

6-1-63

NO. 195

H. W. H.

STATUS REPORT
ON
LANDSLIDE AREA
on
I-75, Covington, Kentucky

A Slide Area Being Studied
As Part of Research Project

DEVELOPMENT OF A PRACTICAL METHOD
OF LOCATING AND TRACING SEEPAGE
WATER IN UNSTABLE SLOPES

HPS-1(24)

by

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In Cooperation with the U.S. Bureau of Public Roads

May 15, 1963

INTRODUCTION

This report has been prepared to describe the history and present condition of a landslide area on Interstate Route I-75 in Covington, Kentucky. This landslide is one of several to be studied as part of a research project on the "Development of a Practical Method of Locating and Tracing Seepage Water in Unstable Slopes." On April 10, 1963, a request was submitted to the Bureau of Public Roads to change the Work Program HPS-1(24) to include this research project. Approval was received on May 2, 1963. Work done on this research project prior to May 2 was at Department of Highway expense with work accomplished since being done on a participating basis.

An attempt will be made to give the history of earth movement at this particular site and to describe the condition of the area at the present time. This discussion will be presented in chronological order using photographs and sketches to illustrate the situation.

A site plan of the general area of earth movement is shown in Figure 1. The details shown in black in this figure represent features that were being constructed or had been constructed at the time the first earth movement was noted.

Plans are being made to attempt to locate and trace the paths of water that may be contributing factors in this landslide movement. Various techniques are being given serious consideration for this purpose and include the use of fluorescent dyes, radioactive tracers and the electrical resistivity apparatus.

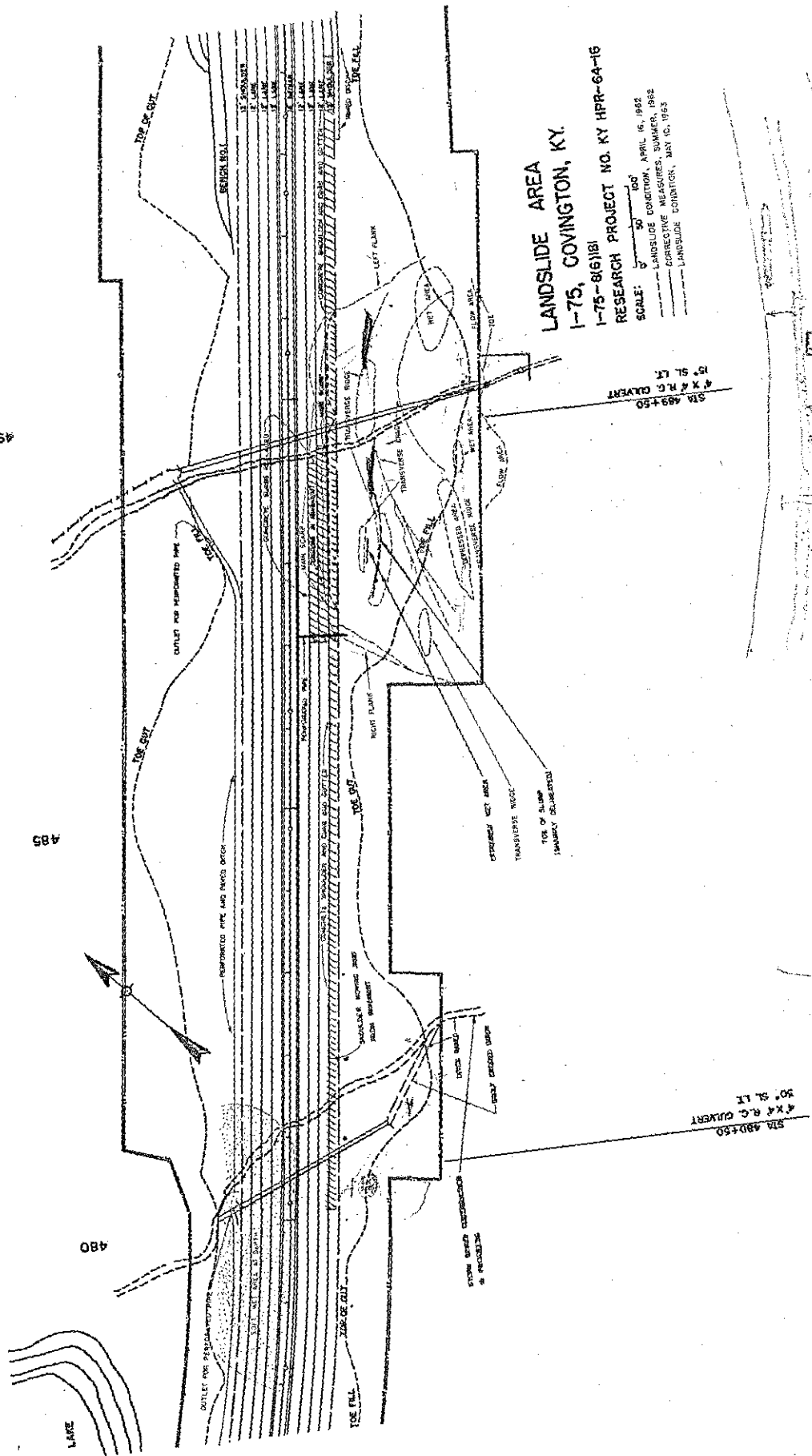


Fig. 1. Plot Plan of Landslide Area.

DESCRIPTION OF GENERAL AREA

The landslide area is located on a section of the I-75 route between Kyles Lane, near Station 440, and the interchange near Station 523. Over this entire section the pavement drops on about a 5% grade. The pavement through this area consists of six, 12-foot driving lanes, three in each direction, with a 16-foot raised median strip and 12-foot bituminous concrete shoulders.

It has been reported that a subsurface drainage pipe was intercepted during construction near Station 454. This drainage pipe was apparently installed by someone to drain a wet area which has been filled and is now the location of the Dixie Drive-In Theater. Reports from people in the area indicate that water flows from this pipe onto the right-of-way practically the entire year.

Between Stations 461 and 466 the roadway passes across an area of an old lake bed. It has been reported that the undesirable material was removed from this area and replaced to a depth of 20 to 30 feet. Personnel present during the construction have indicated a belief that the area was fed by a spring and may still be influenced by such water.

Throughout this section of highway the cuts have exposed thin, interbedded layers of shale and limestone. Several areas of water seeping out onto the cut slopes can be noted, particularly after periods of rain. The embankments have been apparently constructed from this shale-limestone material, the shale weathering rather quickly to a heavy clay and the limestone being more resistant.

HISTORY OF LANDSLIDE AREA

OCTOBER 27, 1961 --- Personnel of the Division of Research had visited the general area in which the landslide later developed on October 27, 1961. The photograph shown in Figure 2 is a general view of the area at this time. It can be seen that driving lanes had been completed by this time and that the paving of the shoulders with bituminous concrete was well underway. It was also noted that the median strip had just been filled with a fine silty sand to a depth of three to seven feet.

WEEK OF APRIL 9, 1962 --- It was reported that during this week a significant amount of earth movement occurred and was sufficient to cause major damage to the essentially completed project.

APRIL 16, 1962 --- The site was again visited by Research Division personnel on this date. The conditions noted to exist at this time are indicated by dashed red lines in Figure 1. Figures 3, 4 and 5 were taken in the immediate vicinity of Station 487 where the major distress was observed. In Figure 3 the sag in the pavement shows that the base has dropped away from the concrete slab and is no longer providing support. This sag can also be seen in Figure 4. Figure 5 shows very clearly that the DGA base is no longer providing support for the slab. In Figures 3 and 4 the distorted line of guard rail posts also indicate large movements. It should be noted in Figure 3 that the embankment slope outside the bituminous shoulder had been covered with a heavy clay preventing the DGA base from draining.

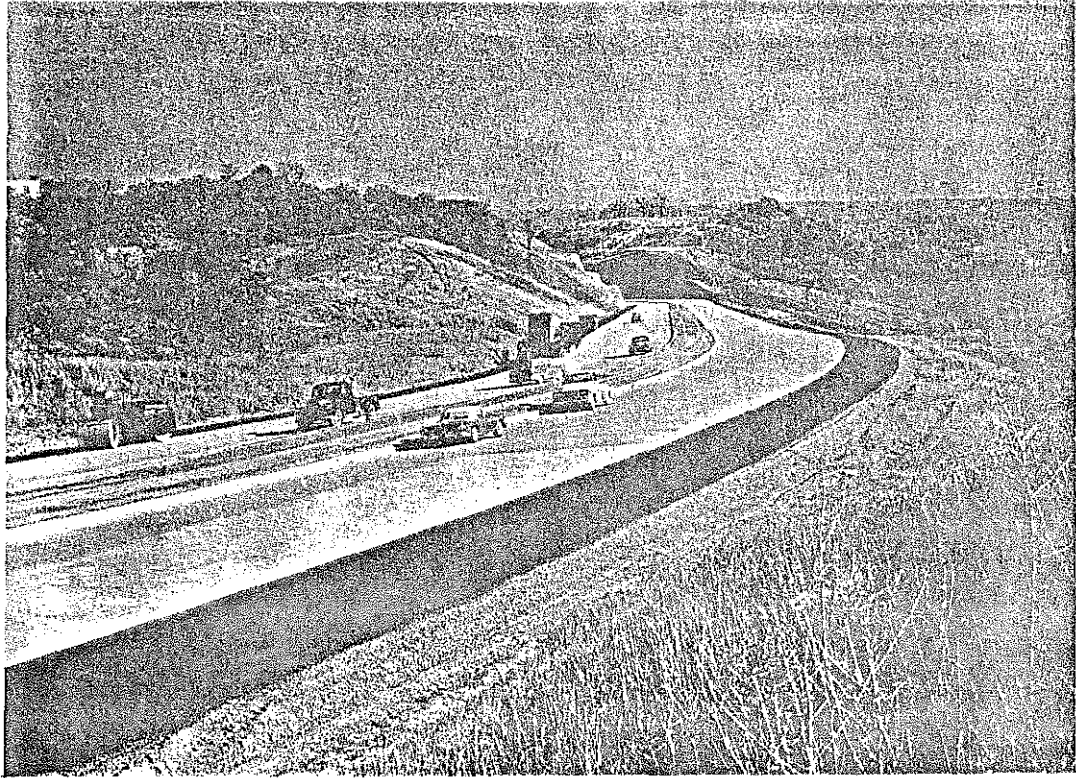


Fig. 2. General View of Landslide Area on October 27, 1961.

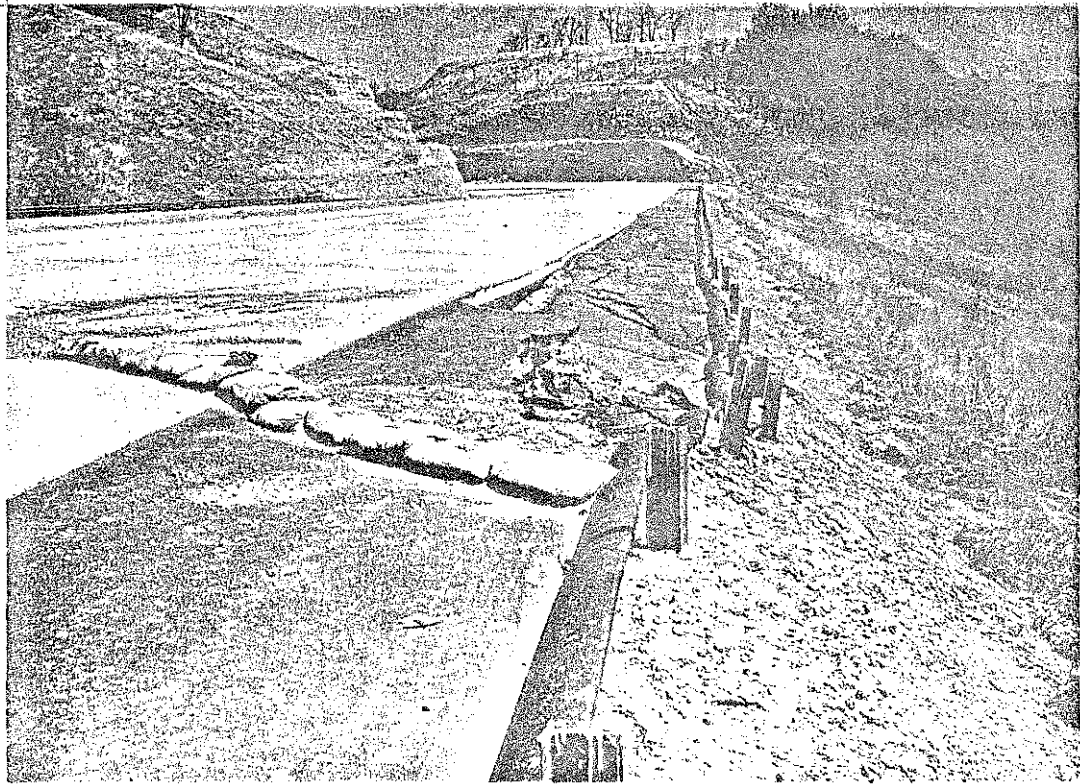


Fig. 3. Area of Major Distress (Looking North), April 16, 1962.

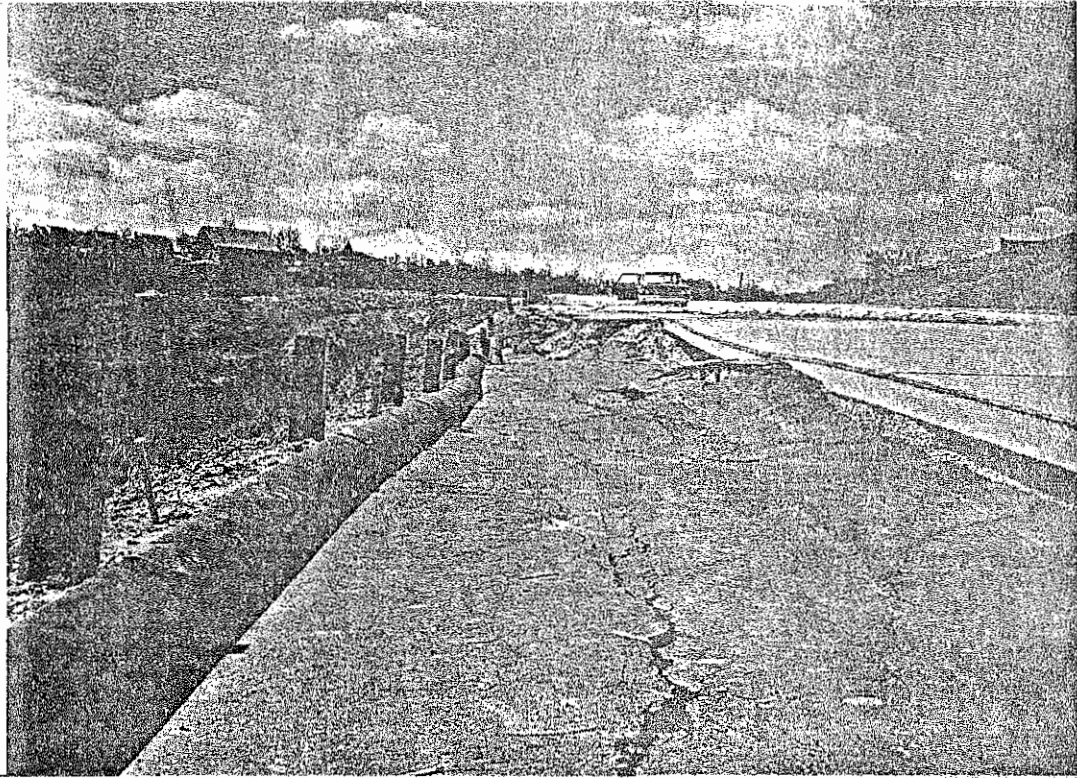


Fig. 4. Area of Major Distress (Looking South), April 16, 1962.

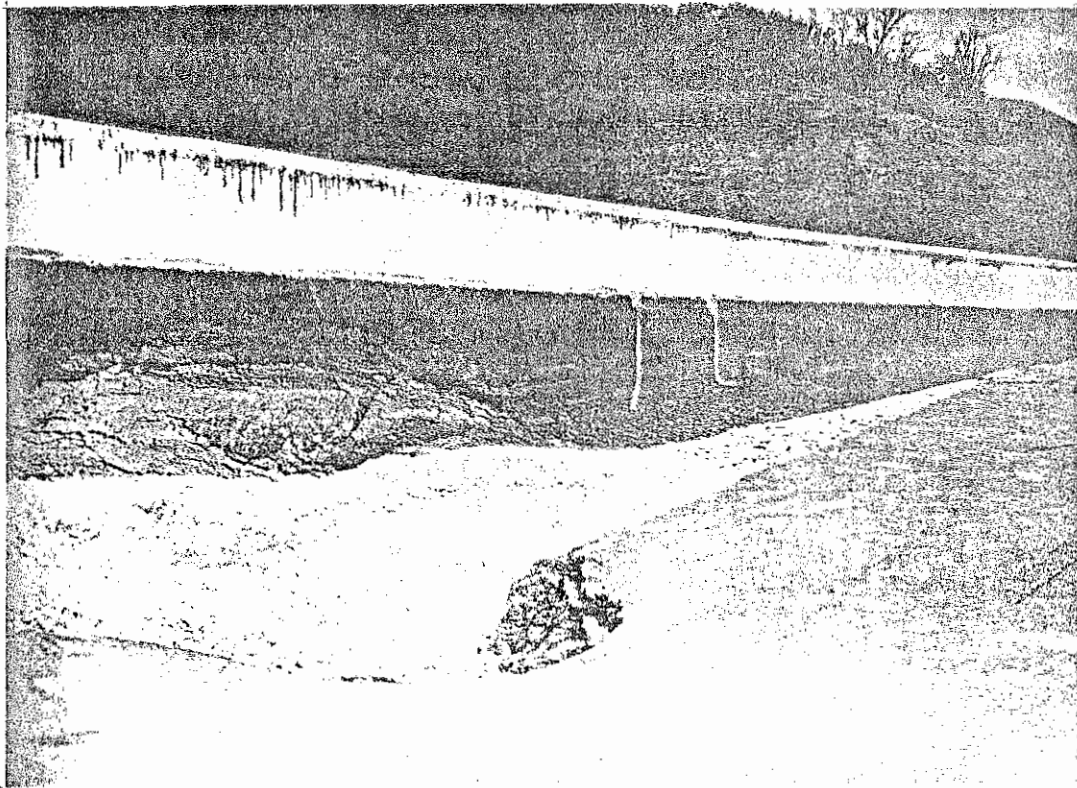


Fig. 5. DGA Base That Has Dropped Away from the Slab, April 16, 1962.

The area of movement extended over a length of approximately 450 feet from about Station 486+50 to 491+00. In Figure 6 an attempt is made to show that the toe of the slumped mass had moved out and over the embankment a distance of approximately two feet. The roll of soil over the embankment was about one foot high.

A second slide of less severe nature had started to develop near Station 482. Figure 7 shows that the shoulder had already started to move down and away from the concrete pavement. The slope of the embankment in this area had been badly eroded (see Figure 8) by discharge from a 4-foot by 4-foot box culvert that passes beneath I-75.

SUMMER, 1962 --- During the summer of 1962 certain measures were taken to attempt to repair the damage that had been done by the landslide and to prevent further movement. The measures are indicated by solid red lines in Figure 1 and are listed below:

1. In the major slide area the embankment was removed to a depth of about 25 feet below the pavement. This zone was recompactd and backfilled and brought up to grade before the placement of new base material and concrete slabs.

2. A perforated pipe was installed at Station 487+05 about 12 feet below the pavement. The pipe was backfilled with sand and extended to the median strip.

3. In the west ditch line between Stations 472+50 and 489+00, a perforated pipe was placed at a depth of about 15 to 20 feet. The trench was

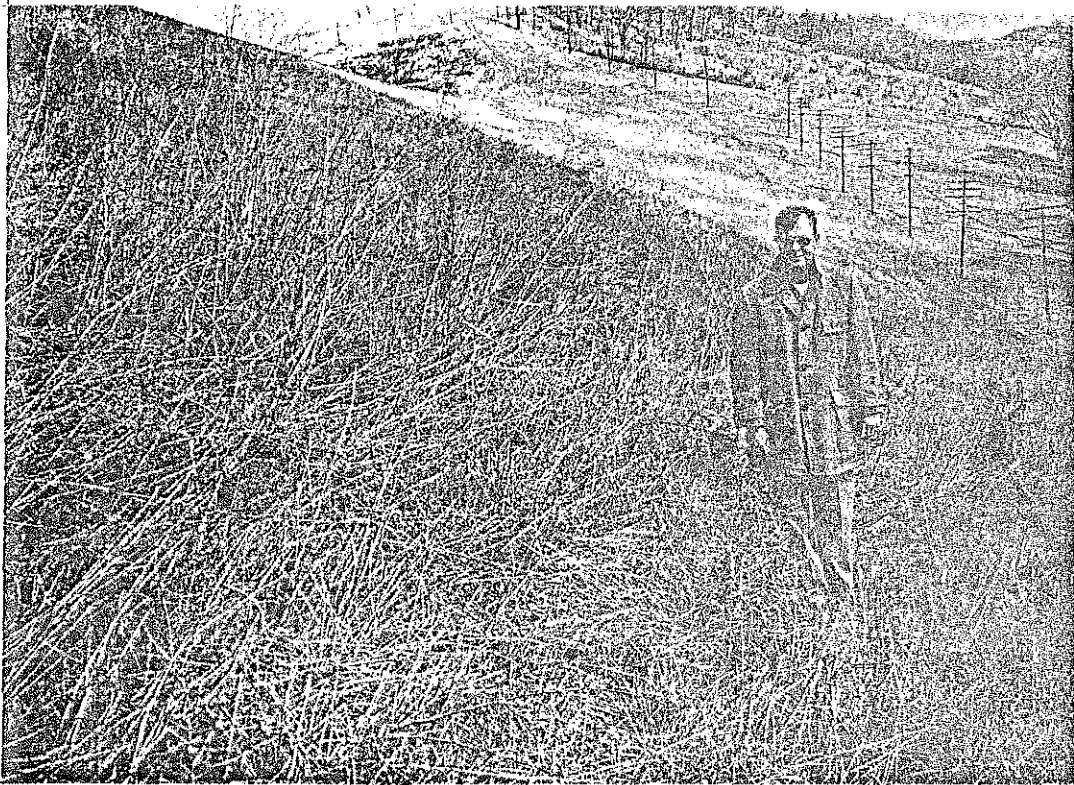


Fig. 6. Toe of Slump Indicating a Roll of Material of About One Foot, April 16, 1962.

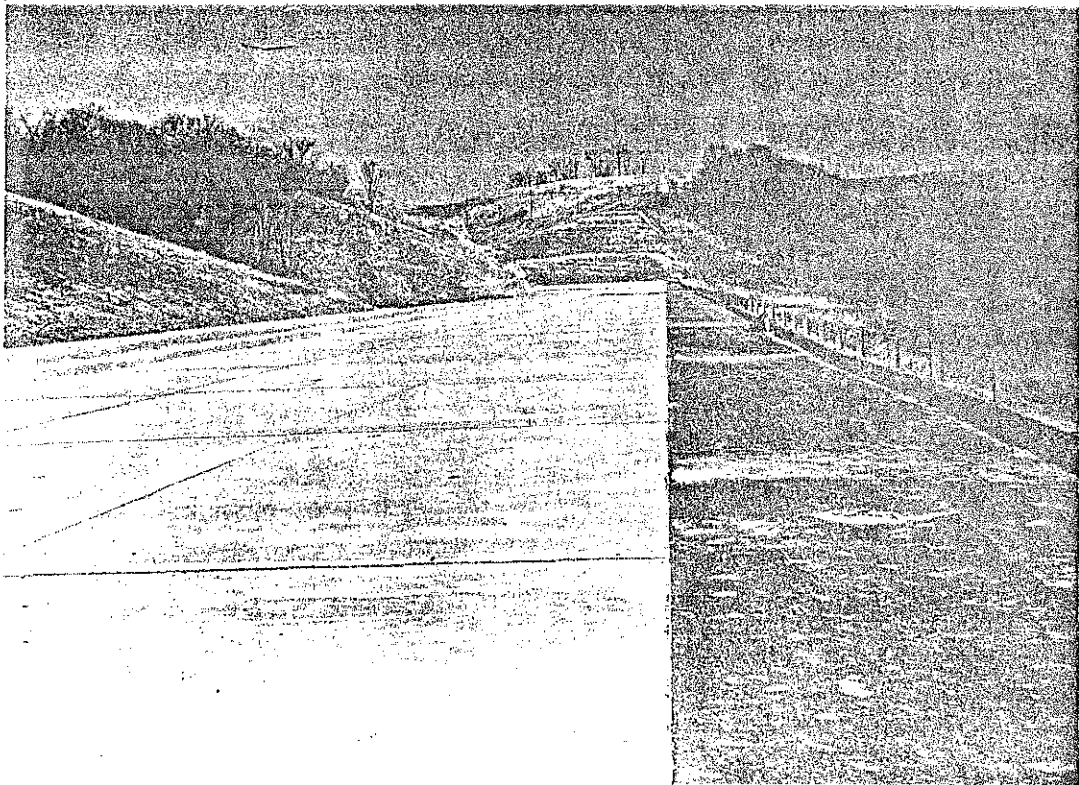


Fig. 7. Area of Minor Slide, April 16, 1962.

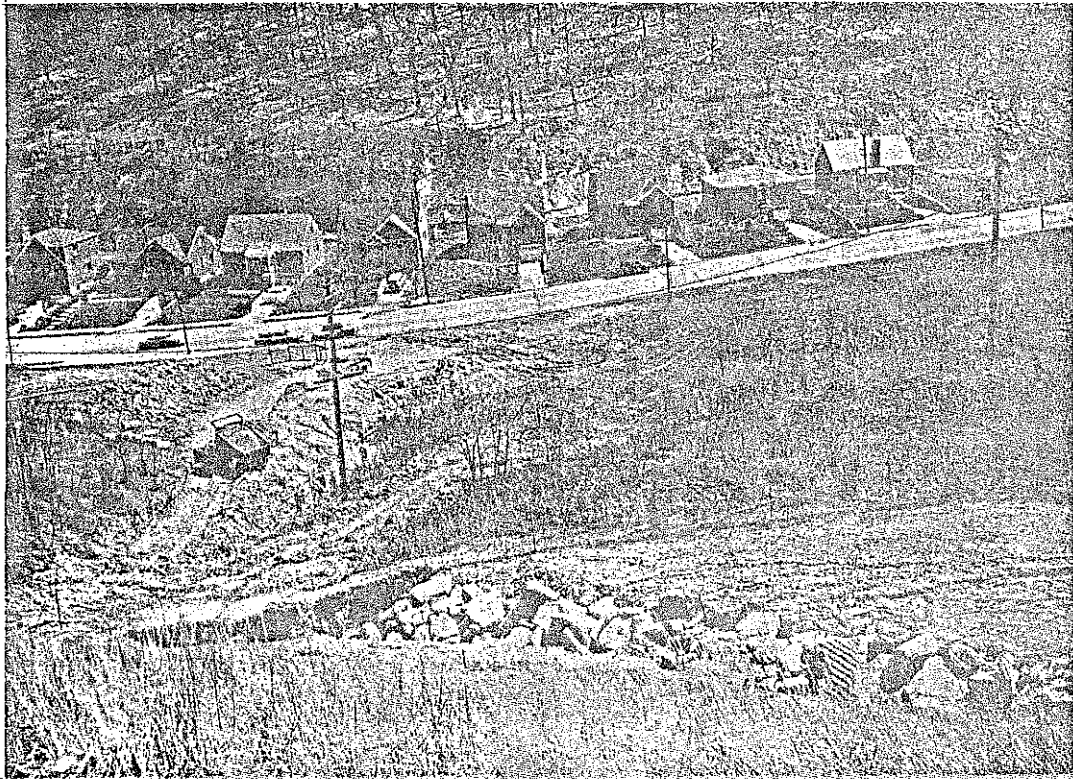


Fig. 8. Embankment Slope in Area of Minor Slide, April 16, 1962.



Fig. 9. Embankment Slope Shown in Figure 8. Note That Ditch Had Been Paved. Photograph Taken March 27, 1963.

completely backfilled with sand and then covered with a paved ditch.

4. On the east side of the pavement a concrete curb and gutter and shoulder was placed between Stations 480+08 and 494+15.

5. A paved ditch was constructed in the east ditch line from Station 493+15 to Station 495+00.

6. The badly eroded ditch shown in Figure 8 was paved (see Figure 9).

7. Large areas where the pavement had been deformed, but not sufficiently to require replacement of slabs, were cement grouted. Some mudjacking was also done in an effort to bring the slab back to the proper cross-section in these areas.

Most of the above work was done by the contractor under an agreement for supplemental construction work. The mudjacking was done by personnel of the Department of Highways.

MARCH 1, 1963 --- 1.05 inches of rainfall

MARCH 4, 1963 --- 2.97 inches of rainfall

MARCH 5, 1963 --- 0.54 inches of rainfall

MARCH 6, 1963 --- 0.01 inches of rainfall

MARCH 7, 1963 --- Trace of rainfall

MARCH 9, 1963 --- 0.24 inches of rainfall

MARCH 10, 1963 -- Trace of rainfall

WEEK OF MARCH 11, 1963 --- It was reported by personnel of the District 6 office that there was some slight movement of the embankment in the same areas which had slumped in 1962.

MARCH 11, 1963 --- 0.41 inches of rainfall

MARCH 13, 1963 --- Trace of rainfall

MARCH 16, 1963 --- 2.22 inches of rainfall

MARCH 17, 1963 --- Trace of rainfall

WEEK OF MARCH 18, 1963 --- More movement was reported with the outside edge of the shoulder dropping about a foot or foot-and-a-half between Stations 487+50 and 489+00.

MARCH 18, 1963 --- 0.32 inches of rainfall

MARCH 19, 1963 --- 1.05 inches of rainfall

MARCH 20, 1963 --- 0.01 inches of rainfall

MARCH 21, 1963 --- 0.01 inches of rainfall

MARCH 25-28, 1963 --- Personnel of the Research Division were on the site and the conditions noted at this time are indicated in green in Figure 1. The following is a list of conditions found to exist at this time and some of the maintenance and exploratory work that was done during these few days.

1. Figures 10, 11, and 12 show the condition of the pavement in the area between Stations 486+50 and 491+00. The views in Figures 10 and 11 are somewhat restricted and show the extent to which the concrete shoulder had dropped between Stations 486+50 and 489+10. Figure 12 not only shows the area of major movement to the right of the photograph but also shows the slight dip of the pavement where men are standing near Station 489+75 to 491+00. Figure 13 is a close up view showing the embankment pulled down and away from the gutter.

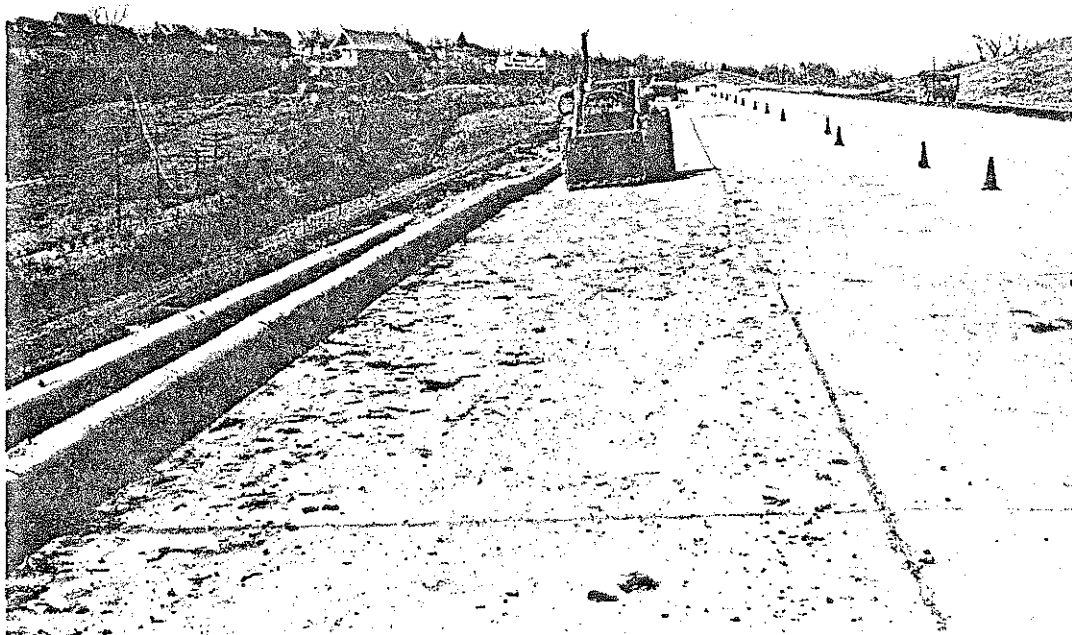


Fig. 10. Slide Area on March 27, 1963 (Looking South).

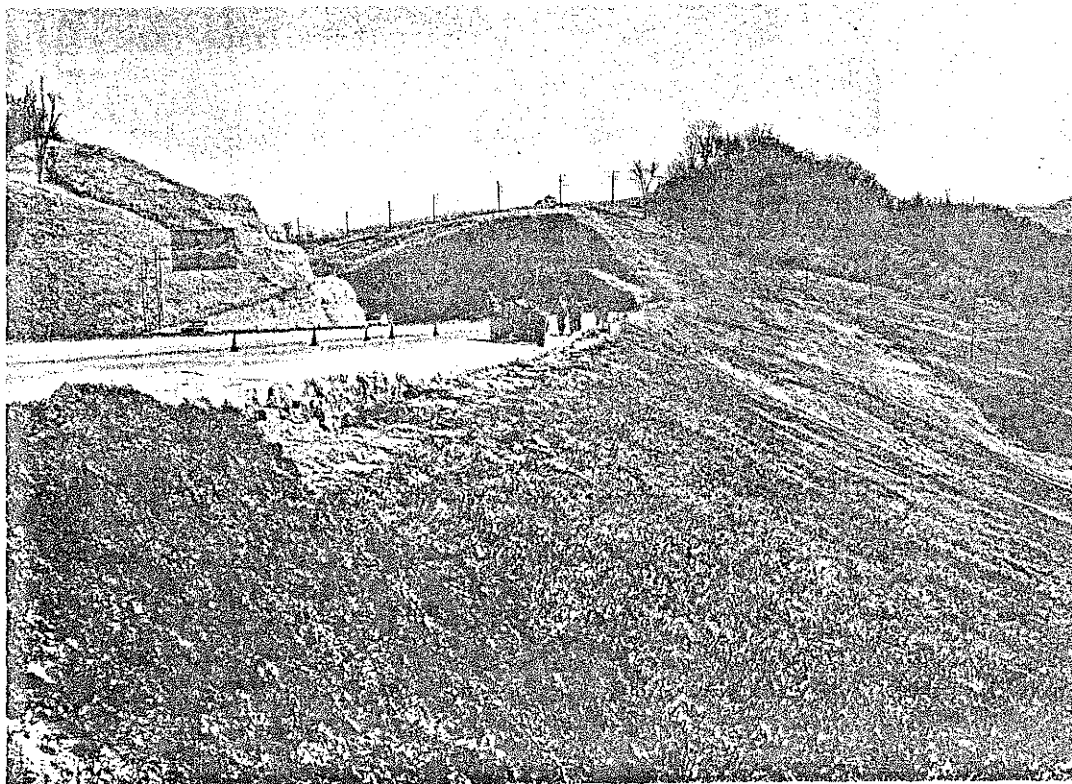


Fig. 11. Slide Area on March 27, 1963 (Looking North).

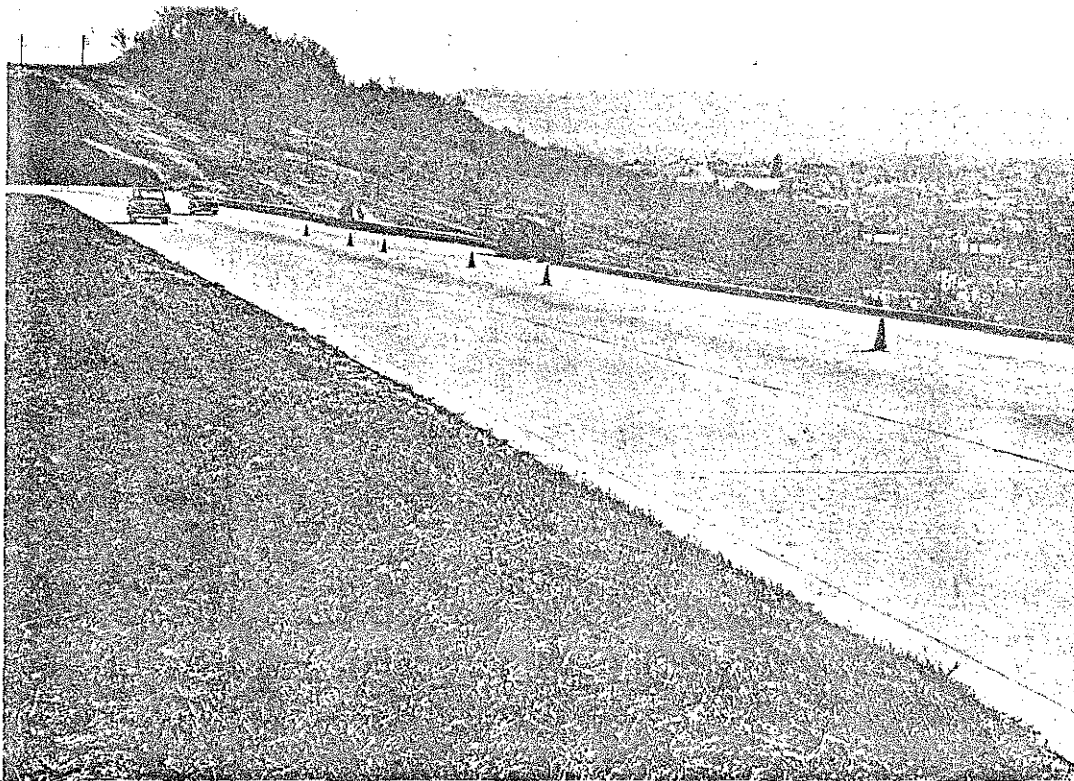


Fig. 12. Slide Area on March 27, 1963 (Looking Northeast).



Fig. 13. Close Up Showing Embankment Pulled Down and Away From the Concrete Gutter, March 27, 1963.

2. Beyond the toe of the embankment, out on original ground which was not disturbed during construction, there were indications of deep-seated movement as manifested by distorted and tilted fence and telephone lines (see Figure 14).

3. A group of 44 timber piles 25 to 32 feet long were driven vertically just outside the shoulder between Stations 487+50 and 489+75. The zone between the piles and the shoulder was backfilled with a clay (see Figure 15). This work was done on March 25-27, 1963.

4. Several areas of seepage water outcropping on the slope of the embankment, as indicated in Figure 1, were noted.

5. Approximately 35 drill holes were sunk in the median strip from Station 448 to 494. These holes were drilled to depths of 10 to 40 feet below the surface of the median strip. Free water was noted to stand in many of these holes. Between Stations 471 and 494 the water stood at levels of one to nine feet below the surface.

6. Numerous holes were drilled through the pavement and into the subgrade in the outside, northbound lane from Station 481+50 to Station 489+75. Several of these holes showed the water level to be 6 to 18 inches below the pavement surface. Two holes had water standing at the surface.

7. Logs of drill holes indicated the presence of an extremely wet and soft material at depths between Station 477 and 482. The top of this soft layer ranged between five and ten feet with the bottom some 20 to 35 feet below the pavement. This zone appeared to exist only under the southbound lanes.

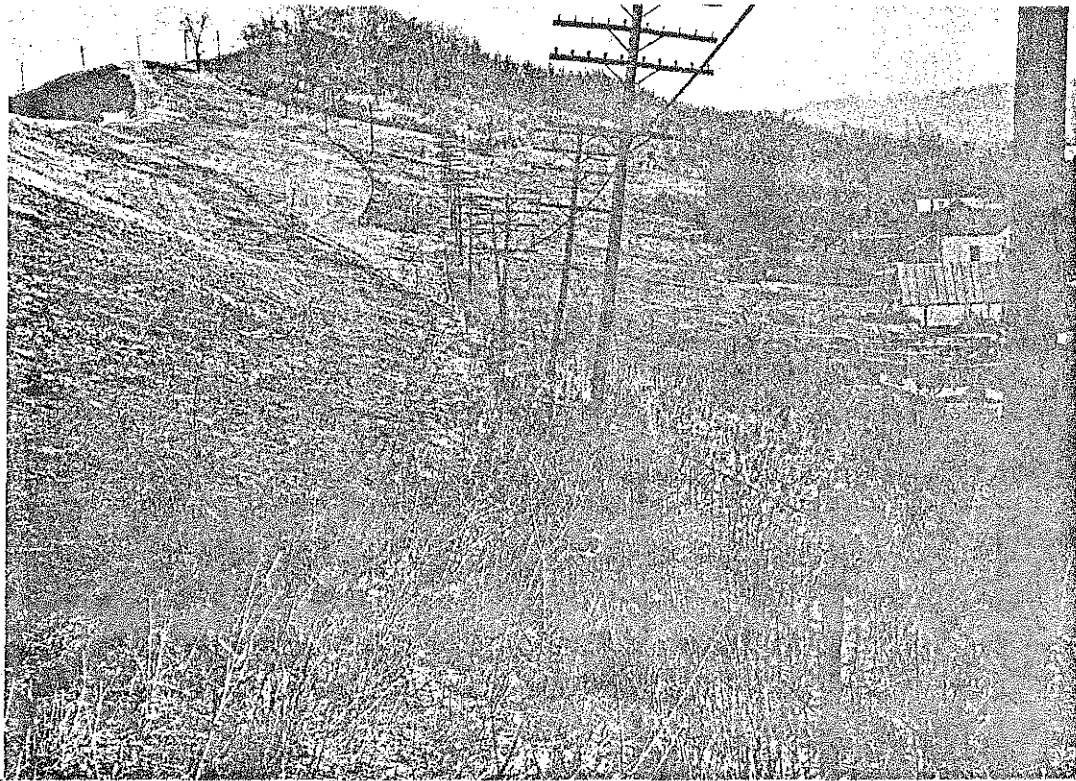


Fig. 14. Area of Toe of Embankment Showing Distorted Telephone and Fence Lines, March 27, 1963.

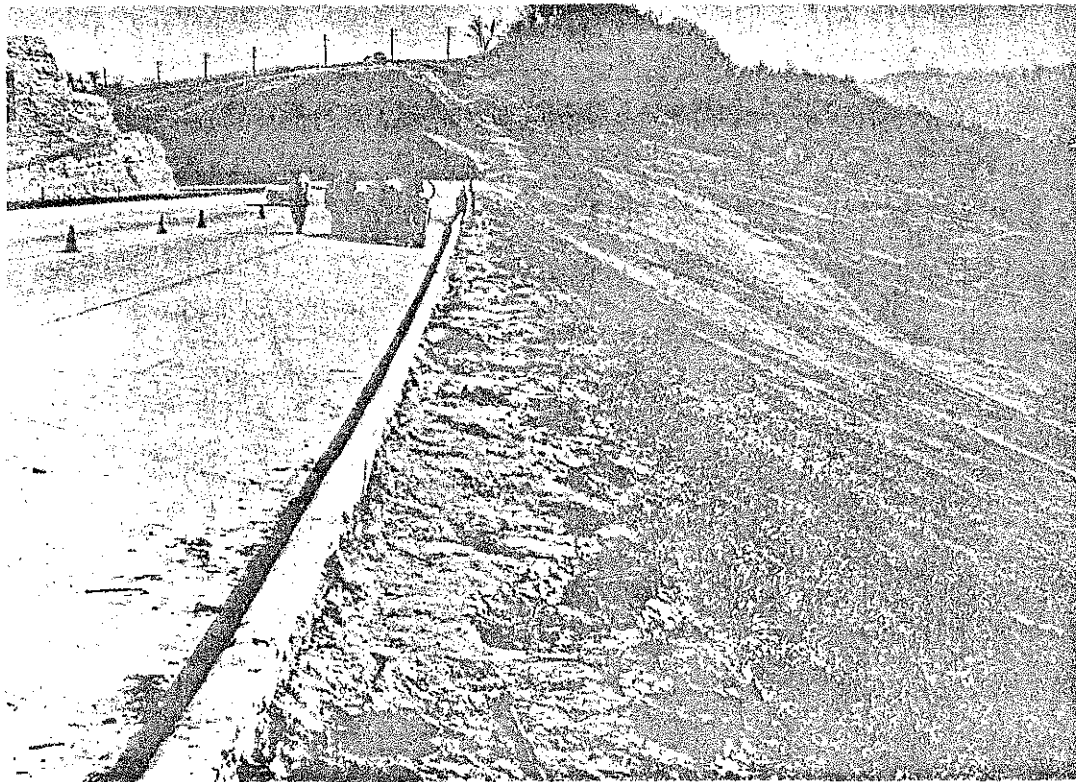


Fig. 15. Timber Piles and Clay Fill Between Piles and Shoulder, March 27, 1963.

8. It was discovered that the 4-foot by 4-foot box culvert at Station 480+50 was cracked sufficiently to permit a large amount of water to escape. These cracks were patched.

9. A situation that was rather common between Stations 467+00 and 487+75 and between Stations 491+70 and 507+00 is illustrated in Figure 16. Significant amounts of water were observed to be flowing through the joint between the shoulder and the pavement in the south-bound lanes.

10. Water was seeping into the west ditch line between Stations 464+00 and 472+50.

11. Water was flowing at a fairly significant rate from the perforated pipe that had been installed in the west ditch line.

12. A rather large amount of water was flowing from the perforated pipe at Station 487+05.

MARCH 25, 1963 --- 0.10 inches of rainfall

MARCH 26, 1963 --- 0.33 inches of rainfall

MARCH 27, 1963 --- Trace of rainfall

MARCH 30, 1963 --- 0.14 inches of rainfall

MARCH 31, 1963 --- 0.51 inches of rainfall

APRIL 2, 1963 --- The site was visited again and conditions were very much the same as on March 28. The water level in some drill holes had risen slightly. Figures 17 and 18 illustrate the condition of the pavement and shoulder on this date. Water was still flowing through the joint between the shoulder and the pavement (see Figure 19).



Fig. 16. Water Flowing Through the Joint Between the Shoulder and
and Pavement, March 27, 1963.

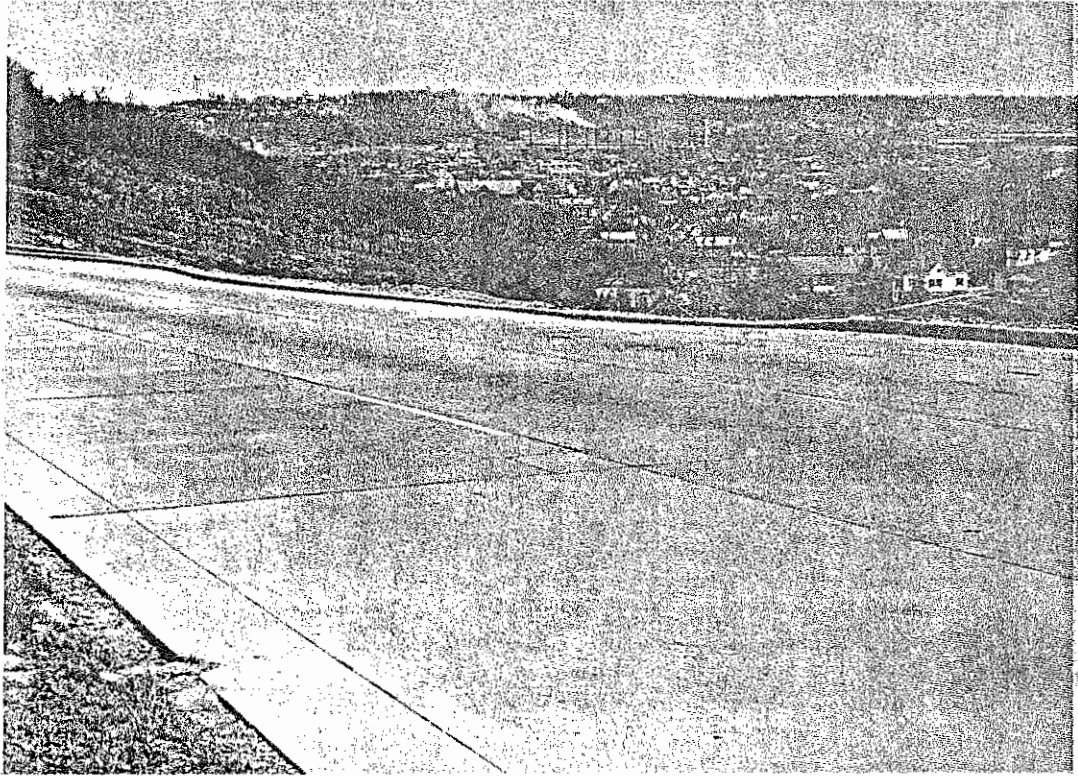


Fig 17. Slide Area on April 2, 1963 (Looking Northeast).

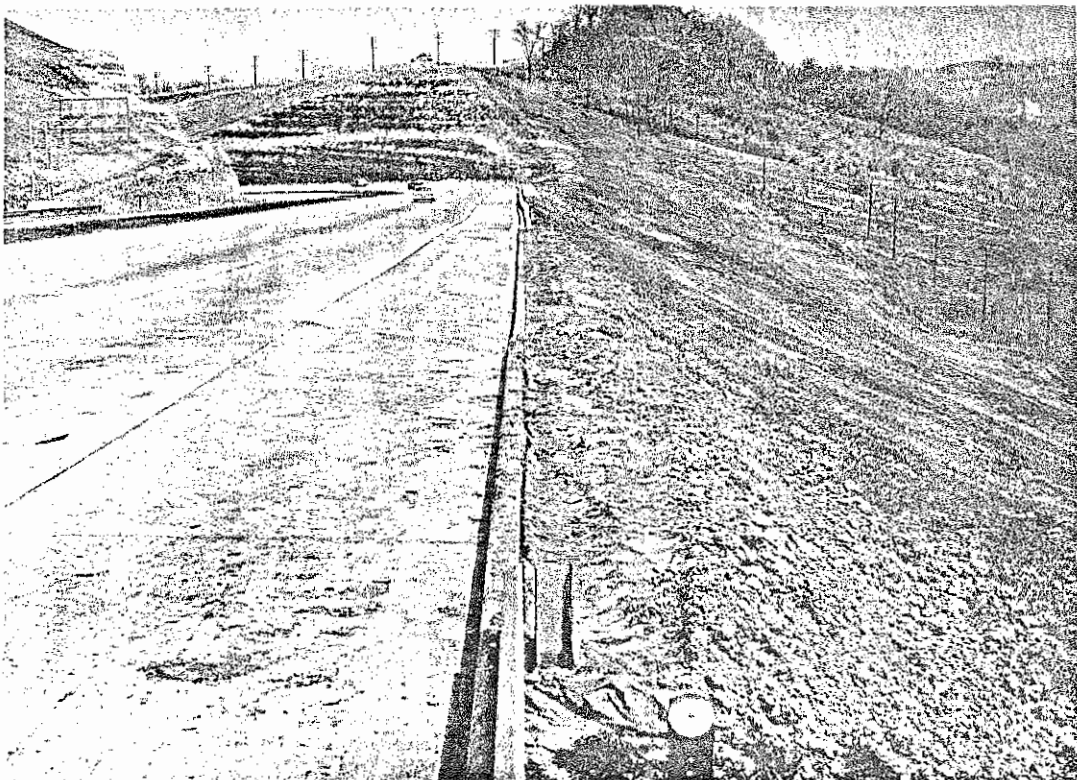


Fig. 18. Slide Area on April 2, 1963 (Looking North).

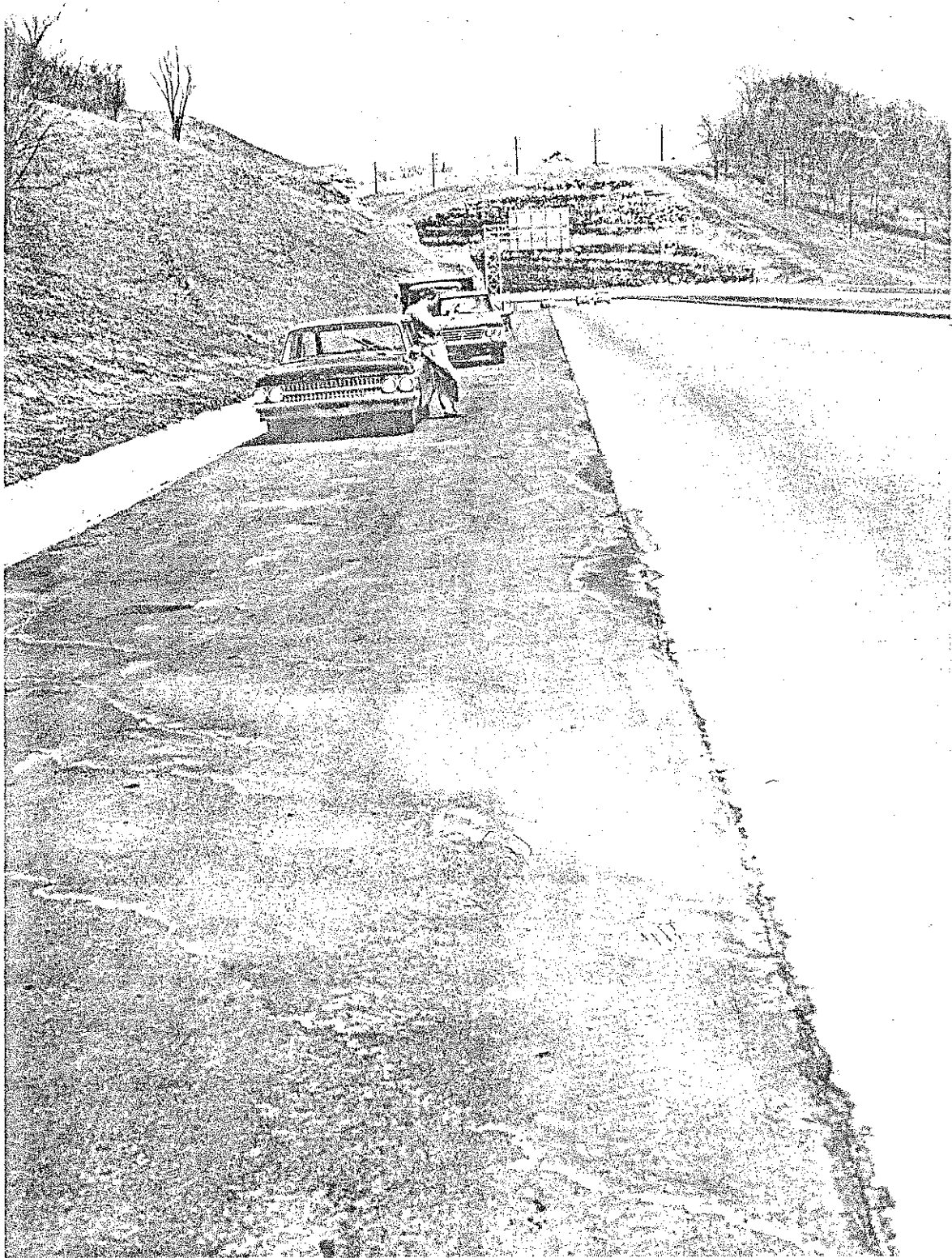


Fig. 19. Water Flowing Through the Joint Between the Shoulder and Pavement, April 2, 1963.

APRIL 3, 1963 --- 0.06 inches of rainfall

APRIL 5, 1963 --- The conditions at the site were very much the same as on April 2. Several reference points were located on the embankment slope so that movement could be checked.

APRIL 8, 1963 --- 0.06 inches of rainfall

The area was very much the same as on April 5. A check of the reference points indicated little movement. Horizontal auger holes approximately five feet below the northbound lanes were located at Stations 480+50 and 481+05 and extended approximately 40 feet toward the median strip. The holes were backfilled with sand and a perforated pipe placed at the exit from the embankment so that the exit would not be sealed off by clay falling over the sand. No water has been observed flowing from these drains.

APRIL 13, 1963 --- 0.02 inches of rainfall.

APRIL 16, 1963 --- 0.10 inches of rainfall.

A visit to the site and a check of the reference points indicate no significant change from April 8. Two horizontal auger holes, one located under the northbound lanes at Station 486+25 and the other under the southbound lanes at Station 487+90, had been drilled since the last inspection on April 8. Both holes were located to drain the dense graded aggregate base and it was noted that water was escaping through these sand drains.

APRIL 17, 1963 --- 0.01 inches of rainfall

APRIL 19, 1963 --- 0.42 inches of rainfall

APRIL 22, 1963 --- 0.34 inches of rainfall

APRIL 23, 1963 --- Trace of rainfall

APRIL 25, 1963 --- During the week before this date, the concrete shoulder between Station 487+00 and Station 491+25 had been removed and replaced with sand and dense graded aggregate. It was also evident that some additional movement had occurred since April 16. Very pronounced transverse ridges and cracks had become quite evident (see Figures 20, 21 and 22). The right flank of the slide area had also become very prominent (see Figure 23). At the toe of the embankment there were several extremely wet areas (see Figure 24). Some of the embankment had apparently flowed out over the original ground.

APRIL 29, 1963 --- 0.98 inches of rainfall

APRIL 30, 1963 --- 0.02 inches of rainfall

The shoulder of the roadway had dropped three to four feet (see Figure 25) and the main scarp of the slide was located some four to six feet back under the outside driving lane (see Figure 26). The escarpment at the right flank of the slide area had become more pronounced (see Figure 27.) The transverse ridges and cracks had become more prominent (see Figure 28). Figure 29 shows the condition near the toe of the embankment on this date. Note the tilted telephone poles and the discontinuity in the fence line just behind the front telephone pole. Between pole 3 and 4 a ridge of soil some four to five feet high had developed outside the right-of-way on original ground.

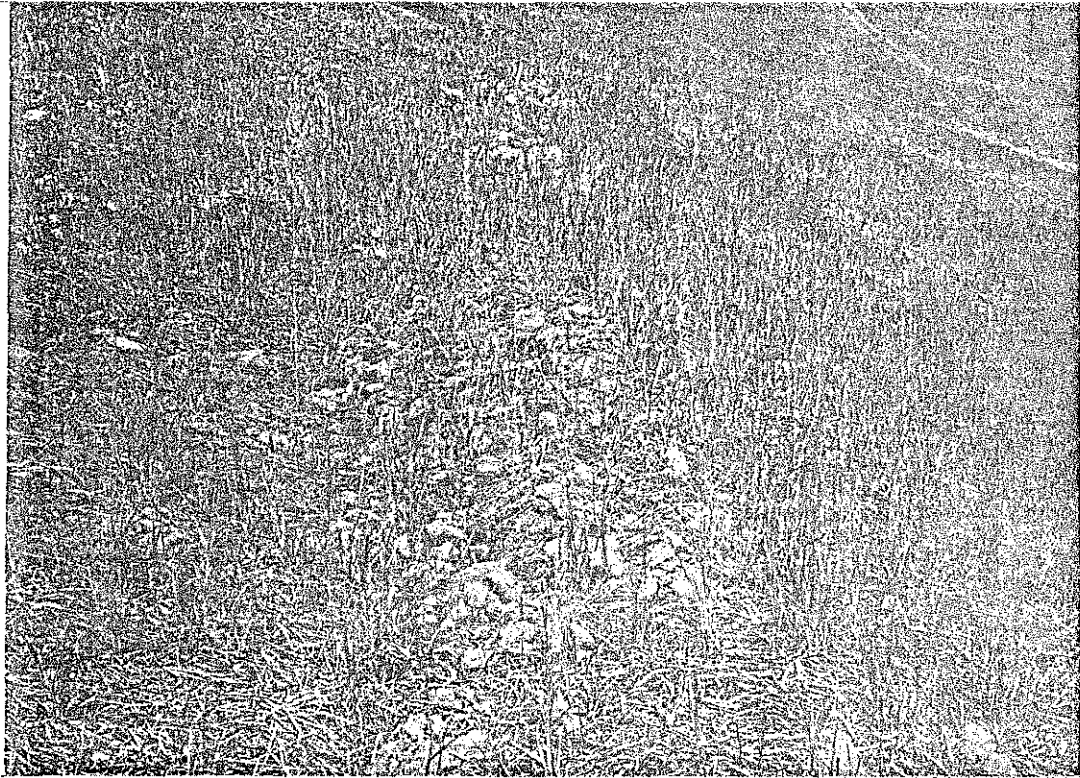


Fig. 20. Transverse Ridge on Embankment Slope, April 25, 1963
(Looking North).

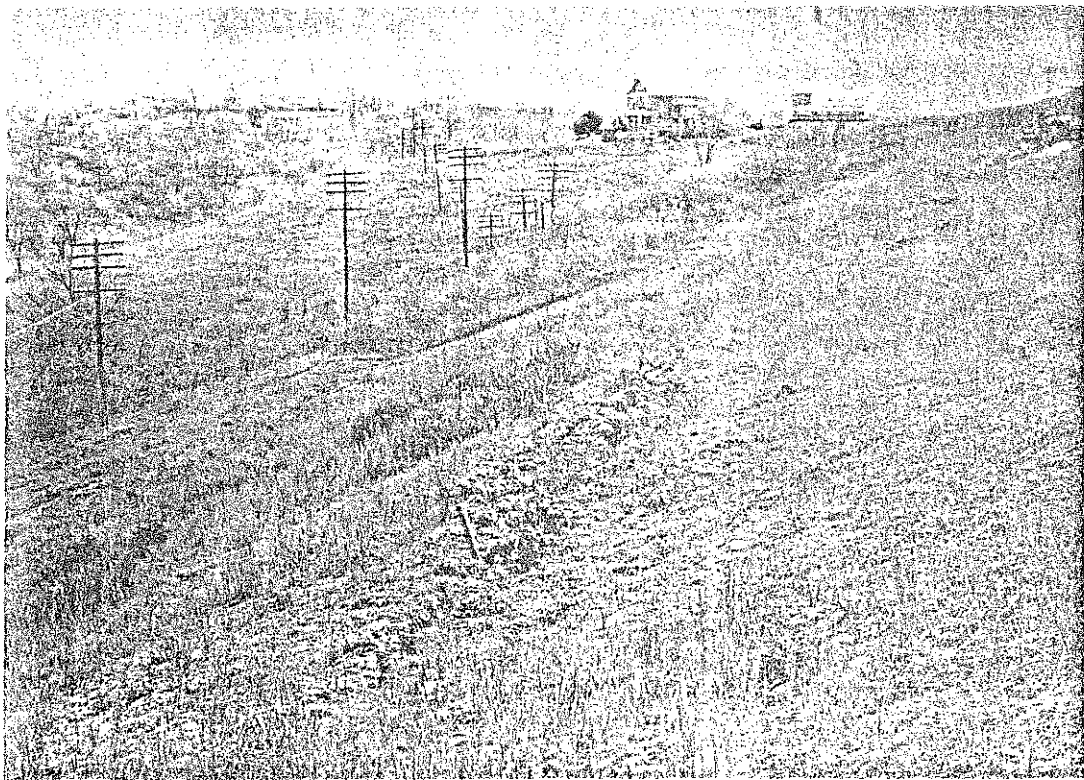


Fig. 21. Transverse Ridge and Crack on Embankment Slope,
April 25, 1963 (Looking South).



Fig. 22. Close Up of Transverse Crack, April 25, 1963.

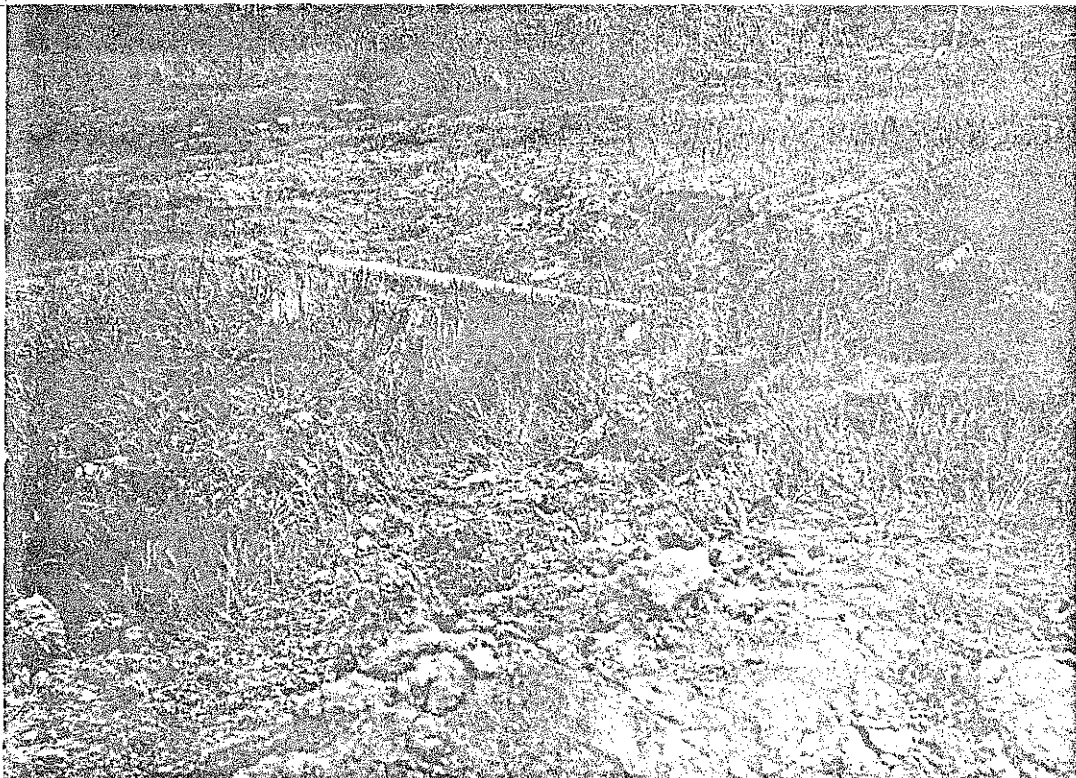


Fig. 23. Right Flank of Slide Zone, April 25, 1963.



Fig. 24. Wet Area at Toe of Embankment Showing Slight Soil Flow, April 25, 1963.

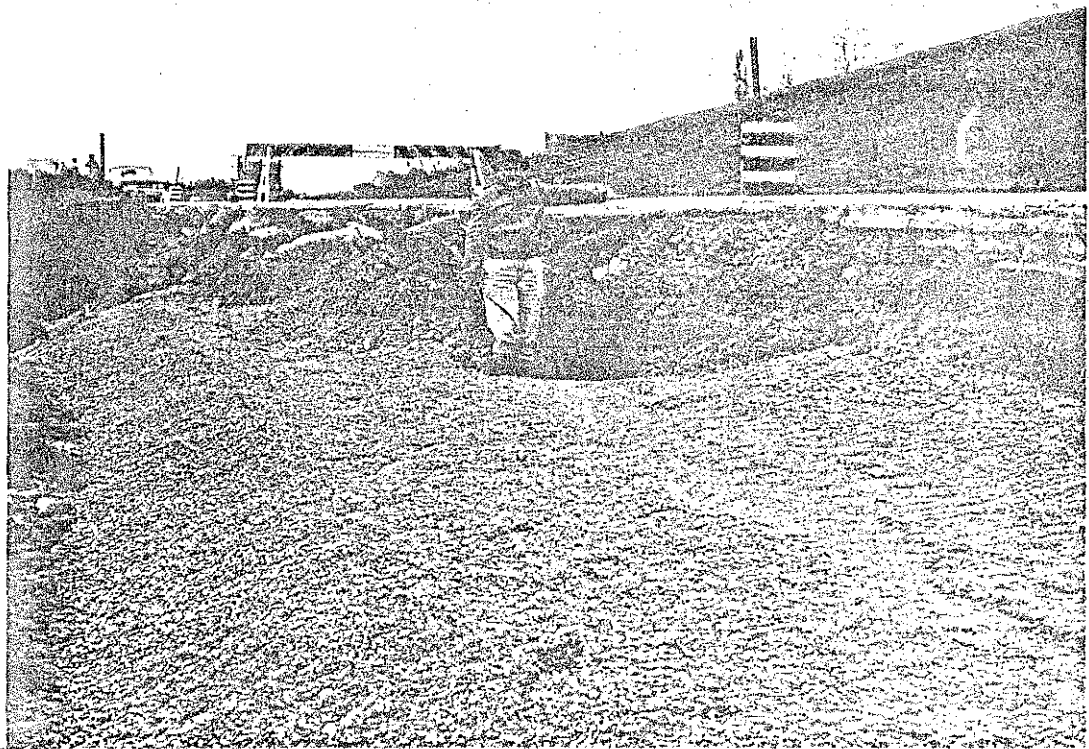


Fig. 25. Slide Area at Station 487+50, April 30, 1963 (Looking South).

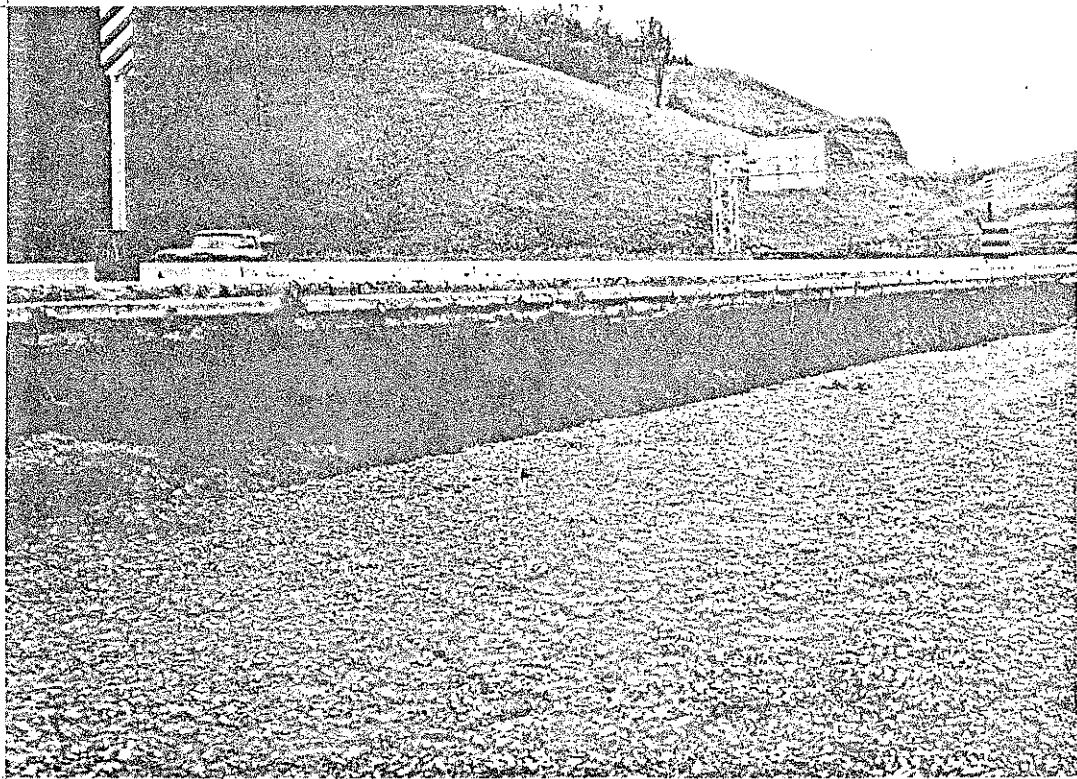


Fig. 26. Slide Area Near Station 489, April 30, 1963.



Fig. 27. Escarpment at Right Flank of Slide Area, April 30, 1963.

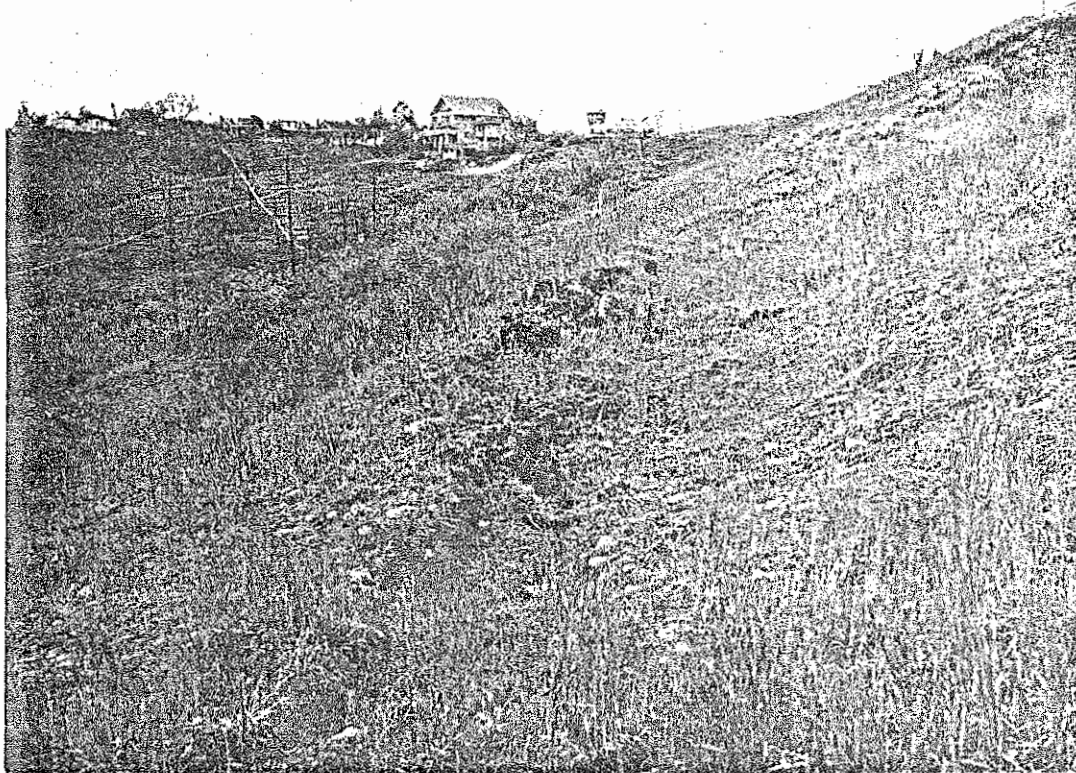


Fig. 28. Transverse Crack and Ridge, April 30, 1963 (Looking South). This Is Same View Shown in Figure 21.

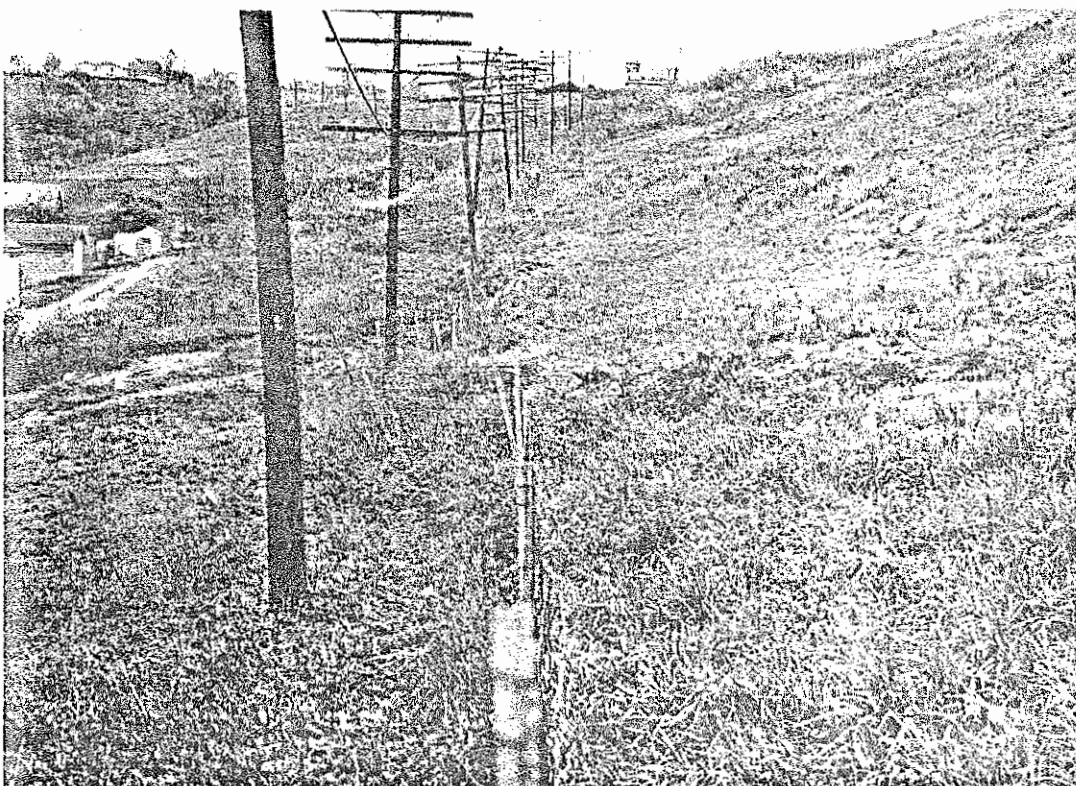


Fig. 29. Toe of Embankment in Landslide Area, April 30, 1963 (Looking South).

MAY 2, 1963 --- Observations indicated that movement was still occurring at this time. Figure 30 shows the general landslide area on this date.

MAY 6, 1963 --- Conditions had gradually worsened. The shoulder, the head of the slide, had dropped a total of about six feet.

MAY 9, 1963 --- A bituminous curb section was placed between Station 486+25 and 491+50 (see Figure 31). This work was done as a temporary measure to prevent surface water falling on the pavement from spilling over onto the embankment in the landslide area.

MAY 10, 1963 -- Trace of rainfall

From Station 480+80 to Station 487+00 the clay embankment immediately adjacent to the shoulder was removed down to the level of the subgrade so as to expose the dense graded aggregate base at the shoulder edge of the northbound lanes. The exposed DGA base was noted to be extremely wet.

Figures 32 through 44 illustrate the conditions in the landslide area on this date. A check of the reference points showed that there had been some additional movement since the last survey on April 30.

A condition at the main scarp is shown in Figure 32. In Figure 33 layers of cement grout and mudjacking material that was placed in the summer of 1962 can be seen exposed as a result of the landslide. The timber piles that had been driven near the shoulder on March 25-27, 1963, were exhibiting three distinct types of behavior. The piles near Station 488 were tilted back toward the pavement and had apparently just begun to cease moving with the embankment (see Figure 34). To the north near Station 490 the tops of the piles are exposed for some four or five feet and are tilted toward the toe of the embankment (see Figure 35). The other piles were still apparently moving with the soil mass.

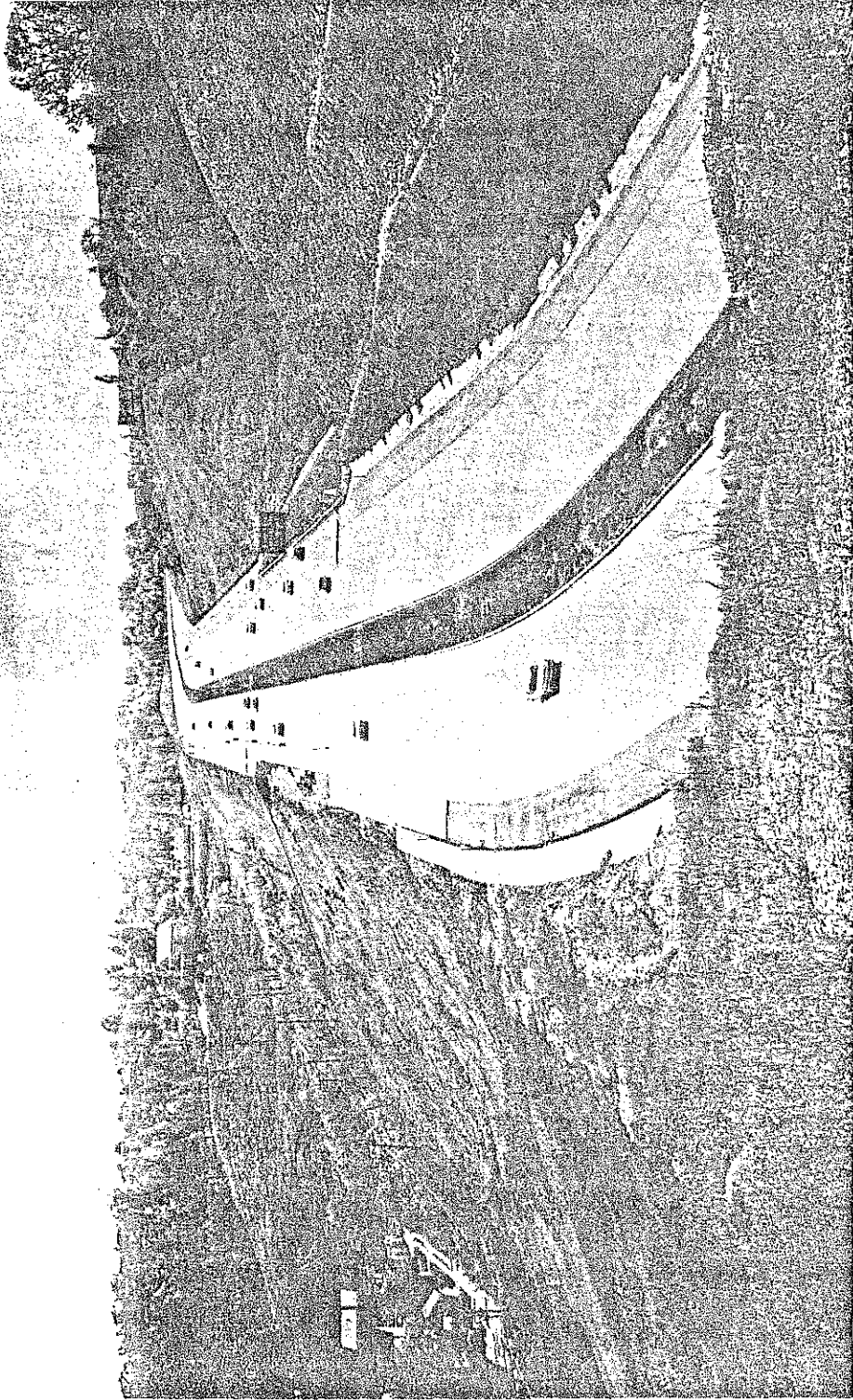


Fig. 30. General View of Landslide on May 2, 1963 (Looking South).

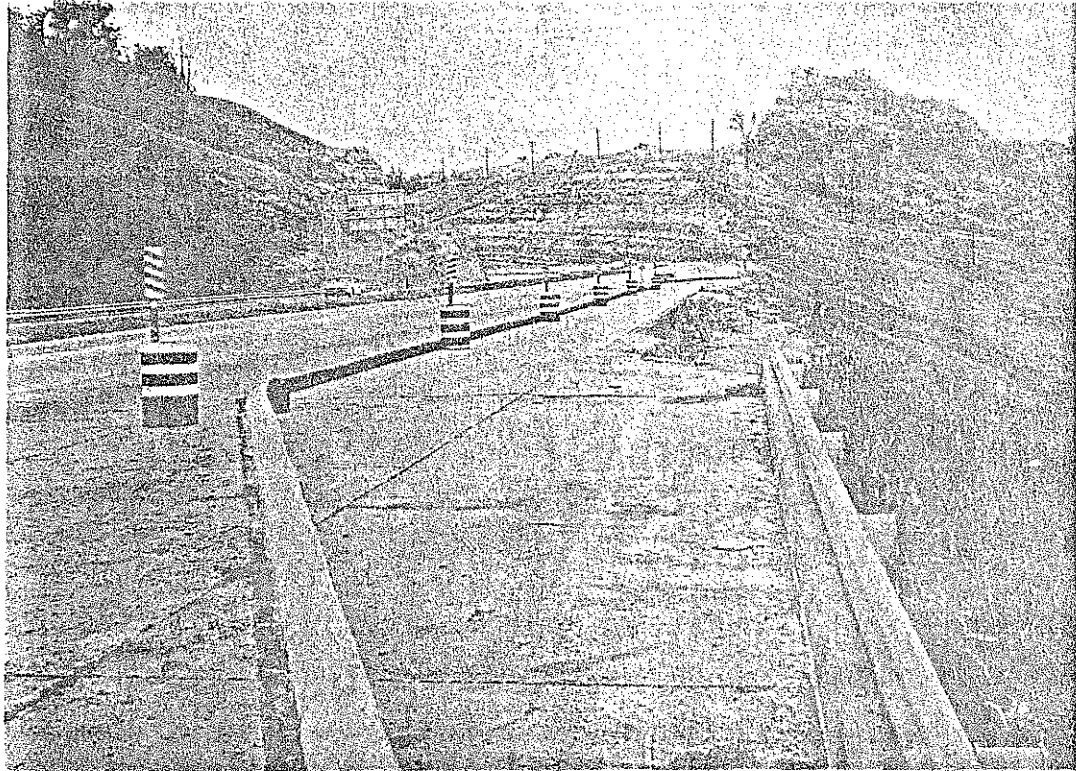


Fig. 31. Bituminous Curb To Prevent Surface Water From Spilling Over the Embankment, May 9, 1963 (Looking North).

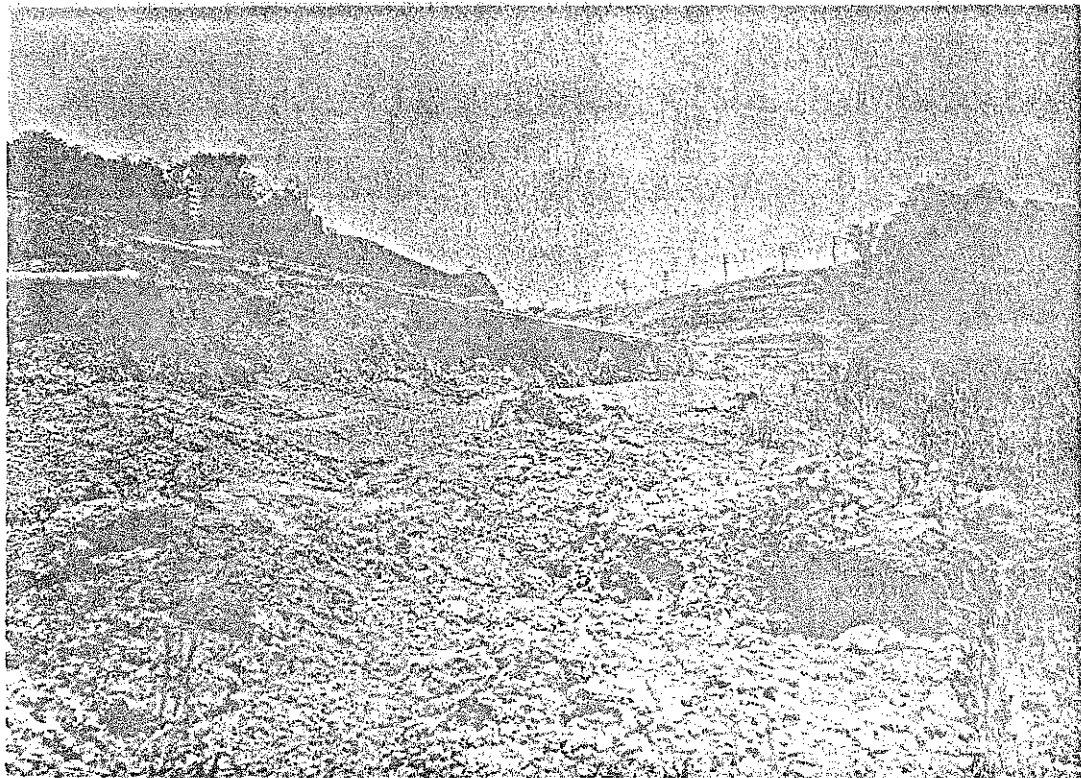


Fig. 32. Main Scarp of Landslide, May 10, 1963 (Looking North).



Fig. 33. Layers of Old Cement Grout and Mudjacking Material, May 10, 1963.

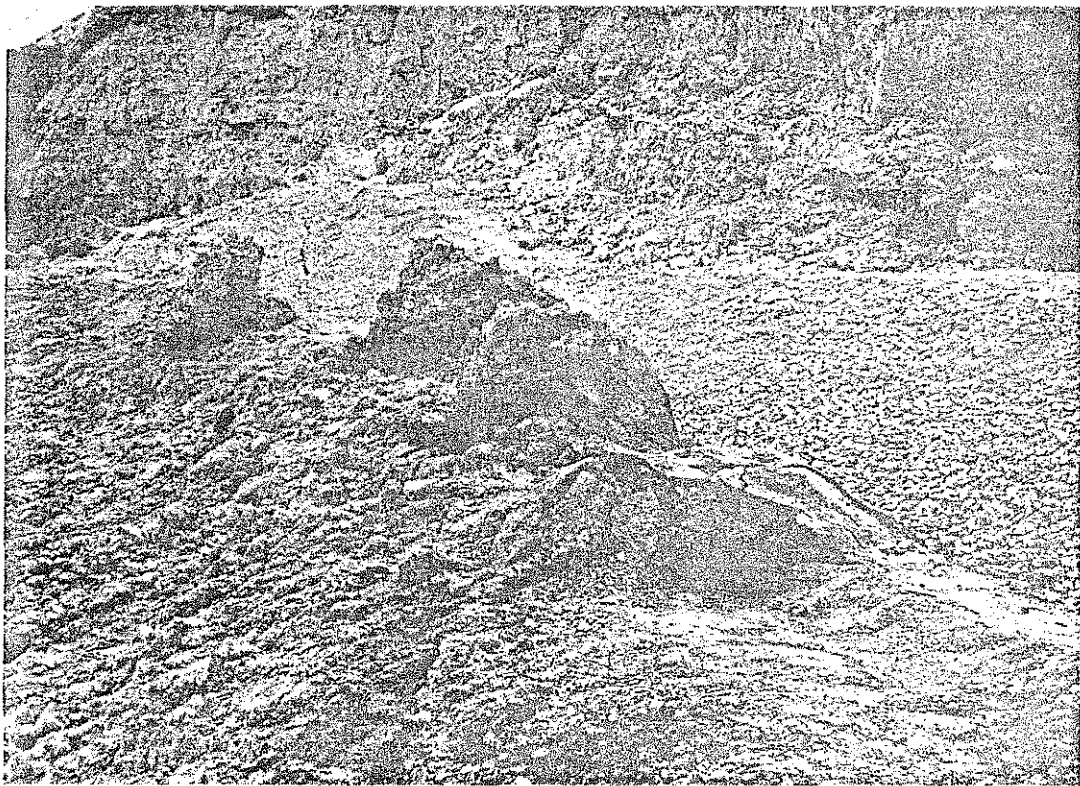


Fig. 34. Condition of Timber Piles Near Station 488, May 10, 1963.

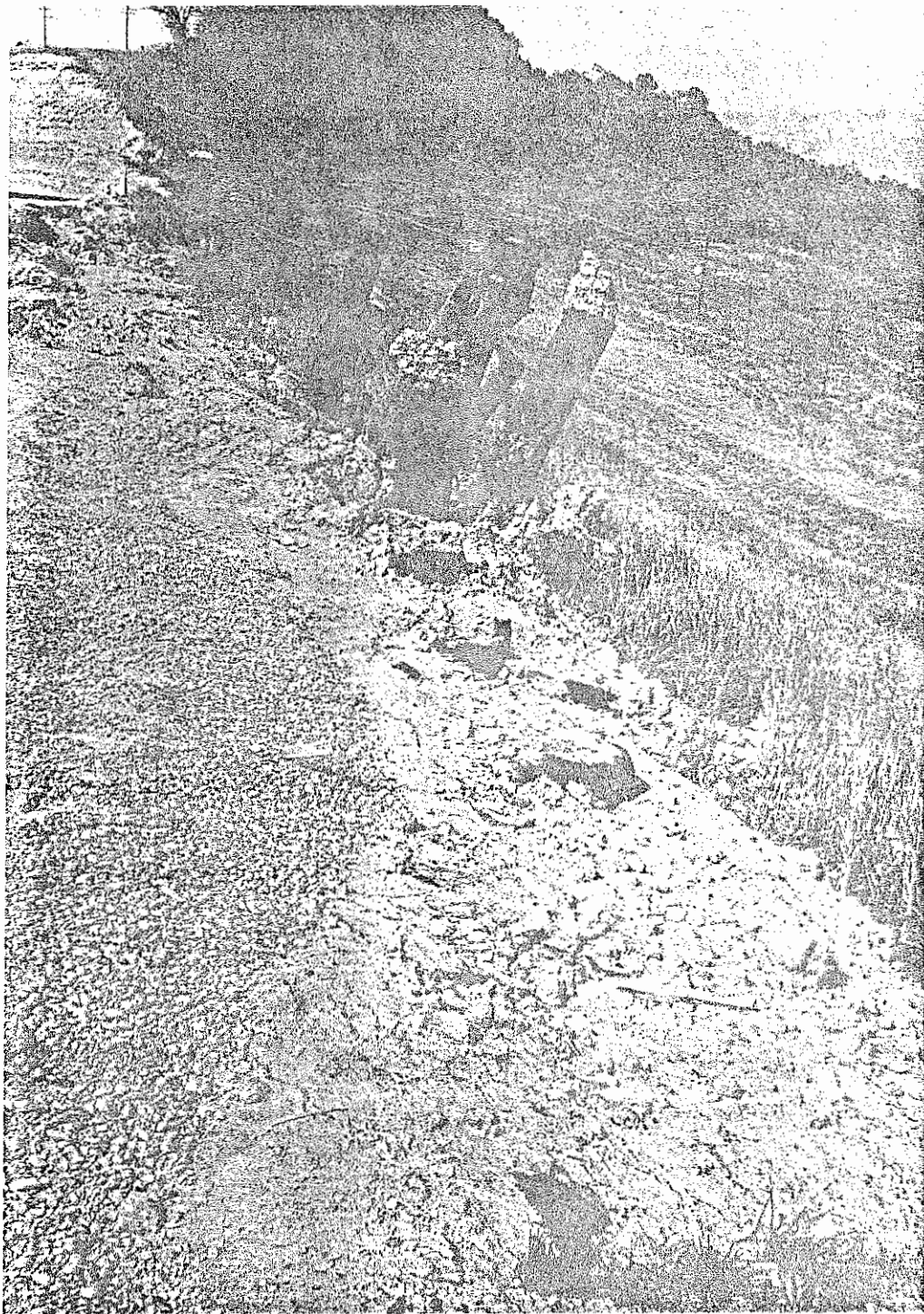


Fig. 35. Condition of Timber Piles Near Station 490, May 10, 1963.

The right flank of the landslide is shown in Figure 36. The area around the perforated pipe was still extremely wet. Photographs of transverse cracks and ridges on the embankment slope are shown in Figures 37 and 38.

The conditions at the toe of the embankment have gradually deteriorated (see Figures 39-42). The toe of the embankment (Figure 39) as well as original ground has flowed significantly (Figures 40-42).

The residents of the house shown in the center of Figure 43 have reported some very recent damage to their property that may be associated with the landslide. The short length of sidewalk between the concrete slab at the rear of the house and the house has buckled (see Figures 43-44). The rear concrete wall of the basement garage already exhibits a new crack that has opened about 3/8-inch. This crack is horizontal, runs the full length of the garage and is about midway up the wall from the floor.

MAY 12, 1963 --- Trace of rainfall

MAY 13, 1963 --- 1.30 inches of rainfall

MAY 14, 1963 --- Conditions in the landslide area were very much the same on this date as they were on May 10. Personnel from the telephone company were on the site realigning their poles near the toe of the embankment.

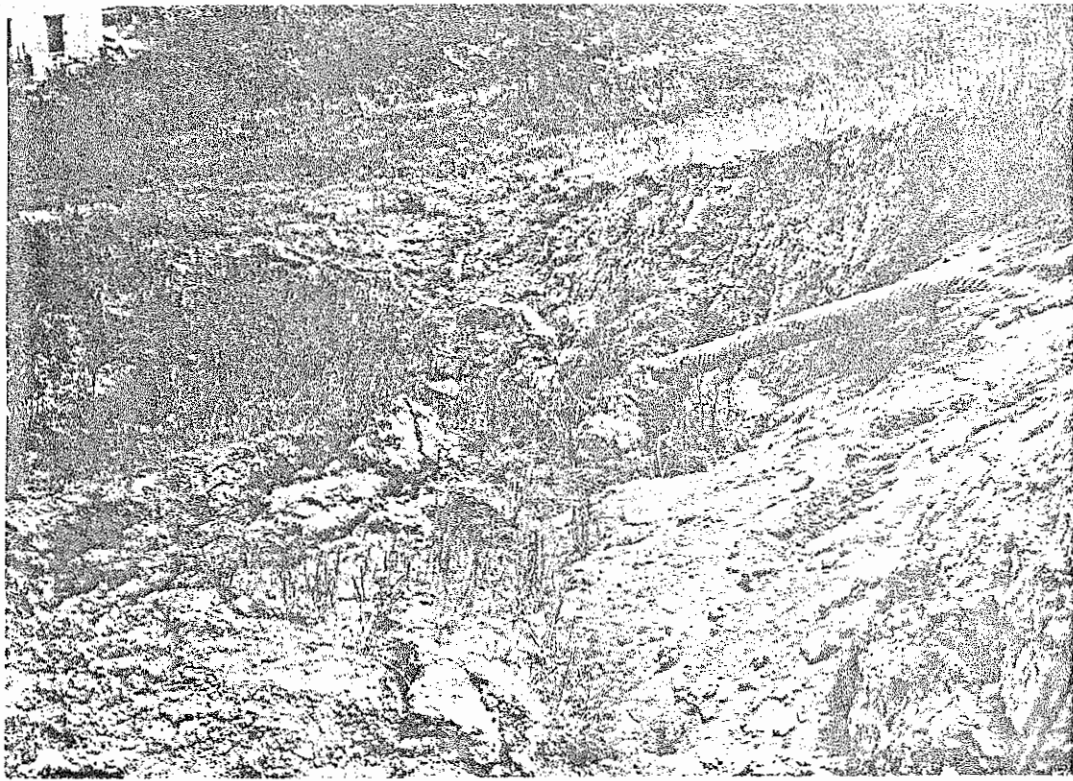


Fig. 36. Right Flank of Landslide, May 10, 1963.



Fig. 37. Condition of Embankment Slope, May 10, 1963 (Looking South).



Fig. 38. Transverse Cracks and Ridges on Embankment Slope, May 10, 1963 (Looking North).

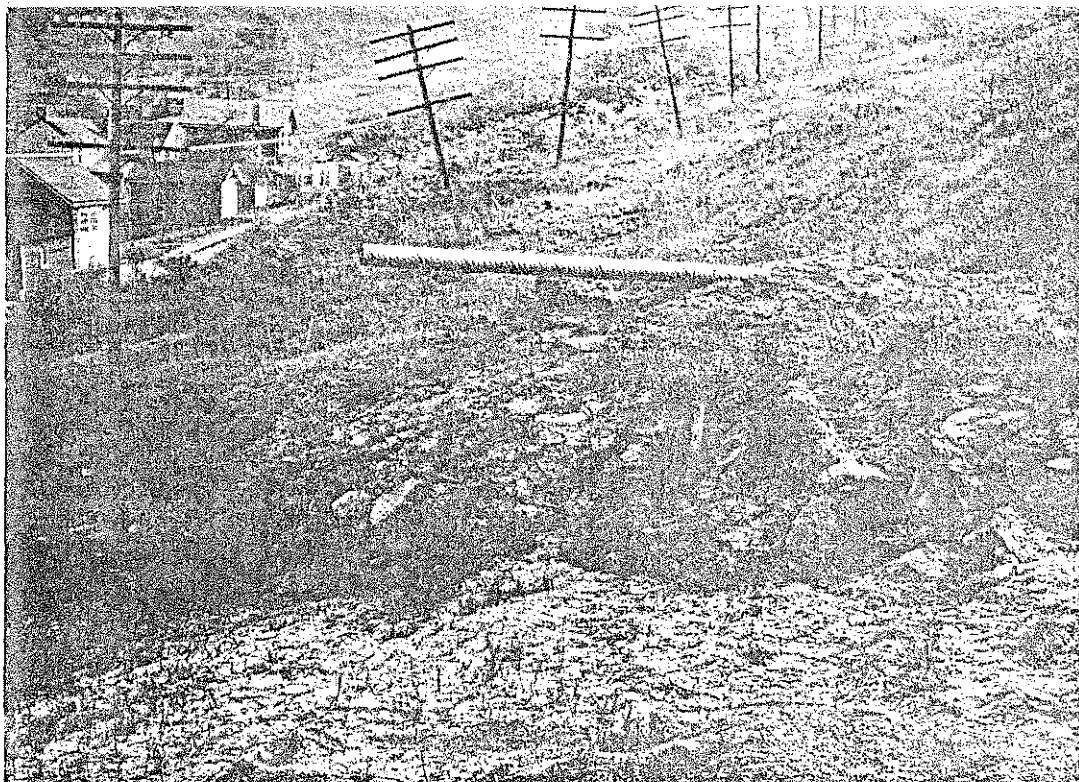


Fig. 39. Soil Flow Area at Toe of Embankment, May 10, 1963 (Looking South).

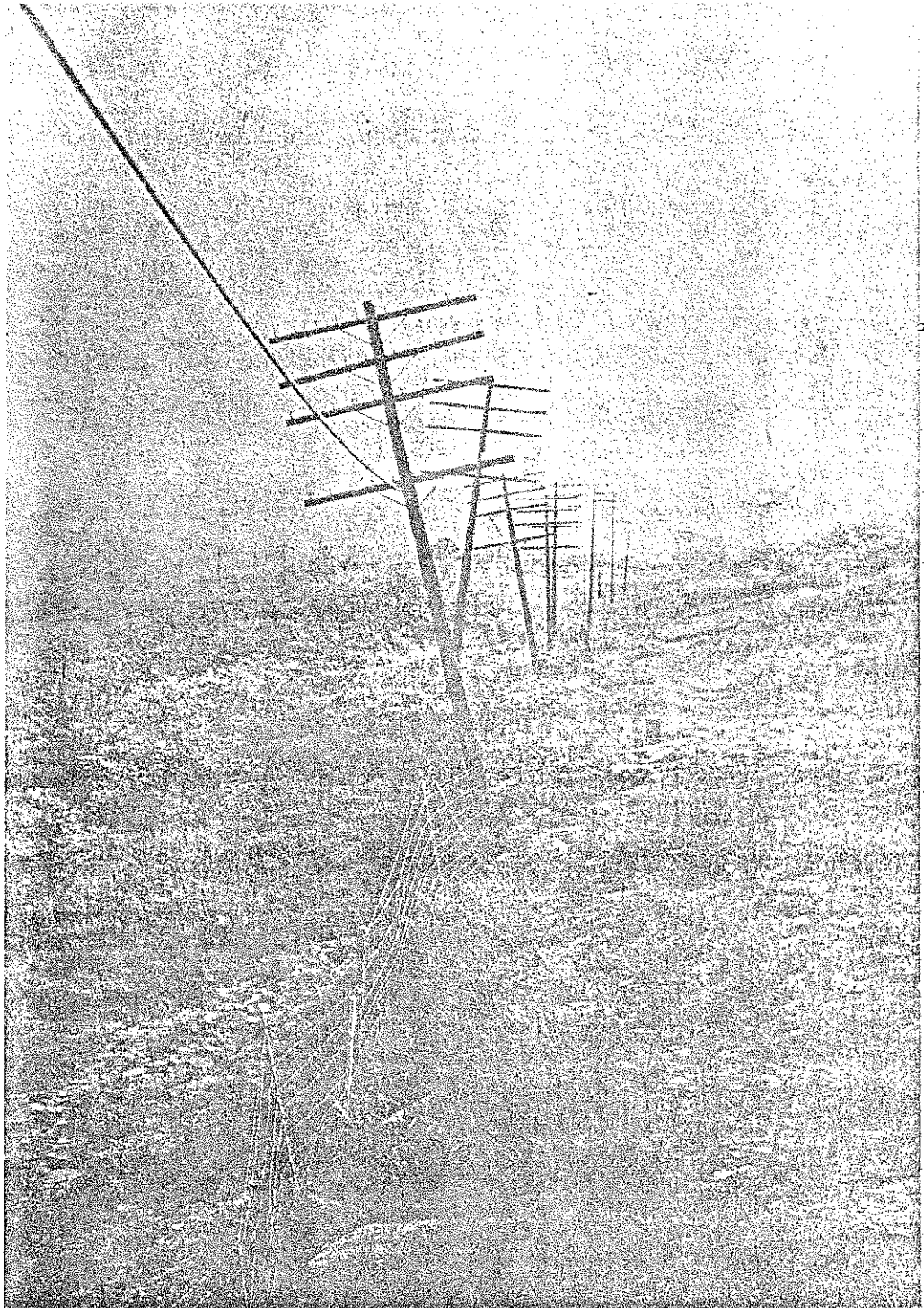


Fig. 40. Condition Near Toe of Embankment, May 10, 1963
(Looking South).

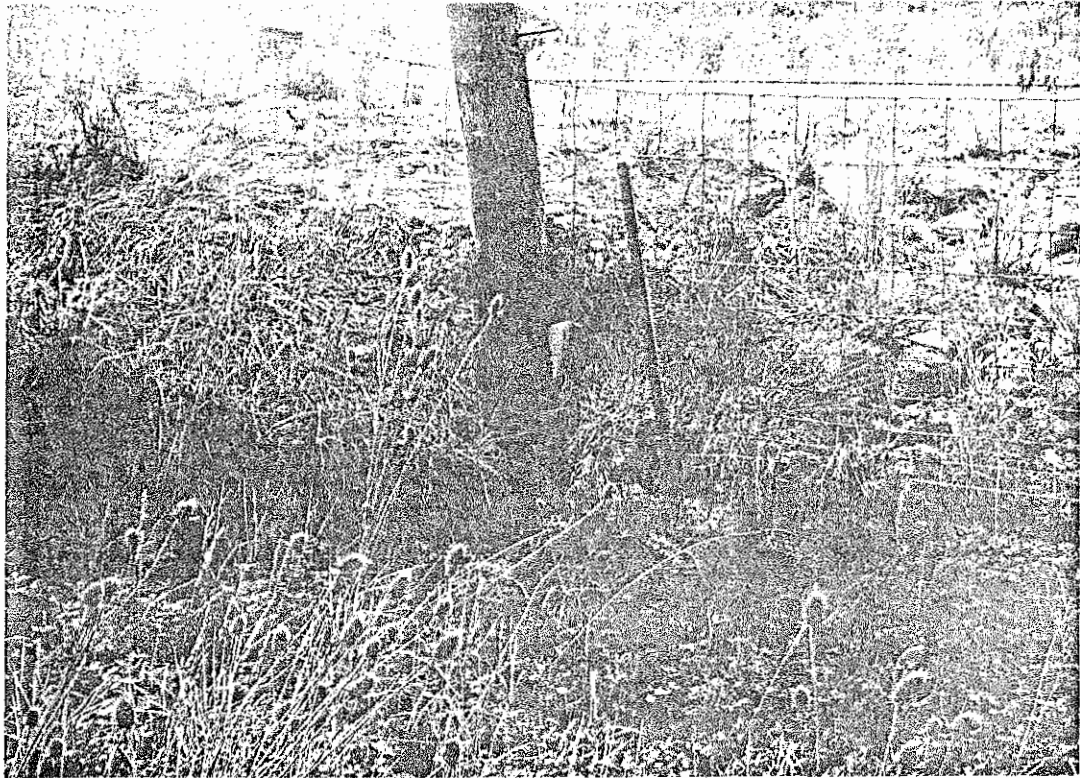


Fig. 41. Soil Flow of Original Ground, May 10, 1963.

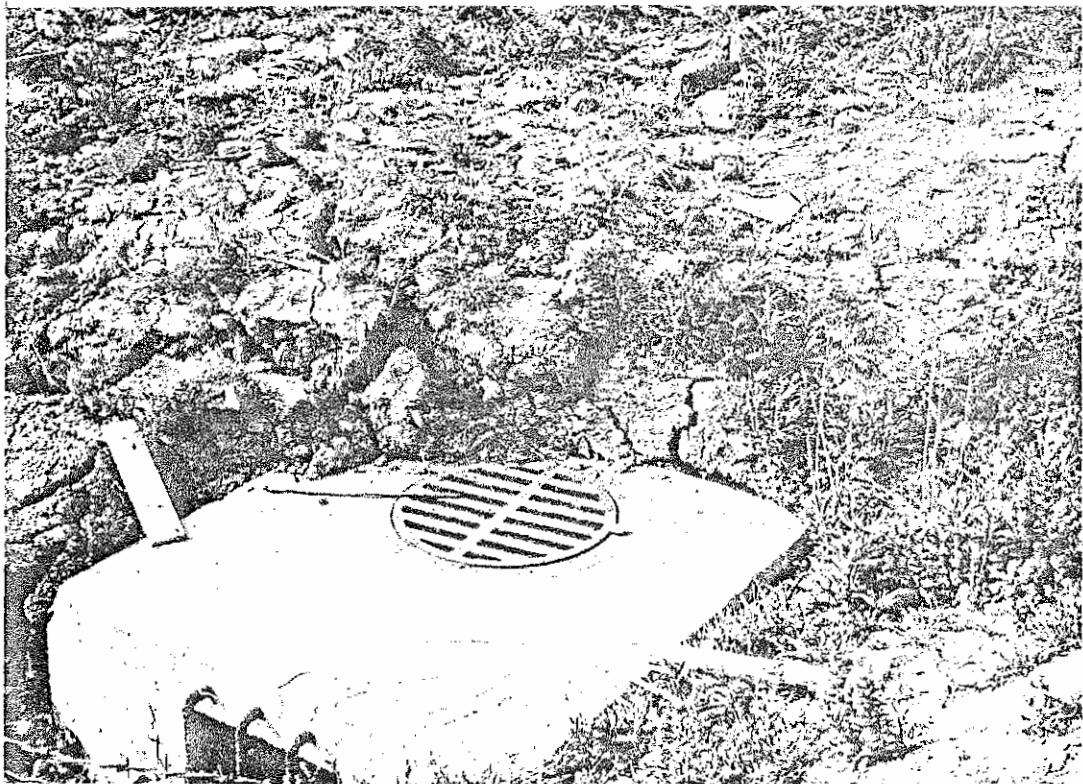


Fig. 42. Soil Flow Over Junction Box, May 10, 1963.

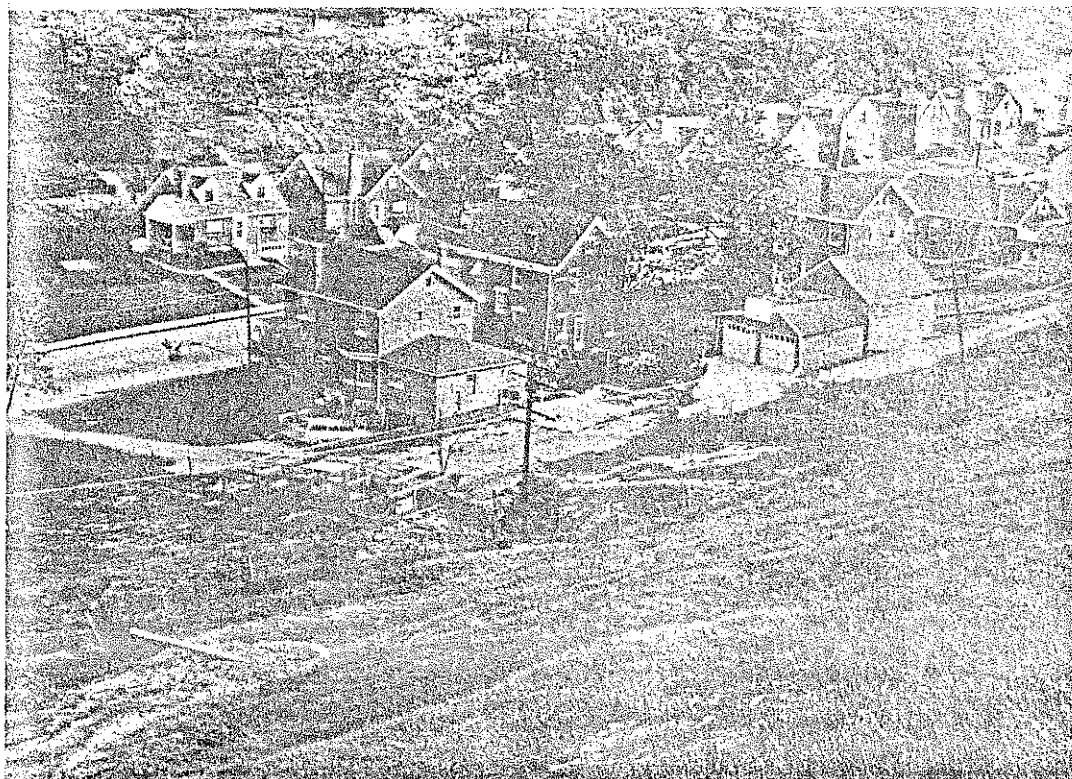


Fig. 43. Houses at Foot of Slope Below Landslide Area, May 10, 1963 (Looking Southeast).

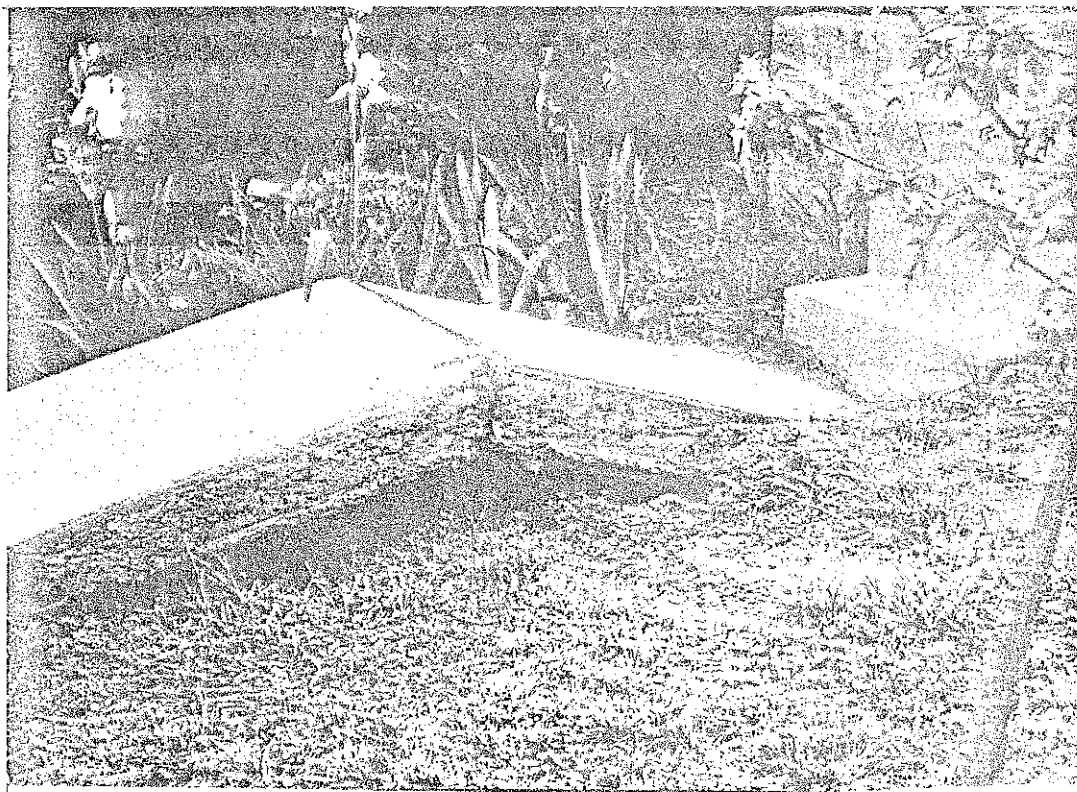


Fig. 44. Buckled Sidewalk, Near Residence at Foot of Slope, May 10, 1963.

