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Summary of Investigations on Effect of Tile Drains in the Lime or Prairie Section of Alabama

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COOPERATIVE DRAINAGE INVESTIGATIONS IN ALABAMA

For a number of years there has been cooperation in drainage investigations and surveys in Alabama between the U. S. Department of Agriculture and the Experiment Station of the Alabama Polytechnic Institute.

Surveys for systems of tile drainage have been made on a number of farms located in all parts of Alabama. On a number of these tile has been laid under the supervision of the agricultural engineer of the Federal Department of Agriculture, who has jointly represented both that Department and the Experiment Station. That part of the expense of the surveys or supervision that has been borne by the Station has been paid from a state appropriation for conducting local (or county) experiments. Of course the cost of tile, labor, etc., has been met by the owner of the farms benefitted.

In most of these experimental fields the laying of tile drains has greatly increased the yields of crops, and has in some cases converted into highly productive fields certain areas previously practically worthless.

The experiments briefly outlined in this publication were conducted on the Elsberry plantation in the lime or prairie region near Montgomery. An especially favorable opportunity was offered here for a detailed experimental study of the movement of water toward tile drains laid in a stiff soil, and for other investigations intended to determine the best depth and spacing for lines of tile.

The results of these and related engineering questions are summarized in this pamphlet. It should be added that the increase in yields of subsequent crops has been entirely satisfactory, and has paid the owner good dividends on his very considerable investment, besides enabling him to operate plow, cultivator, or mowing machine on the drained land much sooner after rains than has been possible in similar fields not drained with tile.

While the first lines for tile were cut by hand labor, most of this ditching on the Elsberry plantation was done with a ditching machine operated by power. In most of the smaller tile drainage operations conducted in all parts of the state under this cooperative arrangement ditching has been done with hand labor.

A careful study of the accompanying maps is well worth while, since these show an approved method of locating lateral lines and main drains on a large field consisting of both upland and bottom land, both having the stiff character typical of lime or prairie lands of central and western Alabama. The map and the text have also highly suggestive value for owners of other types of soils needing tile drainage.

The drainage engineers who have successively conducted drainage work in Alabama are S. H. McCrory, now Chief of Drainage Investigations; Lewis A. Jones; and Guy A. Hart. This line of work is now included in the Federal Bureau of Public Roads (Thomas McDonald, Chief), which Bureau is the agency now cooperating with the Experiment Station in drainage work in Alabama.

J. F. DUGGAR,
Director Experiment Station.

Auburn, Ala., November, 22nd, 1920.

SUMMARY OF INVESTIGATIONS ON THE EFFECTS OF TILE DRAINS IN THE LIME OR PRAIRIE SECTIONS OF ALABAMA

By

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INTRODUCTION

For a great many years the landowners in the "prairie section" of Alabama held the idea that the Houston Clay and Trinity soils, which largely make up the prairie section or "Lime-land belt" could not be successfully underdrained by tile at a reasonable cost. The impression existed that if any benefit was to be received from tile drainage it was necessary to space the drains 30 or 40 feet apart and to place them not over two feet deep, and that even in this spacing the results were not certain, as the soil was considered "Water tight." The result of this fallacy was that prior to 1911, when the investigations discussed in this report were started, practically no tile had been installed, although it was generally realized that large areas could be greatly benefited by drainage improvements.

During the winter of 1911-12 a number of experimental tile tracts were installed in the prairie section under the direction of S. H. McCrory of this office, working in cooperation with the Alabama Experiment Station, Professor J. F. Duggar, Director. The improved conditions on all of these tracts was marked, and refuted the idea that prairie lands could not be drained.

One of these tracts was on the farm of Mr. W. E. Elsberry, Jr., located near Montgomery, Alabama. The crop yield on the drained area during the season of 1920 was more than double that obtained from an equal area of adjoining untiled land similar in character. Mr. Elsberry was much impressed with the results obtained and during the spring of 1914 he installed two additional systems on his place (one of 74.0 acres and one of 23.3 acres, Figure 1.)

During 1914, 1915 and 1916 an extensive study was made of the action of soil water in tiled prairie land, and of the run-off from such lands, with the idea of

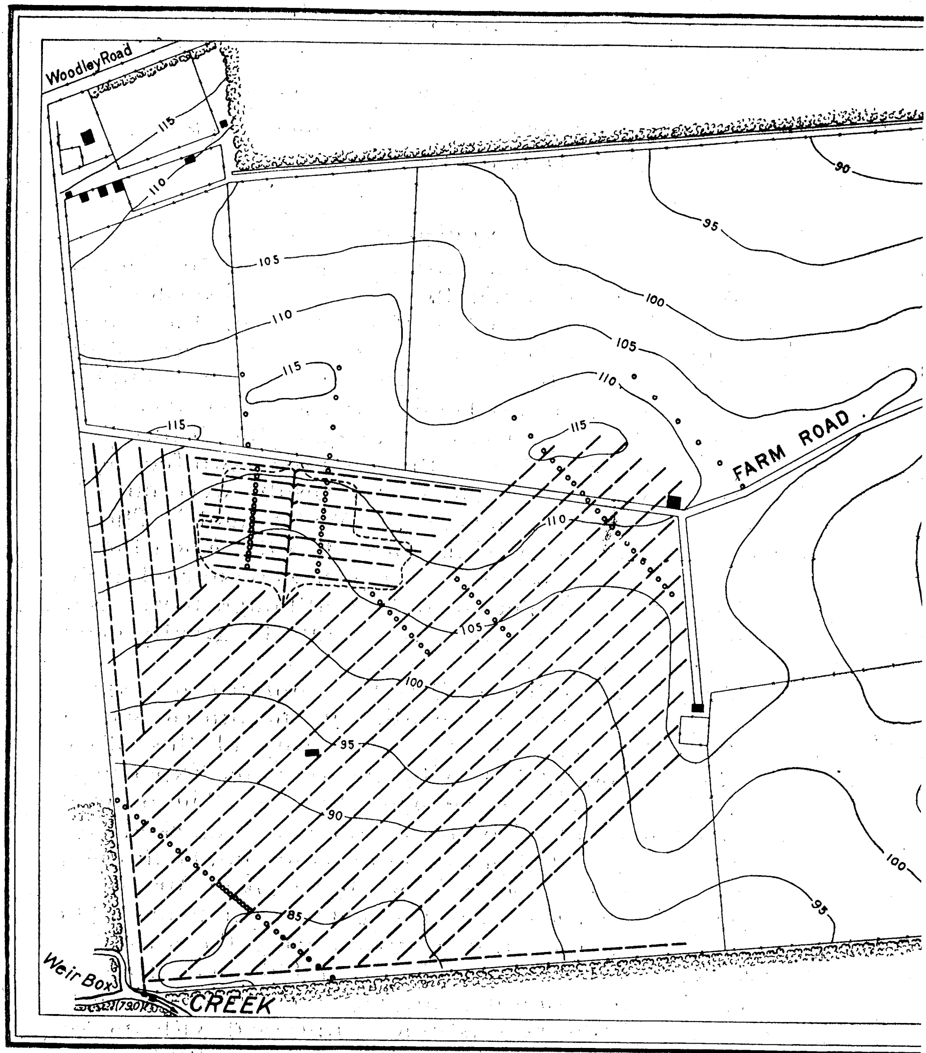
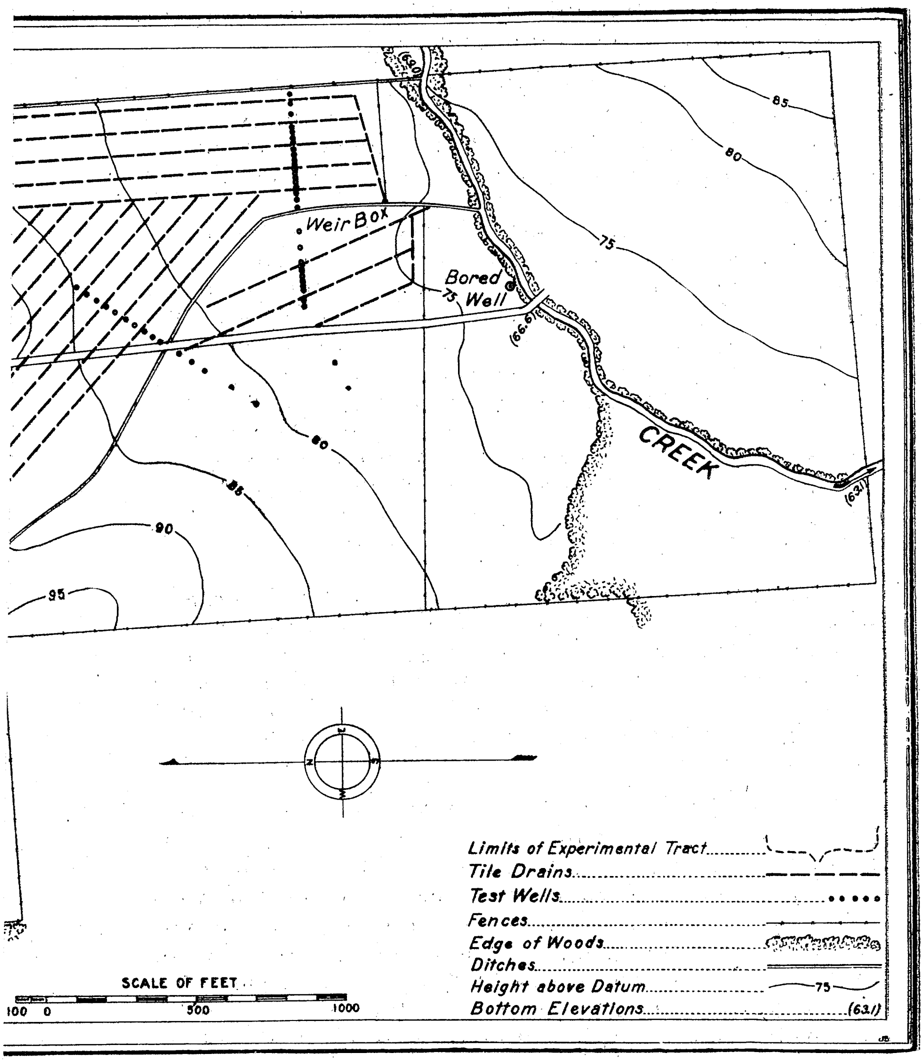


Fig. 1. Contour and drainc



W. E. Ellsberry's farm.

obtaining data as to the most satisfactory spacing and depth for tile drains. The following report describes the methods of obtaining the data and contains an analysis of some of the results obtained.

LOCATION AND DESCRIPTION

The Elsberry plantation is located on the Woodley Road, 5½ miles southeast of Montgomery, Alabama, in what is known as the prairie section of Montgomery County.

The soil is typical Houston Clay, known locally as "lime land", or prairie soil. It varies in color from black to light gray, through various shades of brown and red. The black soil occurs in the lower land and is practically uniform in character to a depth of 4 feet. The red, brown, and gray soils occur in irregular areas over the hillsides, and are underlain at a depth of from 2 to 4 feet by a gray clay containing lime concretions, or by rotten limestone which is comparatively soft to a depth of 3 feet, but which rapidly turns to hard rock as depth increases. The black soil is the most fertile, the fertility apparently decreasing as the soil becomes lighter in color.

The locations of the various soils and the arrangement of the tile are shown in figure 1. With the exception of the experimental tract, (figure 2.) and two lines of tile just east of System B, the tile lines are spaced 75 feet apart and are from 3 to 3½ feet deep. The two lines east of System B are spaced 100 feet apart and are 4 feet deep.

METHODS OF OBTAINING DATA

The rise and fall of the ground water were determined by the use of test wells, located as shown in figure 2. The test wells were made of 4-inch drain tile and were 4 feet deep, the tops of the wells being nearly flush with the surface of the ground. The distance from the top of each well to the water surface was measured at frequent intervals. To insure that the elevation in the test wells should not be influenced by the walls of the vertical tile, open wells were maintained adjoining a number of the tile wells and the elevation of the water in the open wells and in the wells were compared. It was found that the elevation in the open wells and in the tile wells never varied more that .05 foot, and that they were identical during the greater part of the time.

Concrete weir boxes, 3 feet by 4 feet by 10 feet long, equipped with 90-degree triangular weirs, were constructed at the outlets of the tile system, the record of the height of flow being obtained by self recording water registers.

A standard rain gage, such as used by the U. S. Weather Bureau, was located on the farm and the amount of rainfall was recorded for each storm, together with the period of time covered by the storm.

During 1912 and 1913 data were collected on the experimental tract with respect to the section of the soil water in tiled land, in untiled land, and in land that had been dynamited. The arrangement of the tile, the test wells, and the dynamite charges are shown in figure 2. The dynamite charges were spaced 15 feet apart and were placed 3 feet deep, one-half stick of 30 percent dynamite being used in each charge.

RESULTS OF INVESTIGATIONS

The dynamite experiment, carried on in connection with the experimental tile tract, does not appear to have been successful in improving drainage conditions in this type of soil.

The general elevation of the soil water during the spring months in tiled land was from 2 to 2½ feet below the ground surface, while that in untiled land was from 1 to 2 feet below the surface.

After heavy rains, the soil water in the tiled land returns to an average depth of from 2 to 2½ feet within 2 or 3 days after the end of the storm, but in the untiled land the line of saturation remains within a foot or two of the surface for from 5 to 10 days.

Tile placed 3 to 3½ feet deep gives better drainage in the Houston Clay or prairie soils than does tile placed 2 to 2½ feet deep, because it lowers the line of saturation to a greater depth. However, tile lines should never be placed more than 6 inches into the limestone hardpan found underlying the prairie soils, and its distance below the surface should govern the depth of the drains where the hardpan is less than 3 feet from the surface of the ground.

Laterals spaced 75 feet apart and laid 3 to 3½ feet give satisfactory results in the flat bottom land where the black type of Houston Clay is found. The lighter colored phases of the Houston Clay do not seem to drain as rapidly as do the black phases, and drains spaced 60 feet apart and laid 3 feet deep are believed to be advisable for the lighter types. Drains spaced 40 to 50 feet apart and placed 2 to 2½ feet deep did not show more satisfactory results than did those spaced 60 feet apart and laid 3 feet deep. The drainage obtained from tile spaced 100 feet apart and placed 3½ to 4 feet deep is not satisfactory, as the action of the drains is too slow.

During a dry spring or summer, such as occured in 1915 and 1916, the benefits obtained from underdraining flat or bottom lands are greater than those obtained from draining rolling land. It is believed that uniform or regular systems of tile drainage are usually economical in the black bottom lands, but in the rolling or hillside lands a careful study should be made to determine the possibility of obtaining satisfactory drainage by properly locating a few random lines of tile to cut off seepage water and drain wet spots, before a uniform system is planned. A number of random lines will frequently drain a hillside satisfactorily at a fraction of the cost of a complete system.

The main outlet drains in systems A and B were designed to have a capacity of ½-inch of run-off per 24 hours, that is, they were able to discharge an amount of water every 24 hours equal to a rainfall of half an inch. The run-off investigations show that the outlets rarely discharge to capacity for more than 3 or 4 hours at a time, and that the discharge decreases rapidly after the rain ceases. This shows the mains were of sufficient size to furnish outlet for the water as rapidly as it reached the drains. In designing a system of underdrainage in the prairie section it is believed that a run-off coefficient (discharging capacity) of ⅜-inch to ½ inch per 24 hours for the area tiled should be used, the coefficient depending upon the amount of watershed draining onto the tiled area. If there are surface inlets into the tile lines, a coefficient of at least ½-inch should be used. There is nothing in the data collected to show that a coefficient of ¼-inch would not provide satisfactory drainage, but where rainfall is as frequent and as intense as it is in the prairie section during the winter and spring months, it seems advisable to have sufficient outlet capacity.

Test wells placed 10 feet apart indicate that the soil water curves between tile lines has the greatest slope near the tile, the slope gradually decreasing as the distance from the tile increases. The effect of the drains is not marked at a distance greater than 30 feet.

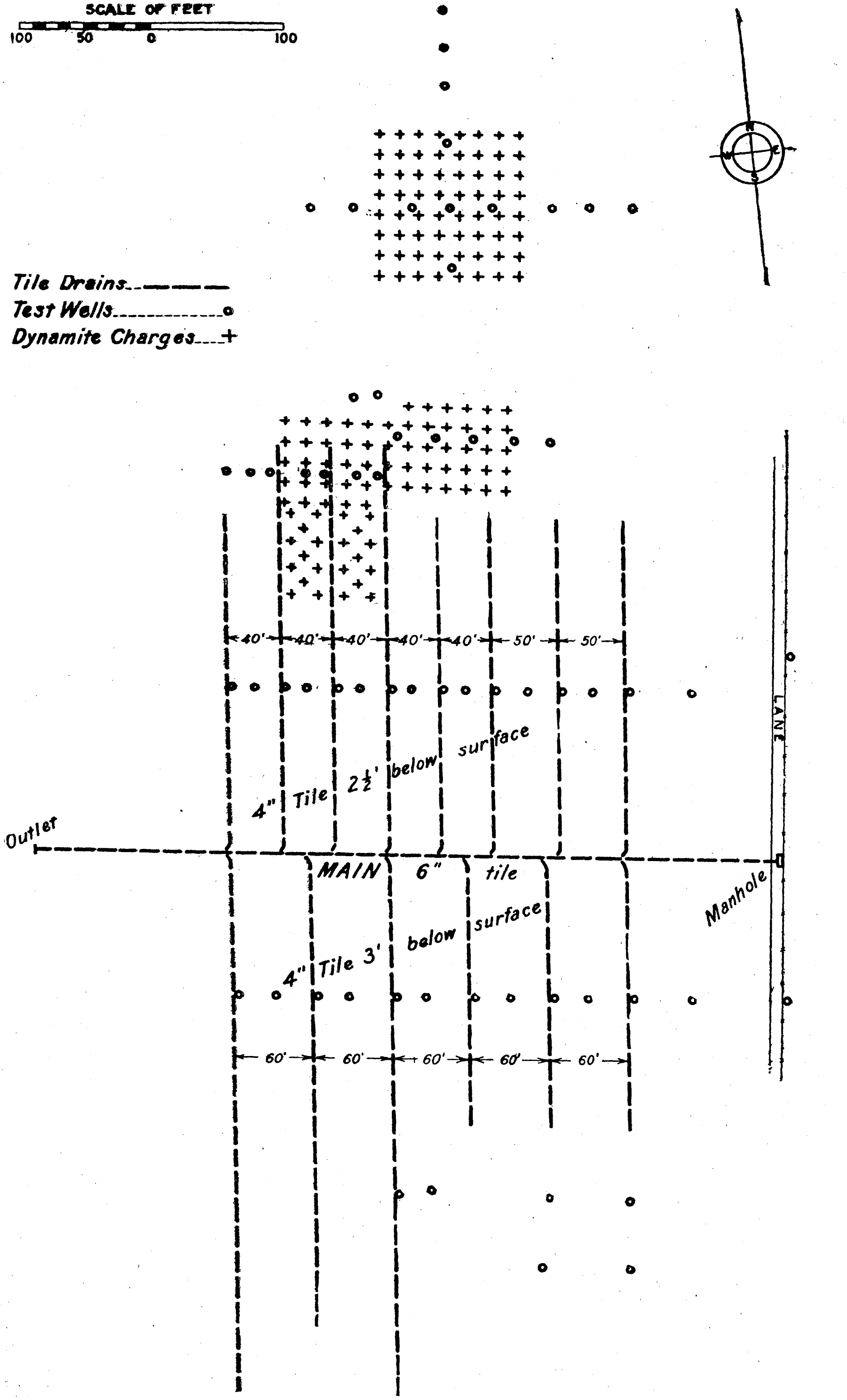


Fig. 2. Locations of lines of tile and test wells.