Straw envelope on 6 inch tile drain.

# TILE DRAINAGE

## *Solves Salinity Problems in Tulelake Basin*

**Drainage problems have been corrected on 45 Tulelake Basin farms in Modoc and Siskiyou counties through installations of tile drain lines. Studies have shown excellent reductions of soil salinity and high water tables, with no failures reported since installation of the drains over five years ago.**

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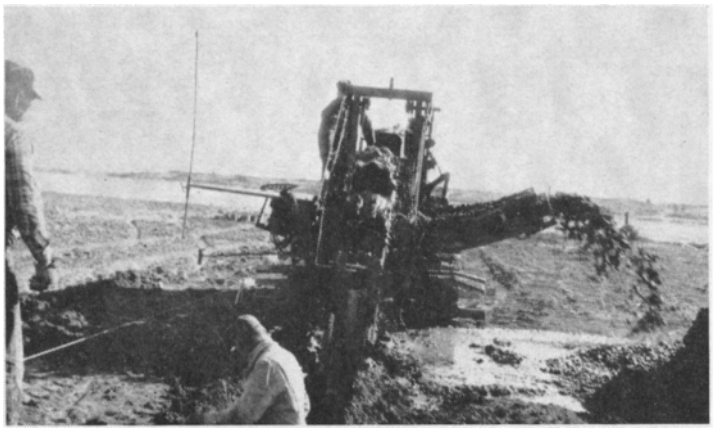
THE TULELAKE BASIN in northeastern California consists of 70,000 acres of fertile farmland and 26,000 acres of lake and marshlands reserved for fish and game. The U. S. Bureau of Reclamation began diverting water from the Basin in 1905 to permit reclamation. In 1906, a homestead program was started, but water was not delivered to the area until 1909. Since then, 684 homesteads have been allotted, and 146 farm units are leased annually to the highest bidders. Major crops now grown in the area are barley, durum wheat, potatoes, onions, alfalfa hay, and pasture.

In many areas of the Basin, it was impossible to grow economical yields of grains or potatoes before drains were installed. Decreasing crop yields—apparently caused by the high water table and soil salinity—were investigated by the Bureau of Reclamation and Agricultural Extension Service in 1953. The Tulelake Irrigation District began a vigorous program of deepening, cleaning, and pumping existing open drains. However, open drains spaced every half mile did not adequately eliminate the salt problem on much of either the private or government lease lands.

Farmers requested assistance of the Tulelake Agricultural Extension Service office in solving the problem. The farm advisor, in cooperation with Bureau of Reclamation and California Agricultural Experiment Station soils and water specialists, studied the soil, water tables, salt content of both water and soil, and soil water movement. The study (from 1954 to 1958) indicated that properly installed tile drains might solve most of the drainage problems. This method of drainage had previously been considered unsuitable to the area by many farmers.

A tile system was designed by the Agricultural Extension Service in 1959 to reclaim one of the highly saline soil areas (8 to 11 mmhos/cm). Field observations revealed seepage from an irrigation canal and an average water table of 1½ ft in the area to be reclaimed. To correct the problem of seepage and high water table, a 3,700-ft tile line was installed adjacent to the irrigation canal at an average depth

Drain trencher at work in Tulelake Basin.



Open drainage system showing height of water in drains.

of 4 ft. Another line was installed 500 ft from the first line in the field to pick up surplus water and aid in drainage. Both tile lines were surrounded with a 6-inch envelope of wheat straw. The original irrigation water had a conductivity of less than 0.5 mmhos/cm. Prior to the first irrigation, the soil was tested in four locations, and after three irrigations, the same locations were checked again. Two and six years later (1961 and 1965), the same locations were sampled for depth of water table and degree of salinity. The results are shown in the table and indicate the success of drainage and leaching in lowering the water table and decreasing the salinity of the soil profile.

In 1960, a 3,000 lb-per-acre barley crop was raised, and the following year a 280 sack-per-acre yield of netted gem potatoes was harvested. These yields came from an area where it had been impossible to raise even one satisfactory crop of grain or potatoes.

Part of the tile system was installed at a depth of less than 5 ft because of the high permanent water table (4 to 5 ft). Where lines ran the full length of the fields, or from 2,500 to 3,700 ft, it was necessary to grade to 0.1% or less.

Today, to drain an entire farm of 70 to 80 acres, three lines are installed at 400- to 500-ft intervals on the organic type soils and 500 to 600 ft on the mineral soils. Six- and 8-inch main lines are used, and 4-inch lateral lines are connected to the main lines to correct special drainage problems. Tile size is increased toward the outlet by at least 2 inches of diameter for each 1,300 ft.

Results of the tests emphasize the importance of locating the tile lines to allow sufficient depth and avoid interference by farm operations. Three lines are usually located lengthwise through the field in a typical installation. The approximate center of the field is the shallowest portion of the tile installation and the lines are graded at a 0.1% slope each direction from this point. There is usually an open drain on the bottom or top of the field and another open drain on one side. The tile lines drain directly into the open drains on one or both ends of the field. On the side, three lines are brought into one large line which runs into a sump or drains into the open drain running adjacent to the field. All individual lines drain in two directions to remove water more rapidly from fields (see diagram).

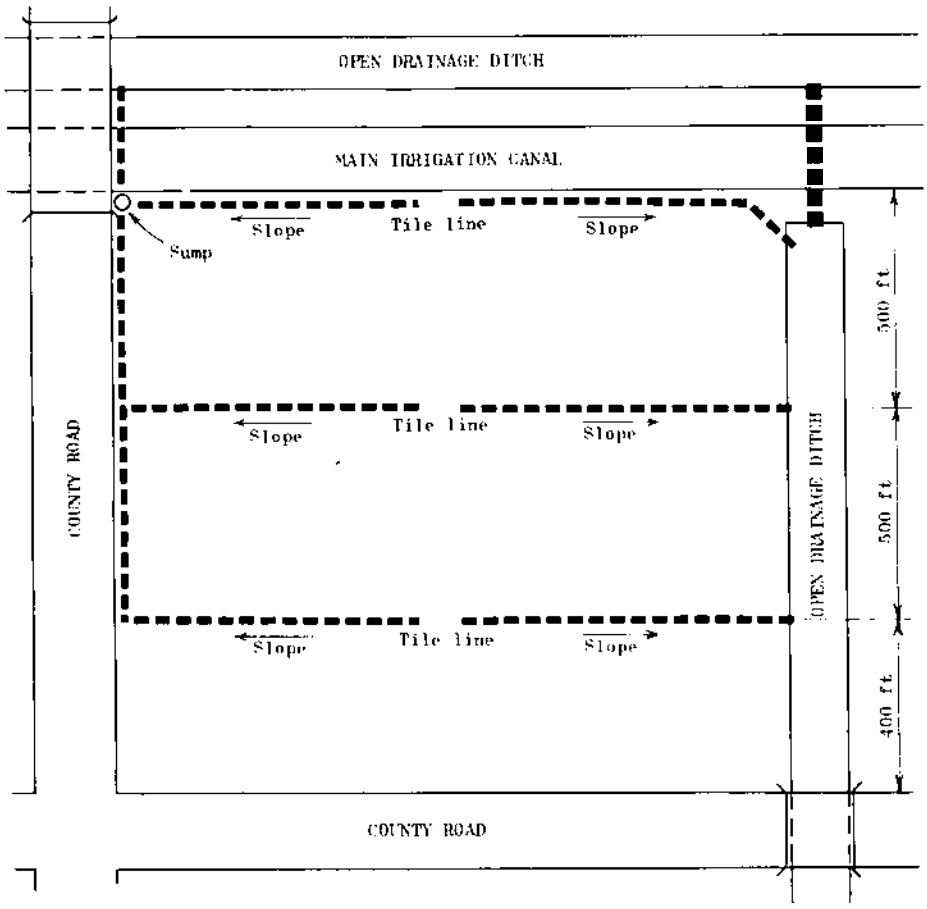
Average costs of 6-inch tile drains installed in the Tulelake Basin have been 70 cents per running foot. Costs increase when it is necessary to use an envelope for the tile. Gravel is not available in the area but cinders or straw are proving a suitable substitute as an envelope material and fiberglass has been used successfully in some locations. However, where a tile line is installed adjacent to an irrigation canal to stop subbing into the field, it has been found best to use either a straw or cinder envelope to increase rate of flow into the tile line.

Recently, the U. S. Bureau of Reclamation installed 45,000 ft of tile in the southwest sump lease area because open drains would not correct the high water table.

SALINITY MEASUREMENTS IN TULELAKE BASIN BEFORE AND AFTER DRAINAGE TILE INSTALLATION (1959 to 1965)

| | | Before tile | | After tile | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 1959 (after 3 irrig.) | | 1961 (after 9 irrig.) | | 1965 (after 16 irrig.) | |
| Sample no. | Depth of measurement (ft) | Depth to water table (ft) | Salinity (EC × $10^3$ at 25° C mmhos/cm) | Depth to water table (ft) | Salinity (EC × $10^3$ at 25° C mmhos/cm) | Depth to water table (ft) | Salinity (EC × $10^3$ at 25° C mmhos/cm) | Depth to water table (ft) | Salinity (EC × $10^3$ at 25° C mmhos/cm) |
| 1 | 0–1 | 1.5 | 9.4 | 3.2 | 5.8 | 3.2 | 1.3 | 3.2 | 0.4 |
| | 1–2 | | 9.2 | | 5.8 | | 1.0 | | 0.6 |
| | 2–3 | | 7.8 | | 5.2 | | 1.2 | | 1.0 |
| | 3–4 | | ... | | ... | | ... | | 1.4 |
| 2 | 0–1 | 1.3 | 8.7 | 2.9 | 6.9 | 3.0 | 1.2 | 3.0 | 0.5 |
| | 1–2 | | 8.1 | | 6.5 | | 1.3 | | 0.9 |
| | 2–3 | | 8.4 | | 6.8 | | 1.0 | | 1.1 |
| | 3–4 | | ... | | ... | | ... | | 1.0 |
| 3 | 0–1 | 1.5 | 7.7 | 2.9 | 5.7 | 2.9 | 1.2 | 2.8 | 0.4 |
| | 1–2 | | 7.9 | | 5.0 | | 1.2 | | 0.5 |
| | 2–3 | | 7.8 | | 5.2 | | 0.9 | | 0.5 |
| | 3–4 | | ... | | ... | | ... | | 1.0 |
| 4 | 0–1 | 1.0 | 11.2 | 2.5 | 8.0 | 2.6 | 1.9 | 2.5 | 0.8 |
| | 1–2 | | 10.9 | | 8.8 | | 2.4 | | 1.8 |
| | 2–3 | | 10.5 | | 8.5 | | 2.9 | | 2.4 |
| | 3–4 | | ... | | ... | | ... | | 1.6 |

TYPICAL FIELD LAYOUT IN TULELAKE BASIN WITH OPEN AND TILE DRAINS

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