STATE HIGHWAY COMMISSION OF KANSAS

November 1949

MEMORANDUM TO: Mr. Robert Willis
Engineer of Design

FROM: S. E. Horner, Chief Geologist
By John D. McNeal, Regional Geologist
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SUBJECT: Geological Report
Project 24-75 F 605 (1)
Pottawatomie County

INTRODUCTION

This report presents geological information obtained by the Kansas State Highway Commission through field study and is submitted for use in the design and construction of the above project with reference to the formations that occur and the engineering problems affected by the geology of the project.

The report is divided into four sections for the purpose of grouping the information and discussions of the different phases. This report is intended to be complete within itself but is best used in connection with the Geo-Engineering Survey.

RESUME OF SECTIONS

Section I. Geological description and formational sequence.

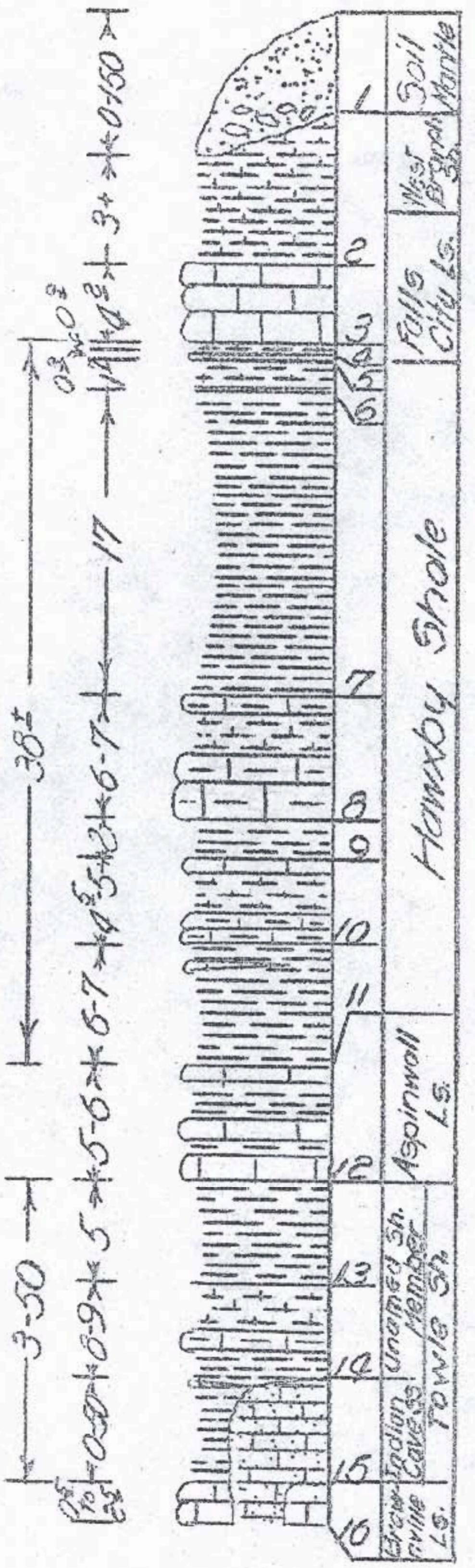
Section II. Geological Engineering aspects of the project.

Section III. Sub-surface Hydrology of the project.

Section IV. Special situations.

SECTION I

Geological Description



Geological description and formational sequence.

Soil Mantle

1. (a) Alluvium.

   (b) Glacial Outwash, clay, silt fine to coarse sand.

   (c) Glacial Till, gravel and erratic boulders.

West Branch Shale

2. Shale, limy, green.

Falls City Limestone

3. Limestone, largely composed of fossils, soft, brecciated tecture, light brown, weathers in large massive blocks of approximately 1 cu. yd.

Hawxby Shale

4. Shale, clayey and calcareous.

5. Limestone, fairly hard.

6. Shale, limy buff.

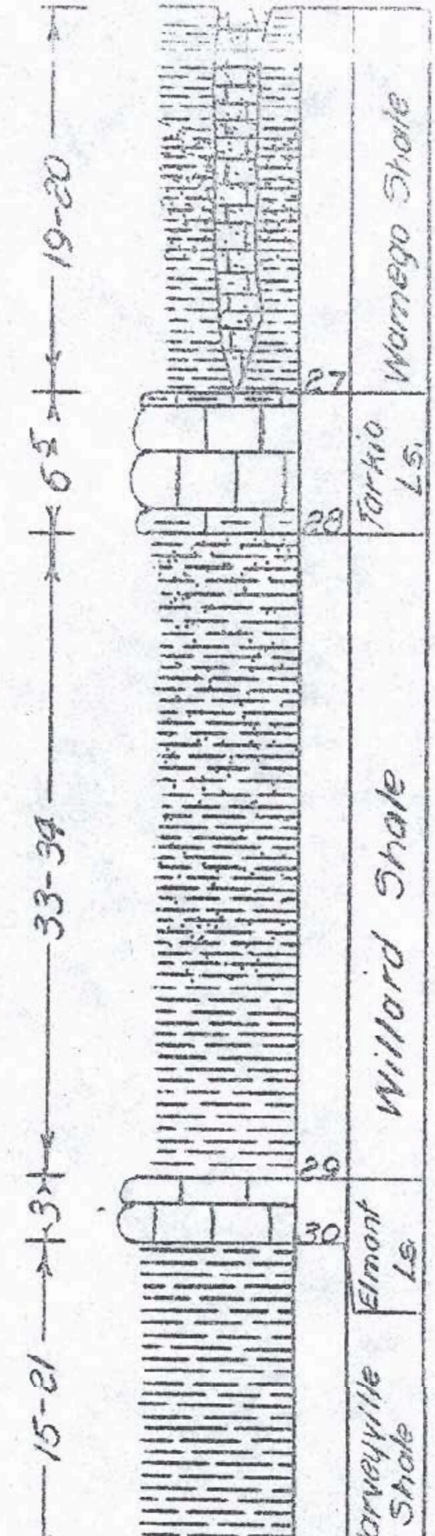
7. Shale, clayey, dark gray to gray-green, soft in upper part, lower part firm. Black fissile, carbonaceous, 0.2 ft. shale at top.

8. Limestone, shaly, and limy shale, firm to hard, gray to dark gray.

9. Shale, clayey, firm in upper part, soft in lower part, dark gray.

10. Limestone and limy shale. Upper limestone hard, gray. Lower limestone shaly, firm. Shale limy with thin clayey zone at base, dark gray.

11. Shale, clayey, thin limy zone near top with thin lenticular limestone locally present. Firm, gray.



Dover Limestone

22. Limestone, single bed or with one to two thin shale partings, hard, gray weathers to brown, weathers in large blocks, fossiliferous.

23. Shale, hard and limy to soft and clayey, dark blue-green.

24. Limestone, upper part hard, lower part sh... generally weathers in shelly chips, fossiliferous.

Langdon Shale

25. Shale, upper half sandy, lower half silty. Contains pebble-to-boulder-sized calcareous and pyritic concretions. Concretionary line generally formed near middle of formation.

Maple Hill Limestone

26. Limestone, blocky, one to two partings, fine-grained, brittle, hard, closely jointed. Blue-gray, weathers brown with concave surface on vertical joints. Fossiliferous.

Wamego Shale

27. Shale, dark clayey zone near top overlying sandy shale which is locally a poorly cemented cross-bedded sandstone. Lower part silty to clayey shale. Heavily iron-stained with abundant limonite chips.

Tarkio Limestone

28. Limestone, massive, wide-spaced joints, weathers in blocks 1 to $1\frac{1}{2}$ cu. yds. Hard, gray, weathers reddish-brown, top and bottom 1.0 ft. shaly and closely jointed.

Willard Shale

29. Shale, sandy and thin sandstones, dark gray to tan, lower part a gray-green, tight, clayey shale.

Elmont Limestone

30. Limestone, in two blocky beds, fine-grained, brittle, hard, blue-gray, weathers in large 1.5 ft.-thick blocks, fossiliferous. Thickness varies over short distances.

Harveyville Shale

31. Shale, clayey, soft, blocky, gray-green. Thins to west.

Reading Limestone

32. Limestone, four limestone beds 0.6 ft. thick separated by wavy partings. Fine-grained, hard. Upper bed soft and weathers platy.

SECTION II

Geo-Engineering Aspects

Soil Mantle (0'-150')

Thick deposits of glacial outwash sand and reworked till, in general, cover the entire area with the exception of the alluvial terrace at each end of the project.

From the west end of the project to station 315 + 00 the mantle in general, consists of fine, loose sand and sandy silt. Backslopes in this material should be a minimum of 3:1 and wash checks will be needed on moderately low gradients.

From station 315 + 00 to 323 + 00 clay and a coarse chert gravel will be encountered below the silt.

From station 339 + 00 east, the sand will generally contain a small amount of clay serving as a binder which should generally add to the stability of the backslopes. Erosion control should, nevertheless, be carried out.

Vegetative covering should be planted in the backslopes as soon as practical after cuts are made to insure a minimum loss from both wind erosion and sheet-wash. Since these glacial sands gulley badly a vegetative cover is the best means of keeping the run-off in a sheet-wash form.

All glacial material will generally be common excavation: however, a few erratics of one-half cu. yd. or larger may be encountered at the following locations:

Station 316 + 00 to 323 + 00

Station 388 + 00

Station 475 + 00 to 482 + 00

Station 491 + 00 to 496 + 00

Station 500 + 00 to 504 + 00

From the beginning of the project to station 312 + 00 silting and choking of stream channels and ditches with sand will be one of the problems encountered after the cuts and fills are completed. Bridges and culverts should be so designed as to leave the present drainage system as much undisturbed as possible. The gradients of these streams are as stable now as they ever will be and it is not advisable to disturb this balance any more than is absolutely necessary. This problem is encountered at special situation number 1 and 5.

<u>West Branch Shale</u> (3 +')

Shale, green, calcareous. Not more than 3 feet of this shale will be encountered on this project (station 315 + 70 to 317 + 70). This shale will be common excavation.

<u>Falls City Limestone</u> (4.2')

Limestone, single bed, pitted and solution channeled, soft, weathers in massive blocks of approximately 1 cu. yd. The Falls City Limestone will be encountered from station 315 + 45 to 319 + 35. It will be rock excavation. Backslopes of ¼:1 will be adequate.

<u>Hawxby Shale</u> (38')

Shale and hard shaly limestones. Only the top portion of this formation will be encountered. The uppermost portion consists of 2.9 feet of limy buff shale overlying 0.2 foot black carbonaceous shale. Below the carbonaceous shale is 17 feet of dark clayey shale which is soft in the upper part. The Hawxby shale will be encountered in the ditches from station 315 + 20 to 319 + 60, and will be classified as rock excavation. Backslope in the Hawxby should be no steeper than 1:1.

Aspinwall Limestone (5'-6')

Three one foot limestones with intervening shales. This unit will not be encountered in excavation.

Towle Shale (3'-14')

Unnamed Shale Member (3'-14')

Upper portion clayey shale, lower half limy shales with lenticular shaly limestones. This member will not be encountered.

Indian Cave Sandstone Member (0'-50')

Hard, micaceous, iron stained, cross-bedded sandstone. The Indian Cave sandstone will be encountered in excavation from station 502 + 00 to 504 + 50 and from about station 510 + 00 to 512 + 50. This sandstone is case hardened at the surface but relatively soft with depth containing a few hard, tightly cemented zones. While of varying hardness, it will generally be common excavation. From the present road the Indian Cave may be seen standing in a smooth, well rounded backslope at station 512 + 00 to station 512 + 30. This sandstone will make good ditches and backslopes. Backslopes of about $\frac{1}{2}$:1 should be stable.

The Brownville Limestone, Pony Creek Shale, Caneyville Limestone, French Creek Shale, and Jim Creek Limestone will not be encountered.

Dry-Friedrich Shale (28'-38')

Firm, green, limy shale. The lower 2.0 feet is generally clayey, very slick and unstable. The Dry-Friedrich will probably not be encountered in excavation. If encountered it will be common excavation.

Dover Limestone (8'-10')

Two limestones separated by 2 to 3 feet of hard and limy, to soft and clayey shale. The top limestone is from 1.5 to 4 feet thick weathering in large blocks. The lower limestone is from 2 - 3 feet thick weathering from small blocks to shelly chips.

The upper limestone of the Dover is exposed in the stream bottom at station 384 + 80, 30 feet left, and both limestones are exposed at station 456 + 00 to 457 + 00.

The lower limestone will be encountered in excavation at station 463 + 00 to 464 + 22 and a small erosional remnant of the lower limestone will be encountered at station 475 + 12.

Backslopes of $\frac{1}{2}$:1 are recommended.

Langdon Shale (19'-20')

Sandy to silty shale with calcareous and pyritic concretions. The Langdon shale will be encountered in excavation from station 462 + 40 to station 465 + 00 and will be in ditch line from station 475 + 00 to station 476 + 40 (approximately). This shale will be common excavation down to about 5 feet. Backslopes of about $1\frac{1}{2}$:1 should be stable.

Maple Hill Limestone (1.7'-2')

A blue-gray, close jointed limestone with two to three wavy partings; weathers blocky. A good exposure may be seen on the present road at station 470 + 42. The Maple Hill limestone will not be encountered in excavation or ditches.

Wamego Shale (19'-20')

Five feet of dark clayey shale at top locally overlying 7' of poorly cemented sandstone and 7' of dark gray-green silty and clayey shale. The Wamego shale is exposed on center line at station 466 + 30 and 469 +00 to 470 + 30. The Wamego shale will not be encountered in excavation.

Tarkio Limestone (6.5')

Top and bottom 1 foot shaly and close jointed; middle part massive with widely spaced joints. The Tarkio is generally deeply buried throughout the project, and will not be encountered in excavation.

The middle portion of the Tarkio is suitable for wash check material. A new quarry has been opened in the NE$\frac{1}{4}$, NW$\frac{1}{4}$, Sec. 18, T 10 S, R. 10 E. This quarry is about 1 3/4 miles south of the project. Good outcrops of the Tarkio also occur in the north $\frac{1}{2}$ of sections 13 and 14, T 10 S, R 9 E along the top of the hill north of the present U.S. 24.

Elmont Limestone (3')

This limestone which will not be encountered in excavation could serve satisfactorily as wash check material. A possible location for quarrying occurs along the north side of the present U.S. 24 in the north $\frac{1}{2}$ of sections 14 and 15, T 10 S, R 9 E. This is a narrow outcrop and the quantity will be greatly limited by an overburden of Langdon Shale.

Wash Check Materials

The erodibility of the mantle will make ditch checks necessary on most grades on this project and a considerable quantity of ditch check material will be required. If Type I-A stone wash checks are desired little suitable stone will be found in the immediate vicinity of the project. However, the Dover limestone in the vicinity of Sta. 472 might furnish some such material. Other sources could be developed at short to moderate distances from center line.

In the area 1 to 2 miles north-west of the beginning of the project several outcrops of the Neva limestone occur. One location is in the SW$\frac{1}{4}$, NW$\frac{1}{4}$, Sec. 5, T 10 S, R 9 E. Within a mile or two further to the northwest are many more outcrops of the Neva and Cottonwood limestones which could serve as sources of wash check materials. It may be desirable to use one of these locations for wash checks on the west end of the project and another location in the Tarkio or Elmont limestone for wash checks on the east end of the project. (See description of these limestones given above).

SECTION III

Hydrology

Most of the subsurface hydrology problems on this project will be in connection with the foundations of heavy fills. There are relatively few locations where softening of the subgrade immediately under the wearing surface is a danger. Some seeps will be encountered in the backslopes and may contribute to instability.

Most of the length of the project west of about Sta. 455 + 00, overlies a rather continuous body of underground water which has accumulated in the very pervious glacial sediments overlying the nearly impermeable bedrock surface. The upper surface of this water is a considerable depth below the present ground surface and below any anticipated grade line. However, erosion of the glacial sediments has cut deep gulleys which intersect the water table. Strong seeps and springs are found in these gulleys under the location of proposed highfills. Thus such fills, in addition to having a foundation on saturated sands (sometimes quicksand), may be subject to piping at the downstream toe of the fill if existing springs break out from under the fill. (See Special Situations No. 1 and 2). Many of these springs which will be covered by fills serve as a source of stock water in the pastures crossed by center line. In at least one location the fill may choke off springs which are at present the only water supply for a rather large pasture (See Special Situation No. 8).

At some locations, (sta. 315 + 00, for example) preglacial bedrock hills lie beneathe the heavy mantle but rise above the water table. At such locations water percolating down in sand is deflected downward along the bedrock surface to the water table and such contacts may be strong aquifers. At most locations, however, the ditches will serve as longitudinal drains to intercept this water before it can affect the road structure. here the road overlies such contacts at depths of from 4 to 6 feet (so that the ditches do not intercept the water and danger from capillary water exists) additional subdrainage may be required.

Soil Mantle

Higher in the glacial sediments several small perched water zones were encountered. Only a trace of free water exists in most of these. (See Special Situations No. 3, 4 and 6.) It is possible that more of these perched water tables exist, but were not detected because of their nature and small areal extent. These seeps occur at contacts of lensing beds which differ only slightly in permeability. Thus a clayey fine sand lense underlying a clayey coarse sand horizon may be itself quite permeable but enough less permeable than the material above to deflect or hold downward percolating water. It would seem advisable to inspect the cuts in glacial sands and clays immediately after they have been made for this type of seepage. The best time for such an inspection would be when evaporation is at its lowest, such as on a cloudy day or in the early morning before the sun is high enough to cause excess evaporation.

Bedrock Aquifers

Bedrock aquifers are of minor importance throughout the project as compared to ground water conditions described above. The Falls City limestone which will be encountered from about station 315 + 00 to 319 + 50 is a strong source of seepage and may, depending upon the position of the final grade line, warrant a simple lateral drain on both sides of the Preglacial hill. This is the only location where sub-drainage of bedrock may be needed.

SECTION IV

Special Situations

1. Station 57 + 00 to 59 + 00 (See Plates I, II and III)

A serious seepage problem exists at this location. A tight clay shale underlying glacial sands and silts is the cause of the seepage.

Actually there are three problems present.

1. Silting in the channel which crosses center line between Sta. 57 + 00 and 58 + 00.

2. A foundation problem under the fill resulting from the quicksand and muck in the seepage area shown on Plates I & II. The muck is from two to four feet thick and is underlain by the quicksand. This can be seen from the sections of Plate III.

3. Unless the grade line is kept high over this area, a subgrade problem will result, the seepage issuing from well up on the east bank at about Sta. 59 + 00. If possible, the center line elevation should be kept above groundline from Sta. 59 + 00 to 60 + 00.

All three of these problems would be eliminated or very greatly reduced if center line were moved about 170 feet to the north. If such a relocation cannot be made, two other possibilities exist.

1. Nearly complete interception of the seepage could be accomplished. However, this will require a drain approximately 300 feet long with an average depth of as much as ten feet and a maximum depth of as much as thirteen feet. A special outlet would be required inasmuch as this drain would be in part a vertical subdrain. If feasible, all muck should be removed from the seepage area before constructing the fill.

2. The other possibility is to remove all muck from the base of the fill and construct all of the base of the fill of coarse granular material to a