreiter, W. E., Onalaska.
Stangel, O. A., Virginia, Minn.
Steinburg, A. C., Farrington, Ill.
Steinhagen, G.,
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Stelter, George, Fairwater.
Stewart, Clinton B., Madison.
Stone, J. A., Reedsburg.
Swerig, O. P., Stoughton.

Techtman, Chas., Kewaskum.
Teigen, Nels, Edgerton, R. 2.
Tennant, H. V., Portage.
Trowbridge, L. A.,
N. Y. Life Bldg., Chicago, Ill.
Tubbs, H. H., Elkhorn.
Tucher, B. H., Kilbourn.
Twedt, J. H., Wyocena.

Uvaas, Ed., Larsen.

Volk, Wm. E., Oconto Falls.
Vaughn, B. M., Grand Rapids.

Walgenbach, John, Fond du Lac.
Wallace, R. Y., Fox Lake.
Waller, Geo., Burlington.
Warren, Geo. E.,
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Weidman, Geo., Green Lake.
Wheeler, Max, Hillsboro.
Whitson, A. R., Madison.
Whitewater Brick & Tile Co.,
Whitewater.
Willard, A. C., Necedah.
Williams, G. J., Portage.
Wilson, Albert N., Rio.
Wisconsin Drain Tile Co., Elkhorn.
Wolfram, Harry J., Kilbourn.

Zeasman, O. R., Green Lake.