Wisconsin State Drainage Association: fifth report, February 1925. 1925

Wisconsin State Drainage Association
[Madison, Wisconsin]: The Association, 1925

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WISCONSIN STATE DRAINAGE ASSOCIATION

FIFTH REPORT

February 1925

Papers of the Eleventh Annual Convention
December 9, 10 and 11, 1924,
and a
Summary of Proceedings
from
December 1920 to December 1924.

Edited by

E. R. Jones, Secretary,
Madison, Wisconsin.

AFTER TEN YEARS

Ten years of usefulness is the record of the Wisconsin State Drainage Association. It was on December 9, 10 and 11, 1914 that its first convention was held. On December 9, 10 and 11, 1924, it held its eleventh annual convention, strong and vigorous.

The convention was called to order by President L. S. Keeley of Mayville. After paying tribute to the men who have stood for better drainage of Wisconsin's cultivated fields, and reviewing the advantages of getting together once a year to talk over drainage problems, renew acquaintances and make new ones, he announced the program.

The following men were present: Carl Foll, Deerfield; C.J. Dodge, Windsor; L. S. Keeley, Mayville, B. M. Vaughan, Wm. Gaucke, W. S. Reeves, Wisconsin Rapids; C. R. Thomas, W. S. Gerber, G.T.Thorne C. R. Pierce, Chicago; Nye Jordan, Mauston; Ira Haverberg, Fred Wilkinson, Finley; Anton Brost, Babcock; C. C. Christianson, Valley Junction; H. J. Vintz, Oakdale; A. B. Larson, Tomah; P. J. Frederickson, Necedah; Swen Norling, Minneapolis; O. A. Ottosen, Stoughton; J. F. Maxfield, Stevens Point; H. M. Sparboe, Webster City, Ia; L. M. Schindler, Appleton; Robt. Kafton, Green Bay; Geo. H. Dobbins, Fremont; H. M. Jones, Auburndale; A. R. Albert, Hancock, Riley Stone, Reedsburg; Geo. McDowell, Sprague; Frank Flohr, Watertown; H. W. Strehlow, Wautoma; W. G. Caldwell, J. H. Waite, Geo. Porter, Waukesha; Nels Holman, F. W. Lucas, A. E. Nelson, McClellan Dodge, John Auby, K. J. Kuehling, Adolph Canneberg, P. H. Hintze, Andrew Dahlen, W. J. Geib, .. K. Reindahl, Frank Bell, C. J. Chapman, A. R. Whitson, R. M. Long, .A. White, F.W. Duffee, O.R. Zeasman, John Swenehar, E.R. Jones, Madison.

TILE DRAINS IN HIGHWAY CONSTRUCTION IN IOWA

W. J. Schlick
Drainage Engineer, Iowa Engineering Experiment Station.

Nearly 400 miles of tile drain were constructed along the highways of the Primary Road System in 1923. The Primary Road System of Iowa comprises 6646.6 miles of highway. On January 1, 1924, a total of 4308.7 miles had been brought to permanent grade, using about 2260 miles of the tile drain. Approximately 190 miles of drain has been constructed in 1924, bringing the total up to about 2450 miles. The records do not show the exact cost of this work, but do show that slightly over two and one-half millions of dollars have been spent for drainage of the Primary roads since the first Federal Aid law became operative. The magnitude of this part of the highway construction program is shown also by the reports of the Department of Materials and Tests. In 1921 they tested samples of drain tile representing 1728 car loads. In 1923 they tested 667 samples.

The present day problems of tile drainage of highways are an outgrowth of the development of improved highway construction and of a more complete understanding of the possibilities and benefits of underdrainage. The construction of improved highways during the last few years has been so wide spread and so rapid that highway engineers have not had time to study and solve all the problems of design. This condition as regards tile drainage of highways has been aggravated by highway engineers' lack of previous experience in tile drainage.

The question of tile drainage of highways is much in controversy due, in no small measure, to misunderstandings of what is necessary and advisable and of the possibilities and limitations of underdrainage. Some engineers have condemned underdrainage because they expected the impossible; others because of the unsatisfactory results with drains improperly constructed, as to location, or material, or both; in other instances the results have been such as to cause thoughtful engineers to seriously question whether the benefits derived from the drains were commensurate with the cost of installation. This question is not simply, "Will tile drains be of value to the highway?"; the problems of the design of the drains must be considered.

There are some types of road drainage problems of which there is little difference of opinion as to the value of underdrains; if they are considered to be of any value at all they are thought quite valuable. For example, some engineers hold that tile drains are the only solution of the problem presented by the seemingly "bottomless pits" that appear on the clay hills, often at the steepest grades near the top, in the spring. Other engineers agree to this, <u>if</u> -- and this "if" is a large one to them -- the drains can be so installed that they will act as drains.

So long as highway engineers hold such different opinions on the value of underdrains in highway construction, no one who has not made an extended investigational study of this phase of drainage should be dictatorial or too emphatic in his statements. This discussion will bring to you something of the practice in Iowa, together with some discussion of the application of the basic principles of underdrainage to this particular problem.

A general understanding of the soil and topographical features of the typical soil area of Iowa will help to an appreciation of the policies as to the use of tile drains in highways.

The northern half of the state, except for a strip one to three counties wide along the western boundary next the Missouri River, and a narrower and more irregular strip along the eastern boundary next the Mississippi River, comprises the Wisconsin and Iowan Drift area. These areas are flat and their natural drainage is very incomplete. Except for a few large streams, the valleys are narrow and not deep, and the tributaries extend back only short distances. The soil of both the Wisconsin Drift and the Iowa Drift area is a black, loam top soil, sometimes of a sandy or clayey nature, with a yellow clay or a sandy yellow clay subsoil.

The section of the southern half of the state between the Missouri loess on the west and the Mississippi loess on the east is termed the Southern Iowa Loess and Kansan Drift area. The subsoil formation is the till from the great Kansan Ice-sheet which covered Iowa long before neither of the other ice-sheets mentioned. At a later time the deposit known as the Iowa Loess was placed over this deposit of till. This area is much older than the other drift areas, and has well defined natural drainage channels. The top soil of this area is the loess deposit which may be described as a fine, black loam. It is usually found now only on the ridges, as erosion has removed it from the hillsides. The sub-soil is the till from the Kansan Glacier; upon the badly eroded portions this former subsoil is now the top soil. This till is a very close clay and is usually yellowish-red to red-brown in color.

The Missouri and Mississippi Loess areas are similar, so far as their characteristics of interest in this discussion are concerned. They contain many examples of the two topographical features characteristics of deep loess deposits; namely, the well-rounded convex curves of the slopes and ridges, and the vertical escarpments. Although this soil erodes easily it still has the property of standing nearly vertical in cuts.

The soil of these loess areas is rather loose and porous, except that some sections particularly in the bluffs along the Mississippi River, contain shale strata and deposits, which produce slips and slides similar to those in the Iowa loess area. In the true loess deposits the erosion of the open side ditches along the steeper grades would be so rapid that tile drains with intakes are necessary.

Besides these main soil areas there are numerous smaller areas. Along both the eastern and western edges of the Wisconsin Drift area there are narrow morainal areas. There are some areas of deeper peat deposits in the eastern moraine and some areas of shallow peat in the counties to the west. There are areas of gumbo in the valleys of the Missouri and some of the larger streams. There are numerous areas of bottom lands along the streams, particularly the Missouri and Mississippi.

The Wisconsin and Iowan Drift areas were originally flat prairies with numerous sloughs and ponds, nearly all of these areas require, and many of them have, artificial drainage. The highway drainage problems here are quite similar to those of agricultural drainage. The Iowa loess area is so rolling that the highways have many clay cuts and steep grades. The drainage problems here are the care of the side-hill seeps and the erosion of the side ditches. About the only highway drainage problems in the two loess areas are the provision of tile drains and surface inlets to prevent erosion, and the side-hill seeps and slides in the shale and clay deposits. The drainage problems in the areas of bottom lands or alluvium are much the same as those in the Wisconsin and Iowan Drift area.

The general policy of the Iowa State Highway Commission relative to the use of tile drains is to specify them wherever they seem to be necessary. No distinction is made whether the road is to be simply graded or graveled or is to be paved in the near future. This policy can be explained more readily if a rough classification of highway drainage problems is made.

The policy is to specify drains along one or both sides of roads through flat or swampy areas, such as are common in the Wisconsin and Iowan Drift areas, and in the valleys of the larger streams. Many such drains are constructed to serve as both underdrains and outlet drains for surface inlets, because good, natural outlets are not available. In some instances it has been necessary to organize small drainage districts in order to secure good outlets for road drains.

An understanding of the action of tile drains along highways, particularly where paved, is dependent upon a knowledge of the classes of soil moisture and their characteristics. For the purposes of this discussion, soil moisture may be divided into two classes; gravitational soil water, which is free to move under the force of gravity; and the capillary and hygroscopic soil moisture which is held by cappilarity against the force of gravity. In a very fine grained soil practically all the soil moisture is of the latter class. Since this soil moisture moves by cappillarity, in any direction, from a moist soil to a drier, tile drains affect the amount of it only by holding the water-table at a lower level. However, as explained below, tile drains cannot vary the height of the water-table sufficiently to cause a very great change in the total amount of moisture in a fine grained soil. Some engineers have studied the action of tile drains on the basis of the total moisture content of drained and undrained sections, and decided that the drains were of no value; they were expecting the drains to do the impossible and remove the capillary moisture.

The flow of water through the soil to the drains is largely an unexplored field, even though the general laws of the flow of water through soil have been determined. These laws show that the velocity of flow is directly proportional to the head, or slope; and inversely proportional to the resistance to flow. The volume of flow is the product of the velocity and the cross-sectional area of the moving column of water. The resistance to flow is low in a coarse grained soil, as sand, and the curve of the water-table between drains becomes nearly flat within a short time after a rain. The resistance in a very fine grained soil, as clay, is high and the slope of the water-table steep, comparatively. This means that the crest, or highest point, of the water-table between drains in such a fine grained soil will be high, and that the drains may be operating even though they do not hold ground water level as low as was expected.

A consideration of the action of tile drains along paved highways presents some interesting problems. If the highway is constructed through an area such that drainage is required for both agricultural and highway lands, there will be little argument as to the need for, or benefit from tile drains. In those cases where the need for tile drainage is not so evident the highway engineer must depend upon his own judgement in deciding where they should be installed and where ommitted.

Tile drains are used along paved highways for two purposes: To so reduce the moisture content as to insure a stable subgrade which will afford the pavement adequate support for the loads it is designed to carry; and to reduce the moisture content to prevent swelling and shrinking with changing moisture content, and the heaving that accompanies freezing. The problems of the first group--holding the water-table low enough to provide a stable subgrade--are confined largely to flat, swampy areas, and to those sections where a seep brings the water-table to, or near to, the surface. Their solutions are obvious in one case, and have already been discussed; the drainage of the seeps will be discussed a little later.

The other problems are largely those of capillary moisture and their solutions are not so simple nor so uniform. Experiments by the Illinois Highway Commission have shown that the water which enters the subgrade through the joints and cracks in the pavement is much greater than was supposed, and is probably sufficient to supply nearly the maximum of capillary moisture regardless of whether drains are installed or not. Experiments by the Bureau of Public Roads have led to the conclusion that much of the cracking of pavements is due to changes in subgrade caused by variations in the moisture content. Unforutnately these changes are greatest in the fine grained soils, which have a very high capillary moisture and in which the amounts of this moisture can be influenced but little by tile drainage.

As has been stated, the drainage problems in the rolling Iowa Loess area are the drainage of the sidehill seeps in the fine grained clay soil. The troubles are nearly always due to water flowing in seam or in a porous stratum underlaid with a more impervious stratum. If these strata outcrop at or near the surface of the roadway, or in the side of a cut, it is practically certain that trouble will develop during each wet spell until drains are installed properly.

It is not uncommon for the highway engineer, or some county highway official, to hurriedly install "some tile" as soon as possible after one of these mud-holes developes. Sometimes these tile solve the problem, but more often they are not so placed that they can be of much benefit. If the seep outcrops in the center of the highway drains under the shoulders can be of little benefit since the water must pass through the mud-hole to reach them. A small amount of time and labor expended with a soil auger will locate the water-bearing stratum and an intercepting drain will solve the problem permanently.

Through this area the Highway Commission specifies many drains located to intercept such flows, sometimes as single lines and at others as a grid across the road. In side-hill cuts where the general slope is at right angles to the highway they specify drains along the up-hill side of the roads. Such drains are placed on, or in, the impervious stratum whenever possible, and frequently the trench is backfilled with broken stone and coarse gravel.

Experience in the loess areas, and in some other instances, has shown that the difficulty from erosion of side ditches is sufficient to justify tile drains with surface inlets. Drains are used for this purpose only when it is considered that wooden retard or baffle boards, in the side ditches will not be sufficient. It is not uncommon to design the pavements on the grades with low curbs so as to carry the surface water on the pavement to inlets and away in the drains, or where conditions permit to inlets discharging directly into culverts.

Where surface inlets are used, except when the pavements are designed with curbs, they are placed with the bottom of the cone grated level with the bottom of the side ditch, but in a recess dug out of the outside bank of the ditch. Such inlets are usually made by placing a small tile, about 6 inches in diameter, inside a larger one and filling the space between the two with concrete. A concrete apron is built around the outside flush with the surface of the ditch bottom. In many instances considerable care is taken to keep the slopes of the recess around the inlet smooth and free from grass and weeds. Some counties build the intakes with a silt, or sand, compartment below the outflow drain. These silt bases must be cleaned out after each rain if they are to be of any value, as the deposit during one rain usually will fill them.

Heavy snows, particularly in the flat Wisconsin and Iowan Drift areas, have been responsible for emphasizing new benefits of road drains with surface inlets. Last winter some county engineers made a special effort to keep the snow shoveled away from the inlets in the side ditches. Where this was not done it was not uncommon for the side ditches to fill with slush, which when frozen completely covered the inlets and so nearly filled the side ditches that the water from melting snow flooded some sections of road. Where the snow was shoveled away from the inlets, they carried away the water as fast as it reached them and prevented this flooding.

Where the roadway was opened through considerable depths of snow, channels cut through the banks at the side to opened side ditches and inlets allow the water to get off the roadway instead of ponding the traveled way. These provisions for carrying away the water as fast as the snow melts allow the roads to be kept in much better condition than would otherwise be possible.

Mention has been made of the claim that tile drains are not justified because they cannot be of much benefit during the spring thaw or "break up", when they are needed the most. A goodly number of Iowa highway engineers will contest this claim; they have found that in their territories the value of drains during this period is enough to justify their installation, particularly if surface inlets be provided. Thawing starts at the surface, and traffic forms shallow ruts and holes in which water accumulates. These water-filled depressions enlarge, the soil around the edges soften, and soon a sizeable mud-hole is started. Where there are drains with surface inlets, much of this trouble can be prevented if the maintenance crews will keep the road surface as smooth as possible and open up small channels to carry the surface water to the inlets. As soon as the frost is out the underdrains will start operating as such and greatly shorten the period during which the road is in poor condition.

The Highway Commission follows a general policy of placing tile drains under the shoulders of the road and at a depth of three and a half feet. This depth is varied as conditions of soil or of outlet and grade demand. This means that the drains are approximately four feet below the crown of the road and one and a half feet below the bottom of the side ditch.

All drain tile for use in Primary Road work are purchased under the Standard Specifications for Drain Tile of the American Society for Testing Materials; and, what is more important, are inspected and tested to insure that they meet the requiremtns for the class specified for the particular job. Each bidder is required to specify the class, or classes, of tile he will furnish and the unit price for each. "Standard" drain tile are used, except in localities where local plants produce only one of the other grades. The tile are required to meet the requirements for supporting strength, percent of absorption and resistance to injury in the freezing and thawing test.

The tile are inspected and sampled at the shipping point if the commission has a field laboratory or an inspector near there; otherwise, this work is done on the line of drain by the resident engineer. The samples are tested in the nearest Commission laboratory.

Shortly after the Department of Materials and Tests, of the Commission, was organized work was started on a rather complete inspection of all tile plants and tests of their product. Whenever a plant's average sample showed a percentage of absorption higher than that allowed for the class in which the strength test placed the sample, a freezing and thawing test was made. It was found that tile from a number of factories would pass the freezing and thawing test, even though they failed in the absorption test. In such cases a new absorption limit was set for each of such factories This revised limit was used till succeeding strength and absorption tests indicated that there had been some change in raw materials or in processes that produced a change in the quality of product; another absorption limit was then determined as outlined above. The freezing and thawing test is used as a measure of durability, and the absorption test as a simple means of checking up on the necessity for this longer and more expensive test. No distinction is made between clay and concrete drain tile, the work in each case being let to the lowest responsible bidder.

It is the policy now to avoid the contract for the drain complete, material, hauling and labor for both drains and inlets. A number of the tile companies have organized construction forces; others take contracts and sublet the construction work. Some labor contractors take complete contracts and purchase the materials as arranged for before hand or in the open market.

Bids are taken on the basis of work four feet deep, to insure that all bids on a job are truly comparable, except possibly as to the class of tile to be furnished. Where the depth exceeds four feet, the labor price (one-half of the combined labor and material bid) is calculated by increasing the labor bid by 3% for each tenth of a foot up to six feet; the prices for work deeper than six feet are calculated in the same way using the calculated prices for six, eight and ten foot work as the succeeding basis.

The Commission report for 1923 shows that the average price for 1,347,300 lineal feet 6-inch drain complete was $0.1165 per lineal foot, with a range from $0.1085 to 0.1595. The average prices for a number of bids for 8-inch, 10-inch and 12-inch drain were $0.175, $0.256 and $0.318 per lineal foot respectively. The range in price is smaller for the larger sizes. The bids for intakes was from $18 to $30 each, depending upon the size, kind and depth. The prices during 1924 have been about the same as those for 1923.

In conclusion, let me say that I believe that the excellent workmanship of our experienced tilers contributes much to our success. The tile laid in the highways of Maine were probably laid by green hands under a boss who had never seen tile before. There are more good tilers in a typical Iowa township than there are in the whole state of Maine.

DISCUSSION OF A PAPER BY W. J. SCHLICK
ON TILE DRAINS AND HIGHWAY CONSTRUCTION IN IOWA

H. J. Kuelling, Construction Engineer, Wisconsin Highway Commission.

The topographic and soil conditions in Wiconsin are considerably different from those of Iowa so it little behooves us to criticise what the engineers may be doing in Iowa. Our soils range from a drifting sand in the south central part of the state, through various stages of light and medium heavy soils to extremely dense impervious clay. This clay covers a considerable area through the Fox River Valley and along the northwestern section of the state. No effort will, therefore, be made to take exception to anything the paper states relative to the practice in Iowa, except insofar as it applies to Wisconsin conditions.

Formerly, that is ten or twelve years ago, it was common practice in Wisconsin to use considerable tile, but not to the extent that is now practiced in Iowa and parts of Minnesota. In all cases where live water, or what is commonly called springs, was encountered, it was and still is the practice to put in tiles. Under macadams and gravel construction it was the practice to use so-called French drains in practically all cases and in many cases drain tile. This was put in in several ways, - the so-called Fish Bone type and in other cases a line or lines parallel with the road.

We tried various kinds of tiling in Milwaukee County under concrete paving, making a careful selection of the places to be tiled. After ten or more years, you cannot see any difference between the pavement on the tiled and that on the untiled sections, one being as bad or as good as the other.

On flat or swampy places it was formerly considered that tile was most necessary. Our experience has shown otherwise, especially with relation to paved roads. The thing that is desired under a concrete pavement or any other hard surfaced road is uniformity. While swamps may be wet, they are uniformly so and the road all raises and lowers together. Our experience has shown that a road built on swampy ground may be difficult of construction in the first place but when once built , will break up much less than one built on a rolling topography. In fact, it is very seldom that we find a longitudinal crack in a swampy job. To illustrate, we had a job in 1920 that called for 7,000 feet of tiling, but this tiling was omitted and today one cannot find a longitudinal crack in this road. We believe that the time is coming when some effort will be made to treat the subgrades under pavements in order to make the bearing more uniform. We believe this can be done in some way better than by tiling.

One of the greatest troubles from frost action in a paved road has been the development of longitudinal cracks. This has been overcome by building a longitudinal joint into the road. In other words, hinging the road so that the road can respond to the frost action and return to its normal position when the frost leaves the ground.

As Mr. Schlick says "Heavy soils are little benefited by tile drain". We found this very true in our heavy clay soils. The sandy soils need no tile. The worst combination we have is an occasional piece of sand surrounded by impervious clay. Where we find this condition tile drain is placed as well as where we find live water. We have found several reasons why the tile fails after a period of years. Frost action may break down one or two sections of tile, thus clogging the drain. Roots are a common trouble just as in sewerage construction. In addition we have the further trouble of rodents using them as nesting places, Another cause was improper construction or frost heaving, causing low places in the system which became filled with sediment.

There have been a number of theoretical tests made on tile drain for road purposes, the most recent perhaps beingthe Bates Road Test made in Illinois. This test was carried on in great detail showing no benefit from tiling insofar as the life of the concrete was concerned. Moisture tests, thousands in number, show this and in many cases the tiled portions show more moisture than the untiled. The engineers in charge of these tests, which were made on black Illinois soil, report that in their opinion the tile was of no benefit to the road. Practical tests, or in other words, tests over a series of years, show practically the same thing. The state of Massachusetts was formerly one of the greatest users of tile in highway construction On a recent visit of one of our engineers to that state, the old engineers reported that practically all of the old tile had gone out or long since lost its value. A similar report was had in New York and Maine and as a result, tile has gone out of use in these states except in the case of live water. While the Wisconsin experience had not been as extensive as that of these older eastern states, still the results have been about the same. On our gravel road construction which has been built without French drains or tiles, we have had some upheavals due to frost action but not enough to warrant extensive tiling.

There is no argument but what the removal of surface water is beneficial, especially in the spring. Whether this water is removed from tile drains or by some other scheme makes no difference. If the tile is so arranged as to remove this water, then the tiling is certainly beneficial but that is not necessarily saying that tiling is the only way to remove this water.

In conclusion we would state that we have no desire to criticise what is being done in Iowa but do wish to leave the impression that Wisconsin experience is quite decidedly against the use of extension tile in highway construction.

Editor's Comment: It is hard for one on the side line to believe that tile should be 90% right in Iowa and 99.44% wrong in Wisconsin.

Granting that concrete pavements are standing up on marshes because the heaving is uniform, we believe that in deep cuts a line of tile under one or both shoulders would regulate the seepage, make the heaving uniform, and prevent cracking of the pavement. Granting also that there are some soils so tight that tile have difficulty in extracting the damaging water from them, we know that most of the soils in Wisconsin have so called "live water" in them that tile can and do extract. Every drop thus extracted means more uniformity in heaving and less damage.

We are proud of the engineers in our highway department. They have given our highways good drainage. But we believe that a line of tile under the uphill shoulder of the road will cut off the seepage at the foot of a hill in Richland County, for example, more cheaply, permanently and safely than an open ditch 3 feet deep. Such a ditch is a menace to traffic and has to be cleaned out every year. Let's get together and do some more experimenting along this line.

Stopping Ditch Erosion

Nels Holman

Erosion is most common at the outside of a curve and in friable soils. Woven wire fencing properly nailed on posts will stop it in either case.

I shall describe what we did at a curve on the main ditch in Dane County Farm Drainge No. 6 (Springfidd, Middleton). We had a 90 degree turn with a radius of only 100 feet. To complicate matters the upper tangent was at the side of a road, and there was a tile outlet at the outside of the curve.

Before the ditch had been completed a year the outside of the curve began to erode, and the inside to fill up. In another year this deposit would have been so great that the water would have to make a reverse curve to get around it. On the outside of the curve, both the highway and the tile outlet were in danger. Something had to be done.

We dug away the bar on the inside of the curve by hand so that the curve was where we wanted it. Then on the outside set cedar posts, 10 feet long and 6 inches through at the top. We set them 4 feet deep and 8 feet apart, and nailed a 2 x 8 on the front of each, half below water and half above it. At the top of the posts we nailed a 2 x 6 girt and another half way down the side of the post.

On the inside of these posts and girts we stapled woven wire fencing. First strong hog wire with a 4" mesh and over it a chicken wire with a 1" mesh. A flap of the woven wire was staked down to the bottom of the ditch to prevent undermining.

Upstream, the beginning of the fence was about 10 feet above the beginning of the curve and the end of the fence was bent over to the bank and fastened there. The downstrean end of the fence was at the end of the curve and also anchored to the bank.

The theory is that the hog wire reinforces the lighter chicken wire. Both allow the water to flow through, but with a checked velocity. This not only stops the erosion of the outer bank but causes the sediment to drop between the fence and the bank.

The first flood after the fence was constructed did no damage at all. The channel was left clean where we had put it and there was a deposit of silt on the outside of the fence. It appears that this big space that formerly eroded will soon be completely filled up with silt.

By that time the fence may begin to weaken, but it will have served a good purpose. While it still has a few years of life left is the time to plant a row of willows in its place, to prevent erosion on the outside of the curve after the fence is gone.

Perhaps we are anticipating too much trouble. Our fence hasn't begun to weaken yet. It may last 20 years. While logs have floated down the ditch, they have not yet damaged the fence materially.

I forgot to tell what we did with the tile outlet. We had to extend it through the deposit of silt on the outside of the fence to a point below the down end of the curve. It is behaving itself all right now. About three feet of silt has settled over it.

DESIRABLE AND NECESSARY CHANGES IN THE FARM DRAINAGE LAW.

B. M. Vaughan, Wisconsin Rapids.

Subsection 7 of Section 88.06 statutes of 1923 should be amended by substituting in the last sentence thereof the word "board" for the word "commissioners."

Paragraph(c) of subsection 1 of section 88.08 statutes of 1923 should be amended by striking out the second "of" and inserting in lieu thereof the word "against" so that that paragraph reads: "(c) assess the cost of construction against the benefitted lands and corporations in propoortion to the benefits received".

Section 88.12 statutes of 1923 should be amended by adding thereto the following:

Any lawful indebtednesses of a drainage may by order of the court be refunded when due (or before if the owners will surrender them) in which event the refunded obligations shall be taken up (and if a written obligation it shall be marked refunded by No.________) but such refunding obligations shall not exceed the face of the refunded obligations and accrued interest, and shall not bear interest exceeding 6% per annum.

Bonds, note or other obligations of a drainage shall not be sold for less than par, except with the authority of the county court.

The second sentence of section 88.26 should be amended to read as follows:

"It shall have power to construct, protect and maintain all drains under its jurisdiction and do all things necessary thereto, and may report to the court all matters on which it desires advice and when authorized by the County Judge may institute all necessary actions."

DRAINAGE DISTRICT LAW.

Section 89.25 should be amended by inserting in the last line thereof after the words "district's general fund" and before the words "as justice", the words "or bond and interest fund".

A condition exists in one district of this state where a commissioner has undoubtedly converted to his own use district moneys belonging to the bond and interest fund.

Subsection (2) of section 89.26 should be amended by either striking out the clause "If the recommendations of one or more state departments".....etc to the end of said subsection or a provision put in that remonstrance against the recommendations may be filed and the issue thus made tried by the court.

Subsection 4 of section 89.27 should be so amended that the adverse report of the commissioners can be remonstrated against and an issue thereon tried by the court. The last legislature struck out the words "and no remonstrance against his report is filed". That shoul be re-inserted in that action.

Paragraph (d) of subsection (4) of Section 89.37 should be amended by striking out the words "when lands shall have been finally sold under order of the court as provided herein, they shall be leased from all lien of assessments levied prior to the time of such sale."

Subsection (8) of Section 89.47 of the statutes of Wisconsin for 1925 should be repealed or so modified as not to apply to refunding bonds. my opinion is that all of the four officers mentioned would prefer its absolute repeal.

DESIRABLE AND NECESSARY CHANGES IN DRAINAGE LAWS.

(Discussion of the paper presented by Mr. B; M. Vaughan.

L. S. Keeley, Mayville, Wisconsin.

I am in substantial accord with all that Mr. Vaughan has said except that relating to paragraph (d) of subsection (4) of section 89.37 under his proposal, I do not think that any sales of land could be made under that statute. When a mortgage is foreclosed, all subsequent mortgagees are frozen out unless they protect themselves at the sale. From an equitable standpoint, I think that the words in question should stand and from a practicable standpoint I think them to be necessary. People will not buy land unless they can get a clear title to it.

It may be well to consider whether section 88.05 should be amended so as to require that the petition shall set forth more clearly whether a complete drainage system is called for or merely outlet drains. The Wisconsin Supreme Court in the case of the Green Bay and Western Railway Company against Brown County Farm Drainage No. 3 decided that supplemental drains must be provided for and installed as well as the outlet drains; that without them the system would be incomplete, inadequate, and therefore not feasible.

In its consideration of the case the court lost sight entirely of the provision of the statutes relating to the petitions for drainage. Section 88.05, subsection 1, (c), provides that the petition shall set forth : " A map or sketch of the area sought to be drained with the proposed drains shown thereon." Now, the drains shown thereon clearly determine whether an outlet drain or a complete system is intended. Again, section 88.06, subsection 1, among other things, requires that the board "shall consider whether the drains as proposed in the petition are satisfactory; and subsection (6), (f), requires the board to report to the court "whether the drains proposed in the petition will best accomplish the drainage prayed for and the area that should be drained. If the proposed drains are not satisfactory the bard shall recommend other drains."

The foregoing shows beyond question to my mind that the drainage boards and the courts must be governed by the drains proposed in the petition and the drainage prayed for by the petitioners. They may ask for complete drainage of their lands or for mere outlet drains as they may see fit. In cases where the area to be drained is over 200 acres, subsection (7) requires the board to file, prior to the hearing in its report, a report from the state drainage engineers on (a) the location, design, feasibility and cost of the proposed outlet drains, (b) a general description of the additional drainage necessary to reclaim the land fully for agricultural purposes and the probable cost of the same. Section 88.07, subsection 1, provides that if on the hearing on the report of the board the court shall find (a) That the petition or petitions have sufficient signers, (b) that the lands described in the petition or petitions together with any additional lands recommended by the board for drainage will be improved by the proposed work, (c) that the public health or public welfare will be promoted thereby, and (d) that the benefits from such proposed work will exceed the cost of construction, the court shall make an order organizing such "drainage" and direct the board to proceed with all convenient speed.

All italicized words in this paper were made so by the writer, Subsection (7) above quoted, strongly intimates that the legislative intent was that the "proposed drains" would be outlet drains; and the report on necessary "Additional drainage" by the state engineer was intended to be purely informational to the farmers, the board, and the court, in cases where large areas are involved. The statutory requirements for organization are the same whether the area be large or small so far as the drains are concerned. Section 88.08 quoted by the Supreme Court to uphold its decision, applies only after a "drainage" is organized, and it applies alike to all installations whether large or small. However, if the decision of the court is a correct interpretation of the law, the law should be amended.

It has been suggested to me that a provision should be inserted in the farm drainage law requiring the papers in all drainage proceedings under this law to be filed with the clerk of the circuit court. Under the present system papers become mislaid, or lost, in transfer from one court to the other. The abstract officials complain against having to go to the county court to look up matters other than those relating to the probate of estates.

Section 85.25 should be so modified that all appeals on matters relating to drainage shall go directly to the Supreme Court instead of to the circuit court. The change would result in a great saving of time, money, and trouble.

Section 88.19 is the only one which makes any reference to the matter of repairs. It is sufficient for drains that have been constructed under the farm drainage law, but not for drains constructed prior to this law. Section 88.30 indicates the procedure to be taken on such drains which do not come under the jurisdiction of the law now in force, but the procedure on petitions for repairing, deepening, and widening ditches "heretofore built in attempted appliance with statutory enactment" over which farm drainage boards now have jurisdiction, is not provided for. In this regard, the law should be made more definite and specific.

Editor's Note: The following bills have been introduced into the legislature:

(1) Bill 5 S by Senator Chase, to repeal the drainage district law. It sought to protect existing districts but there was some doubt as to the breadth of this provision. Furthermore, it did not fill the gaps that would be left in the farm drainage law if the interlocking sections are repealed. It passed the senate but was killed by the assembly committee on state affairs which recommended a substitute amendment that will probably pass both houses. It will prevent new districts, but will keep the law in full force and effect as regards old districts.

(2) Bill 351 S by the Committee on Education and Public Welfare, seeking to give greater privileges in taking water from a drainage ditch for irrigation or cranberry purposes.

(3) Joint Resolution 37A by Mr. Price, seeking to authorize the attorney general to investigate and prosecute claims against those who were parties to the partial drainage of the Horicon Marsh. This bill was laid on the table by the Assembly.

(4) 101 A by Mr. Price, requiring the tax commission to prescribe a system of accounting for drainage districts and to audit the books of any district.

(5) 219 A by Mr. Hanson, amending the Farm Drainage Law as to the meaning of "adequate drainage " and "duties of the board" and filling the gap that would have been made by the repeal of the district law.

(6) 308 A by Mr. Royce seeking to repeal the section now requirin the approval of bonds by the four state departments.

The change will not effect drainage very much because no new districts have gotten into court for the last two years. The smaller drainage projects are the ones to be encouraged now. Of the following projects, none but farm drainages have been organized in the last two years, and all of them are in the well settled parts of Wisconsin.

<u>Applications from Counties since 1919</u>

<u>Farm Drainages</u>: Adams 4; Barron 2; Brown 4; Burnett 2; Calumet 1 Chippewa 7; Clark 1; Columbia 14; Dane 10; Dodge 7; Fond du Lac 1; Jefferson 6; Juneau 4; Kenosha 2; La Crosse 1; Manitowoc 1; Marquette 2; Milwaukee 5; Oconto 1; Outagamie 5; Ozaukee 5; Racine 1; Rock 2; Rusk 4; Sheboygan 7; Walworth 1; Washington 1; Waukesha 3; Waupaca 8; Waushara 1; Winnebago 2; Wood 3; Total 118.

<u>Drainage Districts</u>: Crawford 1; Dane 4; Dodge 1; Door 1; Jackson 1 (Under old law); Oconto 1; Racine 1; Total 10.

CLEANING DITCHES WITH PYROTOL

John Swenehart

Five hundred miles of open ditches in Wisconsin are dammed up with soil and rubbish washed in. Many of these ditches are on the higher priced and most productive lands in the state. Often these ditches have grown up to cat tails, willows etc. Such ditches are, to a large extent, of little value. Outlets are closed, land is wasted, labor is expended without return because of partial or complete crop failure.

On some of these jobs, some sort of a dredge is the most economical method of cleaning. In other cases, particularly where yardage is small, the cost of putting in a dredge is often prohibitive. It is in these places that explosives may be of help, particularly in view of the availability of low priced materials and the fact that the work can be done without any particular equipment.

It is believed that a combination of pyrotol, the new explosive prepared from surplus war materials, can be used in combination with fifty per cent straight nitro-glycerin dynamite in many operations to move soil from the ditch at a cost of between fifteen and twenty-five cents per cubic yard. The pyrotol costs $7.90 per one hundred pounds delivered in carload lots in Wisconsin and is secured by farmers through the College of Agriculture. Fifty per cent straight nitro-glycerin dynamite is a commercial product secured from all powder companies at a wholesale price of $18.75 per one hundred pounds in lots of two thousand pounds delivered to any railroad station.

Pyrotol cannot be used alone in ditch blasting without the use of expensive electric blasting caps in each charge. This practice ordinarily prohibits the use of such a method. The use of not less than one-quarter pound of the straight nitro-glycerin dynamite in each charge permits the use of the so-called propagated blasting methods where one charge sets off the next when they are placed in a row eighteen or twenty inches apart. The soil must be saturated with water so that water immediately rises in the holes where the charge is made as it is the water in the soil which carries the explosive wave. The dynamite used to carry the explosive wave must be the so-called straight nitro-glycerin and not less than fifty per cent strength. Ordinary ammonia dynamite will not propagate. While the work can be done in cold weather, it is obvious that a temperature above freezing is necessary, even though most explosive manufacturers can now furnish a straight nitro-glycerin dynamite which will stand temperatures below freezing.

In placing the charges it is usually well to run a line down the center of the ditch. This line can be marked every eighteen inches in some convenient manner so that the charges may be easily and properly spaced. As a rule, the water level can be used to establish the depth of the charges. The effect of the explosion will probably deepen the ditch to from three to six inches below the bottom of the charge, depending on the soil conditions. After the line is set, a man with a round stick, usually a long-handled shovel handle marked at eighteen and twenty-four inches, so that the operator may know how deep he is going, punches the hole down to within a few inches of the bottom of the proposed ditch. Immediately after the stick is withdrawn a cartridge of pyrotol and the necessary half cartridge or more of straight nitro-glycerin is put in, the straight nitro-glycerin primer being put on top.

It is impossible here to state exactly how much will be needed but a few trial shots will soon indicate how much to load. It is also possible to change the depth of distance to get the desired results. If the distance apart, the depth and the quantity of explosive used is correct, the ditch will be "U" shaped and the banks not badly disturbed. If the load is too deep and too heavy, the depth will be "V" shaped and the banks will be disturbed. If the charges are too far apart, the ditch will be irregular.

Adter the loads have been placed, a single primer is placed in the center; that is, an extra cartridge of the straight nitroglycerin in which has been placed a blasting cap fitted to a length of fuse. This primer should be waterproofed with a heavy grease to protect it from moisture as it has to be placed in the water. This one cap sets off the entire line of charges. It is usually unwise to try to shoot more than one hundred feet at a time as conditions may change and different loadings may be necessary as the job progresses. Naturally, a wind blowing across the ditch will prevent soil from falling back into the ditch. Sometimes it may be necessary to wait for a breeze in order to get the best results from the ditching work. Unless the old ditch banks are very high however, this is seldom necessary.

The use of explosives in ditch clean-out work leaves little spoil banks as the soil is scattered over several rods on each side. Very few tools are needed, tamping stick, cap crimpers and the necessary guide line. Any number of men may work conveniently at the job. No investment is tied up. An ordinary man can soon learn the method. Individuals or districts can avail themselves of it although districts may not purchase pyrotol. A farmer living near an open canal can clean his own ditch and receive direct benefit. Other dynamites may be used in place of pyrotol with slight increase in cost. Under some conditions such as a thin watery muck the use of straight sixty per cent nitro-glycerin dynamite for the whole charge is necessary.

It seems up to farmers as well as drainage commissioners and engineers to protect their investments in open ditches, particularly in rich and otherwise valuable land by keeping ditches open.

It is possible for commissioners of a district to arrange for some man in the district to learn how to do the work for the district. If crowds are avoided, more work will be done and less chance of accident. Explosive, caps and fuse can be ordered by the district through the local dealer if there is one, or direct from the jobber or manufacturer. A demonstration from the department of agricultural engineering will teach a man from any district how to do the work, spending a day with him. With a few trial shots on any new job a good man will do effective work.

Since ditch clean-out work involves largely the removal of mud, the job is not dangerous if reasonable precautions are taken. Telephone or power lines twenty or thirty feet from ditch will not be damaged unless load is heavy and wind blows mud over the line.

Where willows are growing in ditch, increased quantities of explosive will remove them. Only experience will determine how much to add.

For the propagated charge there must be water enough that the hole for charge fills up when stick is pulled out. More water is unnecessary load for explosive and required heavier loading. In this case start at lower end of ditch and let excess water run out.

DISTRICTS DODGING DELINQUENCY

E. R. Jones

The drainage districts of central Wisconsin are still solvent in spite of the crisis through which they are passing. In 1924 twelve of the largest districts received $91018 in drainage taxes, while the interest on their indebtedness was only $73,567. Bond holders generally are willing to wait for their principal if they can be assured of the payment of interest in the meantime and the payment the principal in the end. In only one of the twelve were the receipts less than the interest on outstanding bonds.

The $91018 received consisted of $51286 for the current year and $39732 for back taxes. The owners are trying hard to redeem their lands before they become subject to tax deed after three years delinquency.

Nevertheless large areas are subject to tax deed now with no takers because of the penalty that has accumulated like a snowball since delinquency began. In 17 of these districts in Juneau, Wood, Jackson, Clark and adjoining counties containing 463,322 acres on which the drainage cost $2,558,000 and of which $1,226,125 was unpaid July1, 1924, there are 107,835 acres known to be subject to tax deed from the tax sale of 1922. Taxes of 1923 and 1924 have brought more acres into delinquency making the total 170,931 acres to date in the 12 larger districts. There are also about 10,000 acres delinquent in the five smaller districts whose records were not examined in detail. These figures are taken from the certificates actually offered for sale by the counties and not from the list as advertised in local papers. Redemption by the owner between the time of advertisement and the tax sale is a common practice. The delinquent lands are generally limited to the large holdings of non-resident promoters, but they do jeopardize the smaller holdings of resident farmers.

These promoters made at least four mistakes and ruined themselves thereby: (1) they drained some sandy lands on which the peat was so shallow that it never should have been drained at all; (2) they started some districts 25 years before they were needed; (3) they began selling the land to settlers before enough ditches were dug to give satisfactory drainage; and (4) they charged high prices for their lands, extending little or no service in return. The depression caught them with large holdings of unoccupied land and most of them have been crushed thereby.

It was the tax drainage district law of twenty years ago that started the present difficulties. Under Chapter 340 Laws of 1923 these districts could not have been organized without the consent of the county board of supervisors. But that does not help the 350 farmers in these districts today who are suffering from the mistakes of twenty years ago.

A gratifying feature is the success that some of these farmers have made in spite of their handicap. Filling their silos, milking their cows, and raising special crops, they are reasonably prosperous. It was on the drained peat of the Cranberry Creek Drainage District that Anton Brost raised the Rural New Yorker potatoes that won first prize at the Wisconsin State Fair of 1924 in open competition with the world. He did the same in 1922 also and scored high on other truck crops.

The original ditches have been supplemented with more ditches until today the drainage is satisfactory on three-fourths of the land. The soil is free from stumps and stones and has been mellowed and sweetened by twenty years of drainage. Practically every eighty acre tract has a sandy island for a convenient building site. What the farmers there need now more than anything else is neighbors to help them keep up their roads, schools and churches and to ward off the cloud of delinquency.

Part of the 170,931 acres, now temporarily delinquent, will be redeemed by the owners before the delinquency has run three years. Other acres may become delinquent. A conservative estimate is that 170,000 acres will be subject to tax sale in the final count. Adding the drainage tax sales of 1922 (now subject to deed) to the delinquent drainage taxes of 1923-and 1924 and computing the proportionate share of the present debt, it appears that $970,000 would redeem the acres finally delinquent. In other words 170,000 acres of land is for sale with all drainage taxes and debts fully paid for $970,000 plus interest from 1924, if the counties will cancel the general taxes due on these lands at a rate of about 30 cents an acre a year. The counties could afford to do this to help clear up the situation.

It has been suggested that the State of Wisconsin pay these delinquent drainage taxes and take deed to the land. Then sell the better half of it to settlers at the cost of the whole and make a game pre- game preserve of the rest. That would give the state a game preserve of four townships at no cost to itself. The plan has merit but probably lacks legality. There does not appear to be any reason however, why a committee of the bond holders can not organize a holding company to execute a similar plan. The question would be, could such a company handle the project in a manner so favorable to the farmers now on the ground, to the county, and to the state?

PLOWING MARSH LAND

F. W. Duffee, College of Agriculture, Madison, Wis.

The subject of plowing marsh land naturally divides into two parts:

1. The plow and plow equipment
   (a) For sod
   (b) For stubble
2. The power to draw the plow.

The plowing of virgin marsh presents special difficulties in that, the surface is frequently very boggy, the sod is extremely tough, the soil does not scour well, and brush (usually willows) are freqently present.

It is ordinarily desirable to plow marsh 7 to 9 or 10 inches deep in order to bury deeply the grass, brush and rubbish, and this is especially true of boggy land.

It is also better to completely invert the furrow slice if possible as the sod is too tough to work down if the furrows are lapped one on the other as is the practice in ordinary plowing.

In order to meet these conditions most successfully a single bottom plow turning a furrow 18 to 24 inches wide is best. If properly designed and adjusted this plow will lay the furrow over in nice shape and absolutely prevent its turning back into its original position which frequently happens when regular 14 or 16-inch plows are used.

The most popular size now used is a 20-inch and at least five of the principal plow manufacturers now produce this size for marsh and brush plowing.

Where the marsh is quite soft extension rims are sometimes needed to hold the plow up, but this is unusual as these plows are commonly equipped with wide wheels.

Cutting the tough sod requires a large rolling coulter 24 to 33 inches in diameter. This is frequently set to cut the full depth of the furrow slice, and this together with the need for considerable clearance for trash, below the bearing and hanger, explains the need for such a large blade.

Where the sod is extremely tough and trouble is encountered keeping the plow in the ground it is advisable to set the coulter as low as possible, and also keep the plow fairly deep, this causes the coulter to present a nearly vertical edge to the sod, which causes less lifting action.

The point of the share on a marsh plow is shaped differently than regular plows, being more pointed and the share edge being almost straight from the point to the wing. Many blacksmiths will attempt to shape up the share similar to the regular plow unless instructed to the contrary. This specially shaped point is used to prevent tough roots from hanging onto the point.

The rolling coulter cannot be used in brush or willows that are of any size as the coulter will usually roll over the roots rather than cut through them. Under these conditions the standing or duck bill cutter is used. This cutter usually requires a different share, one having a little round lug forged on the point, onto which the bottom of the cutter attaches. The top of the cutter is clamped to the beam, usually in such a way as to be adjustable backward or forward, to decrease or increase suck. This is the type of cutter that is always used for brush land but is not as good for marsh land as the rolling coulter which should be used wherever possible.

The pusher used on one marsh plow serves to crowd the furrow over very tightly against the previous one, thus leaving a wide, open furrow for the next round. This wide, open furrow permits the furrow slice to fall over completely inverted, and makes a smooth job of plowing as well as preventing almost entirely the growth of grass between the furrows.

The plowing of stubble or fallow marsh land presents an altogether different problem. After the sod is rotted, a true muck or peat soil is usually light and fluffy, so much so in fact that a mouldboard plow of any type will not scour. Disc plows were originally designed for very hard land, and consequently were equipped with very narrow wheels, most manufacturers, however, can supply so called marsh, or wide-tired wheels. We have found, however, that this is frequently not enough, and have bolted on a solid row of 2 by 4-inch pieces about 6 inches long on to the rim of the wheel thus giving a wheel rim 6 inches wide.

Twenty-six inch discs rather than the regular 24-inch discs also give a little more clearance and less trouble in clogging in corn stubble.

Considerable side draft is encountered if the tractor runs on the land rather than in the furrow which is usually the case, and may cause serious trouble but this can be overcome to a large extent by lengthening the draw bar 2 or 3 feet. This should be done by bolting the extension securely to the old bar so as to be stiff and rigid for proper control of the plow. Disc plows can be secured in 2, 3 and 4 disc sizes or multiples of these. The 2-disc size can be handled by a small 2-plow tractor, and the 3 and 4-disc sizes by a 3-plow tractor.

Tractors as a rule will do the work better and more easily than horses, and if properly equipped will go where horses cannot go.

A good 3-plow tractor, developing from 15 to 20 horsepower at the draw bar is required to handle a 20-inch breaker. It should weigh not less than 5,000 or more than around 7,000 pounds for best results, and requires special equipment in the way of lugs for practically all marsh conditions.

Extension rims should be used to give a total wheel width of from 18 to 24 inches and high angle iron lugs used. Most tractor companies can furnish what is known to the trade as rice land lugs, these are angle iron lugs 4 to 5 inches high and very long, usually from 2 to 3 feet, but making a wheel only 24 to 28 inches wide due to the angle at which they are attached.

Extension rims are also needed on the front wheels so as to give a total rim width of 8 to 12 inches, and sometimes a very high steering flange is also used on the front wheels to aid in steering.

In breaking it is usually better practice to operate the tractor with one side in the furrow, as this gives less side draft, and makes control easier. Contrary to common opinion, the wheel in the furrow has better traction than does the one on the land, providing proper lug equipment is used. If the land is very wet, however, this is not true.

The pusher mentioned before widens the open furrow somewhat permitting a 26-inch wheel to operate in the furrow, without cutting up the former furrow. Any of the 20-inch plows, however, leave a furrow wide enough so that little damage is done to the former furrow.

This discussion would hardly be complete without speaking about getting over or out of soft spots. In the first place, equip the outfit with a good long heavy log chain, preferably 30 or 40 feet long, attach one end permanently to the tractor, ready for pulling so as to save time. Just as soon as the tractor stops going forward and starts going down, stop. Stop immediately as an additional half turn of the drivers may mean an additional half hour's time

A wide breaker is best for marsh soils. If a tractor is used, the wheel type with extension lugs is best. Correct commercial fertilizers and marl help marsh soils.

in getting out. Back the tractor just enough to loosen the clevis pin, do not permit the wheels to spin, just back a half inch or so. Drive ahead to the best footing available within reach of the log chain and pull the plow through the soft spot, then hitch up close again.

When stuck in a hole, lay posts or rails in front of the wheels and cross ways of the tractor, shove them up in under the lugs in good shape, otherwise they will be forced out ahead of the wheels and do no good.

It is said an ounce of prevention is worth a pound of cure, and this is a place where it surely applies as a few feet of chain judiciously used may save a half day's work getting the machine out of a hole.

Some Results of Fertilizer Tests on Peat in 1924.

O. R. Zeasman.

Fertilizer tests on peat soils bring out the striking fact that the different deposits vary. In general those in central Wisconsin are low in the mineral elements, potash, phosphate and line. After a number of years cropping perhaps all three elements will need to be supplied but when comparatively virgin, field plot tests show varying requirements.

At Valley Junction in 1924 the unfertilized plot grew corn less than 18 inches tall, the manured plot made about 1/2 normal growth, while the plot treated with marl (rate 1 ton per acre) made a normal growth. Only very slight increase over lime alone was shown on the plot where potash and phosphate were used in addition to lime. With continued cropping, the addition of these elements will undoubtedly become necessary.

Following table shows yields of potatoes on virgin deep peat plo[illegible] at Portage. Variety was Rural New Yorker. Growing season 3½ months.

Treatment	Bushels Marketable	Bushels Small & Culls	Total Yield per acre	% Increase over Blank
Blank	48	10.6	58.6	100
260# KCL Horse Manure	248	69	317	441
260# KCL 180#Treble super-phosphate	269	61	320	446
260# KCL	117	21	138	135

Unfertilized plot was unprofitable. Potash alone gave only a moderate increase. Potash and phosphate combined gave a good yield but the plot with horse manure substituted for phosphate was practically as good.

On George McDowell's farm, shallow peat that has been cropped fo 10 years shows need of Lime, potash and phosphate. The use of the 3 fertilizers gives marked increases in corn, oats and soy beans. Following is yield in 1924 of green clover first cutting on plots that were fertilized and seed to oats in 1923.

Plot No.	Treatment	Lbs. Green Hay per acre	Per Cent Increase over Blank
21	Blank	5299	100
24	Manure 6 per acre	5976	127
13	Limed 2T per acre	4305	19 decrease
22	300# 0-8-24	6982	317
23	2 tons lime 300# 0-8-24	8222	551

Manure alone gave very little increase over no fertilizer. Lime alone showed slight decrease but this was probably due to uneven stand. Fertilization with potash, phosphate and lime show the biggest increase. Lime and a heavy application of unleached manure would undoubtedly give a good yield.

The differences in results shown in the above three tests point out the importance of making a field test of each deposit of peat in order that intelligent fertilization may be practiced.

EXPERIMENTAL WORK ON PEAT SOILS

A. R. Albert.

Experimental work has been under way on the Coddington Experimental farm since 1918. In the following paragraph only a few of the important findings will be discussed.

The rainfall records have been taken at the Coddington Station since 1919 and in August 1921 the temperature station was installed. The rainfall seems to have a fair distribution throughout the season but the last years 1921, 22 and 23 were considerably below the Station normal, yet crops suffered little from drought. The water holding capacity of peat is very high and when in spring the surface soil has once dried out, it takes heavy rains to penetrate to a sufficient depth to benefit the crops. Such rains being an uncertainty, this points to the necessity of securing deep rooting of plants to benefit fully by the water stored and also to the importance of getting fertilizers into the moist soil. On the other hand, crops well established and properly nourished will seldom suffer for want of moisture.

Recently the idea has gained ground that there is a need of irrigation. This idea is based on the observations of the browning of certain plants during the later part of the season. This brown, blotched appearance of crops is due to potash starvation. Experiments on the Station farm with and without fertilizers have shown that on the same soil where potash has been supplied, the crops grew much more thriftily and in consequence have used much larger amounts of water and yet there was no indication of drying up in the plant even in the dry seasons we have had. Some people maintain that it is getting drier every year as evidenced by poorer crops but the fact of the matter is that the small amounts of available potash are being rapidly used and unless potash is added to these soils, conditions will get even "drier" and poorer. Fields which have been manured (and manure is a good potash fertilizer) produce good crops while others apparently no drier but unmanured still seem to be suffering for want of moisture.

Temperature records are of short duration but indicate the danger of frost and emphasize the need for frost resistant crops and the greatest utilization of the short growing season. The frost danger is considerably less on sandy peats wherever they occur. On the west side of the Wisconsin River the growing season seems to be a little longer and corn is a more promising crop.

An experiment with manure, phosphates and potash and also ground limestone which has been run since 1919 indicates that manure alone produces the largest gross return per acre but no farmer on peat soil can hope to cover his land with the amount of manure per acre every four years which is being used in these experimental plots, until he has first produced the roughage for livestock by means of other soil treatments. It is, however, a big mistake to permit the manure to lie in the barnyard around the buildings, thinking that the soil is already too rich. While the soil is very rich in nitrogen, manure supplies potash and phosphorus as well as nitrogen and it should be used for the sake of its phosphorus and potash, if not the nitrogen. Such experiments have further shown that the largest return per dollar invested in fertilizer is secured through the Muriate of Potash treatment. This statement applies to the first four years but it is probable that phosphate treatment in conjuntion with potash will show a better response with longer cropping. Acid phosphate has so far produced no results whatever. Ground limestone has produced very small increases but the data is yet too limited to draw any conclusions. However, it must be remembered that this is what is known as a high lime peat. On peats which are sour, limestone will undoubtedly give good returns, provided potash is also supplied. Rolling with a heavy concrete roller has not been profitable and we may say that once a new breaking has been packed with this heavy roller thereafter the use of the ordinary corrugated roller to firm the seed bed is sufficient but highly important.

While it is quite certain that most farmers are doomed to eventual failure unless they use proper fertilizer, it does not follow that they will reap success if they do use them. There are many other factors that enter into the question of success on these peat soils, many of which are personal factors inherent in the cultivator himself. Some of these are, frost hazards and crop adaptation to soil and climate, plan of rotation, choice of special crops and the crops in rotation, selection of correct varieties of suitable crops method of fertilizer application, proper fertilizer combination, disposal of manure, tillage method, drainage and irrigation, weed control and finally the price of farm produce.

CROPS FOR PEAT SOILS

In general, grain crops should be avoided on peat soils. They have too great a tendency to lodge. The grain crop can, however, and should be used as a nurse crop for new seedings and for this purpose thin seedings of rye seem to be the most satisfactory. Where the frost hazard is great, corn should be avoided as much as possible. Of course, something should be grown for the silo and while their feeding quality is not as good nearly as that of corn, sun flowers can endure more frost and grow during a cooler season than corn. They, therefore, offer a substitute silage crop. Alsike clover has yielded as high as 2¼ tons per acre, with proper fertilization, of course. The four year average for oats is about 40 bushel; for rye about 22. Potatoes have been grown a few years and a yield of from 125 to 150 bushel may be expected. Carrots will yield in the neighborhood of 500 bushels per acre and make a fair feed for horses and cattle. Oats and peas and soybeans for emergency hay crops have done very well, both crops yielding over 2 tons of hay per acre. Sweet clover and alfalfa have produced good yields when abundantly supplied with potash. Other root crops such as parsnips, canning beets, carrots and rutabagas have done quite well but the sugar beet crop has not been successful. In the very near future a bulletin covering this work will be prepared and anyone desiring copies should address their request to the Agricultural College, Mailing Room.

Rotations on peat soils should be planned in such a way that there is only about one plowing every five or six years. That plowing should be on sod. One rotation that seems to be working out well on the Coddington farm is; first year, root crop or corn; second year corn or soy beans; third year, rye or oats seeded to alsike and timothy hay; fifth year, mixed hay. Weed control is a serious problem in such a rotation, inasmuch as a small proportion of the farmers time is spent at plowing, he can well afford to devote a little extra tim to keeping the weeds out of his root crops and corn. This can be facilitated by planting corn in check. If soybeans are grown they will smother most of the low growing weeds, if planted in solid drills All seedings should be followed with a corrugated roller. Heaviest application of commercial fertilizer should be on the root crop. Small applications may be made upon the corn in the hill. Manure may be applied upon the sod land at any time, preferably between the first and second year's hay. Considering the experiences of the past, it would seem that a combination of a few dairy cows, hay for sale and some special cash truck crops would make a suitable combination on these peat soils. By no means should the dairy herd be large. Far better to have hay to sell to needy sandy soil farmers in the vicinity than to be compelled to starve cattle before spring pasture. Hay crops, of course, require large amounts of potash and if the crop is sold this potash is removed from the farm. The sale of hay from upland soils is generally discouraged because of the fact that it carries nitrogen as well as other plant food from the soil, but in case of these peat soils we have abundant stores of nitrogen which can be made into hay if we will but supply the minerals. The growing truck crops must of necessity be limited. Canning beets have been grown successfully, so have a few other crops, but the selection of crops should be based upon the ability to dispose of that crop, or failing profitable disposition, the crop should be such as to furnish food for livestock. To secure clover stands, the use of potash or manure is absolutely essential. If potash is not supplied cinquefoil will crowd out the clover. The stand will be excellent in the fall nd the next spring there will be nothing, making it appear as though the clover had frozen out or been drowned out when it is only a case of potash starvation. The amount of potash to use depends upon the nature of the crop. It need not be applied every year but may be concentrated on those crops which promise the best returns. It should be applied at about 75 to 100 pounds per acre per year. In case the farmer is uncertain whether phosphate is required or not, it will be well to use also 100 pounds, of acid phosphate per acre per year until such time as suitable tests can be made to determine what proportion of phosphorus and potash would be best on a particular deposit. The acid phosphate may be mixed with the potash by the farmer himself or be purchased already prepared in a commercial fertilizer. A mixture of 100 pounds of Muriate of Potash and 100 pounds of 16% acid phosphate would provide a fertilizer of the formula 0-8-24 and it should be applied at the rate of about 300 pounds per acre every two years. Peats which indicate a deficiency of phosphorus are better fertilized with an 0-12-12.

COMMITTEE REPORTS

The auditing committee reported that it had examined the books of the secretary and found them correct.

The committee on resolutions offered the following resolutions which were adopted:

Whereas, since the last meeting of this association, the loving God has, in his wisdom, seen fit to remove from our midst Walter B. Coddington, as valued and loved past-president and charter member of this association, and

Whereas, Professor John G. D. Mack, State Chief Engineer, and a loved and valued member of this association, has passed on to his Maker, to our great loss and profound sorrow.

Be it resolved, That this association publicly recognize and express our deep sorrow recognizing our great loss, and

Be it further resolved, That this resolution be spread at large upon our minutes and that a copy of this resolution be sent to their sorrowing families.

SUMMARY OF PROCEEDINGS

1921 - 1925

The program for the Seventh Convention held February 22, 23 and 24, 1921, appears on page 4 of the Fourth Report.

Program
Eighth Annual Convention
February 21, 22 and 23, 1922.

Agricultural and Drainage Advisor for Drainage Districts.
B. M. Vaughan, Attorney.

Discussion led by--
A. P. Niles, Anton Brost & Percival Brooks Coffin.

Patrol System for Maintaining Drainage Ditches.
Nye Jordan, Juneau County Farm Drainage Board.

Discussion led by --
J. Q. Daniels

Leveling Waste Banks
G. S. Hales, County Agent

Discussion led by --
Frank Flohr and A. P. Nelson

Movies of Drainage Machinery

First Year for the Settler on a Drained Marsh Farm
I. A. Haverberg, Farmer and Commissioner.

Discussion led by
George McDowell

Permanent Agricultural Policy
Anton Brost, Farmer and Commissioner.

Farming Marsh Lands on a Big Scale
Charles M. Creuziger, Farmer

A Design for a Sub-irrigation Dam
Jerry Donohue, Drainage Engineer and Commissioner.

Organizing a County for Drainage
James A King, Mason City Brick & Tile Company

How Drainage Increased the Value of My Farm
Fred Rocque, Farmer and Commissioner.

Standard Form for Contracts and Specifications
James A. Stokes, Wisconsin Drainage Company

Discussion led by --
F. W. Lucas

Program
Ninth Annual Convention
February 21, 22 and 23, 1923.

Sub-Irrigation Dams
B. M. Vauhan.

Discussion led by --
E. I. Phillec and L. B. Arnold.

What the National Drainage Congress can do for Wisconsin.
Jas. A. King

Report of Committee on Legislation on Improvements in our Drainage Laws.

The Bond Solution
Percival Brooks Coffin.

Discussion led by --
B. M. Vaughan.

What Kinds of Tile are Best in Deep Cuts
O. R. Zeasman.

Discussion led by --
J. H. Waite, W; D. Gerber, Jas. A. Reeves.

The Problem of Adequate Inspection
E. R. Jones.

Discussion led by --
Jerry Donohue, Jas. L. English.

Problems in Pump Drainage
C. H. Young.

Wisconsin Highway Program for 1923
A. R. Hirst

Tile Drainage for Highways
Edgar A. Rossiter

Discussion led by --
A. R. Hirst

Relation of Sanitation to Drainage
L. K. Sherman.

Report of Committee on Drainage Specifications.

Control of Dam at Neenah and its effect on Riparian Interests
Geo. Randall

Discussion led by --
Major Skinner and George Stanchfield.

How Can Efficient Sewage Treatment be Developed and Maintained.
Wm. M. Hansen.

Discussion led by --
T. Chalkey Hatton.

Colonization of Drainage Districts
L. B. Arnold

Discussion led by --
B. G. Packer and Percival Brooks Coffin.

Development Problems in Wisconsin Drainage Districts
Edwin Pierce.

Program
Tenth Annual Convention
February 4, 5 and 6, 1924.

Land Drainage and Game Preservation
C. H. Young

Discussion led by --
F. W. Lucas and L. S. Keeley.

Organization to Take Care of Delinquent Taxes in Drainage Districts.
B. M. Vaughan.

Discussion led by --
Nye Jordan and H. M. Jones.

New Way of Safeguarding Drainage Bonds
E. R. Jones

Discussion led by --
Percival Brooks Coffin.

Use of Drainage Water for Sub-irrigation
O. R. Zeasman.

Which is Better for Wisconsin, The Great Lakes St. Lawrence Waterway, or the Mississippi Outlet.
Jerry Donohue.

What Drainage Has Done
L. A. Jones.

[illegible] - PAST AND PRESENT

	President	Vice President	Secretary
1921	G. R. Hall	Jerry Donohue	O. R. Zeasman
1922	Edwin Pierce	George McDowell	O. R. Zeasman
1923	Geo. McDowell	L. S. Keeley	O. R. Zeasman
1924	L. S. Keeley	Carl Foll	O. R. Zeasman
1924	F. W. Lucas	Nels Olson	E. R. Jones