SECTION III

Geo-Engineering Aspects

General - The alignment of this project follows the centerline of an existing county road between Stations 42/00 and 83/00, where it starts a curve to the south of east which stops at about Station 93/00, then is on tangent to about Station 275/00 where it curves north to about Station 286/00, then it parallels a township road with the centerline about 50 feet south of an existing road to the end of the project. It parallels K-16 from Station 312/75 to the end of the project. The county road on the west of the project has cuts that expose the Towanda limestone, Holmesville shale and the upper part of the Fort Riley limestone.

Cut Section from Station 53/00 to Station 58/60
Backslopes

A cut on the right of the existing road exposes the weathered base of the Towanda limestone, the Holmesville shale and the uppermost Fort Riley limestone. The lower Holmesville shale and the upper Fort Riley limestone are exposed in the left backslope.

The mantle of silty clay and limestone fragments should have a backslope of 2½:1 or flatter.

The Towanda limestone on the right has weathered to form numerous vertical and horizontal joints, therefore, a backslope of 1:1 is suggested. The upper Holmesville shale is weathered and should be placed on a slope of 2:1 to prevent undercutting of the Towanda limestone. The limestone-siltstone zone of the Holmesville shale will be satisfactory with a slope of 1:1. The lower shale of this unit where weathered should be 2:1 and unweathered will be satisfactory on a 1:1 slope.

Only the upper part of the Fort Riley limestone will be cut. Backslopes of 1:1 are recommended for the weathered part. Slopes of ½:1 will be satisfactory on the unweathered part.

Excavation

The Towanda limestone in this location will be rock excavation.

The Holmesville shale above the siltstone is badly weathered and will be common excavation. The siltstone and thin limestones above and below will be rock excavation except where weathered. The shale below the siltstone will be common excavation. The lower 2 to 3 feet of the Holmesville shale is very limy and will be rock excavation, except near its outcrop where it has weathered to common.

The unweathered upper part of the Fort Riley limestone will be rock excavation. Weathering to a depth of two to three feet can be expected where there is no Holmesville shale overlying the Fort Riley limestone.

Cut Section from Station 61/50 to Station 66/00
Backslopes

From two to four feet of the Towanda limestone and upper part of the Holmesville shale are exposed in the right backslope of the existing road. The slope of the land drops rapidly to the left and only mantle is exposed.

The mantle is very thin and should have a slope of $2\frac{1}{2}$:1 or flatter.

The Towanda limestone is highly jointed and should be on a slope of 1:1 to prevent fallout.

The upper Holmesville shale is weathered and has undercut the Towanda limestone. A slope of 2:1 is advisable to prevent undercutting. Should the siltstone-limestone zone be cut, a backslope of 1:1 would be satisfactory.

Excavation

The Towanda limestone will be rock excavation.

The upper part of the Holmesville shale is weathered and will be common excavation. The limestone-siltstone zone will be rock where covered by overlying shale but will be weathered to common to a depth of about two feet if no cover is present, such as at the ends of the cut. About three feet of the shale under the limestone-siltstone, if cut, will be common excavation. The remaining lower portion of the Holmesville shale and the Fort Riley limestone, if encountered, would be rock excavation.

Cut Section from Station 69/00 to Station 82/00
Backslopes

Cutting through this hill will encounter a silty clay mantle, weathered Cage

shale, Towanda limestone and possibly the upper Holmesville shale. The mantle of reddish brown silty clay varies in thickness from less than one foot to ten feet. A backslope of 2½:1 or flatter is recommended to prevent surface wash and slumping.

The upper part of the Towanda limestone is shaly and would be satisfactory on a slope of ½:1. The lower six to eight feet is thicker bedded and would be satisfactory with a slope of ¼:1.

Cutting into the upper part of the Holmesville shale is anticipated and because of its weathered condition, should have a backslope of 2:1 to protect against undercutting.

Excavation

The Towanda limestone will be rock excavation.

The Holmesville shale cut in the hill will all be common excavation, providing the grade line stays above the limestone-siltstone zone of this unit.

Hydrology

A test hole 10 feet left of Station 78/00 penetrated the Towanda limestone and into the upper Holmesville shale. Free water was encountered at a -12 feet (1237.1) and after standing, the water level was -16 feet (1233.1). The water apparently is moving from right to left with the slope of the topography through joints in the Towanda limestone. The only evidence of water movement other than this hole, is the clayey nature of the limestone near the surface. If the grade line approaches an elevation of 1230 feet near Station 78/00, subdrains should be considered.

Cut Section from Station 85/00 to Station 100/00
Backslopes

The Towanda limestone, Holmesville shale and the Fort Riley limestone will be cut in this hill. The mantle on the crest of the hill is thin and thickens to about 5 feet at Station 95/00. The mantle consists of silty clay and should be satisfactory on a 2½:1 slope.

The Towanda limestone from Station 88/50 to Station 91/25 will be thin bedded and should have a backslope of ½:1 or flatter while the lower six feet of the unit will be satisfactory with a slope of ¼:1, because this zone is composed of thicker beds.

The Holmesville shale immediately under the Tuscumbia limestone is highly weathered and to prevent undercutting should be placed on a slope of 2:1. The siltstone zone of the Holmesville shale will be resistant and a slope of 1:1 should be satisfactory. The shale below the siltstone is less resistant to weathering and a backslope of 2:1 is recommended. The lower three feet of the Holmesville shale is limy and should be satisfactory on a slope of 1:1.

The upper part of the Fort Riley limestone is shaly and will require a backslope of ½:1 to 1:1. The "rimrock" zone may be as much as eight feet thick and will stand on a vertical slope. Overbreakage may be a problem at this location. The natural joints form blocks four to five feet square and may range in thickness from eight-tenths to three feet. The limy shale below the "rimrock" should have a slope of ½:1 to prevent undercutting.

The Chase shale in this location, is fairly fresh and should be satisfactory on a ½:1 slope.

Excavation

The Tuscumbia limestone, where unweathered, will be rock excavation. A few tenths of a foot of clay formed by weathering may be found on top of the unweathered material.

The upper 12 to 13 feet of Holmesville shale will be common excavation. The siltstone zone will be rock excavation while the green weathered shale below will be common excavation. The lower three to four feet of this unit will be rock excavation except where weathered near its outcrop.

The Fort Riley limestone will be rock excavation except for the thin weathered zone in the vicinity of Station 99/00.

The Chase shale will be rock excavation, if cut by the grade line, except for the weathered zone of about two feet where exposed below Station 103/00.

Hydrology

A test hole drilled 24 feet left of Station 50/00 encountered free water at -7 feet when drilled. After standing five hours, the water level rose to -6½ feet. This hole was later deepened and its water level after standing about [illegible] hours was -5 feet, which falls in the Holmesville shale below the silt-

stone zone. The water conditions of this cut should be observed when opened and the decision upon the necessity of an underdrain be made at that time. The higher water levels are probably a result of heavy rainfall and probably will be handled by ditch construction.

Cut Section from Station 107/75 to Station 141/75
Backslopes

The Towanda limestone, Holmesville shale, Fort Riley limestone, Oketo shale, Florence limestone and Blue Springs shale will be cut through this section. The mantle is mostly silty clay and averages about two feet thick. Where encountered, backslopes of 2½:1 are recommended.

The Towanda limestone will be cut from Station 116/50 to about Station 123/00. The lower six to eight feet will be satisfactory with slopes of ¼:1 while the upper part should be no steeper than ½:1. A maximum thickness of four feet will be cut from Station 137/60 to Station 138/75 where the limestone has weathered into thin blocks. A slope of 1:1 is recommended for this location.

The Holmesville shale cut from Station 114/00 to Station 125/25 will be classified as before; that is, the upper 12 to 13 feet of weathered shale should be placed on a slope of 2:1, the siltstone zone on 1:1, the shale below on 2:1 and the limy shale at the base on a slope of 1:1. The Holmesville shale cut from Station 135/75 to 139/75 will find the upper shale thickened to 18 to 19 feet and weathered so a slope of 2:1 is suggested. The siltstone zone and underlying unweathered shale will be satisfactory on a slope of 1:1.

The Fort Riley limestone should be placed on three different angles of slope. That part above the "rimrock", if fresh, will stand on slopes of ½:1. This zone is weathered near its outcrop so should be on a slope of 1:1. The "rimrock" zone will stand vertically but overbreakage should be anticipated. This zone ranges from two to seven feet on weathered surfaces but in fresh cuts probably averages about seven feet. The zone below the "rimrock" weathers shaly so should be placed on a slope of ½:1 to prevent undercutting of the "rimrock".

The Oketo shale is weathered to a depth of two feet in the vicinity of Station 132/00 to Station 133/00 and near Station 141/00. These weathered areas

should have backslopes of 1:1 and where unweathered, ½:1 should be satisfactory.

The Florence limestone will be unweathered where cut between Station 130/00 and Station 142/00 and an overall slope of ¼:1 is recommended.

The Blue Springs shale may possibly be cut in the vicinity of Station 142/00. A slope of 1:1 is recommended for this unit.

The cut section from Station 133/00 to Station 142/00 may be as much as 80 or 90 feet. Berm construction to act as catchment areas should be considered in this location if steeper slopes than those that are suggested are used.

Excavation

The Towanda limestone from Station 116/50 to Station 122/80 will be rock excavation. A maximum thickness of about 14 feet is expected in the vicinity of Station 120/00. Only four feet of this formation remains capping the hill from Station 137/50 to Station 138/75.

The Holmesville shale from Station 116/50 to Station 125/00 will be classed as follows: The upper 12 to 14 feet and weathered zones of the siltstone will be common excavation, the siltstone zone of two and one-half to three feet will be rock excavation, about three feet of shale below the siltstone will be common excavation and the lower one and one-half to two feet will be rock excavation, except near its outcrop where it has weathered to common excavation. From Station 136/50 to Station 139/50 the shale in the upper Holmesville shale is about 18 feet thick and will all be common excavation. The siltstone zone is about two feet thick and will be rock except for the very outer part of the zone that has weathered to common excavation. The shale below the siltstone that will be common excavation is about two and one-half feet thick and the lower portion of this unit will be rock excavation.

The Fort Riley limestone will be rock excavation except where it is not overlain by the Holmesville shale where weathering to a depth of three to four feet has formed a tan clay that will be common excavation. Overbreakage should be anticipated in the Fort Riley limestone because of the large blocks of the "rimrock" formed by jointing.

The Oketo shale is exposed only between Station 131/80 and Station 133/20 and on the east face of the large hill near Station 141/00 where weathering has progressed to a depth of one to two feet and excavation will be common. All other Oketo shale cut will be rock excavation.

The Florence limestone will all be rock excavation. The face of the hill from Station 141/00 to 141/75 will be covered with one to two feet of mantle consisting of clay and limestone-chert fragments.

Any Blue Springs shale cut will be rock excavation except on the face of the hill where it has weathered to a depth of 7 to 8 feet.

Hydrology

The only free water found in this cut section during the field investigation appeared to be coming from the joints of the Towanda limestone and in the siltstone zone of the Holmesville shale. Should the grade line cut the base of the Towanda limestone or the limestone-siltstone zone of the Holmesville shale, subdrains should be considered.

Cut Sections from Station 194/50 to Station 226/50

The Fort Riley limestone, Oketo shale, Florence limestone, Blue Springs shale, Kinney limestone, Wymore shale and Schroyer limestone will be encountered through this location. The mantle overlying these bedrock units is very thin and consists of silty clay with limestone and chert fragments with one exception. This exception is between Station 206/00 and 209/00 where a wind-blown silty clay that varies from 3.0 feet to 9.0 feet overlies the Florence limestone.

Backslopes

A slope of 2½:1 or flatter is suggested for the mantle.

The lower portion of the Fort Riley limestone will be encountered between Station 219/80 and Station 225/00. The small amount of shaly limestone that overlies the "rimrock" of the Fort Riley should be placed on a 1:1 or flatter slope. The "rimrock" is vertically jointed and will tend to be excavated in large blocks leaving a vertical slope. It has slumped down over the lower shaly limestone zone of this member along its outcropping edge. It has also settled down in place between Station 222/00 and 225/00. Some overbreakage can be expected from this

zone and care should be taken to remove any loose blocks from the backslope. A 1:1 slope is suggested for the shaly limestone that underlies the "rimrock".

The Oketo shale is a very limy resistant member. A slope of 1:1 or flatter for common excavation and ½:1 or flatter for rock excavation will stand satisfactorily.

An overall slope of ¼:1 will stand satisfactorily for the cherty Florence limestone member.

A slope of 1:1 or flatter for rock excavation and 1½:1 or flatter for common excavation is suggested for the Blue Springs shale. These slopes will protect against spalling and undercutting of the overlying Florence limestone.

A slope of ¼:1 is suggested for the limestone zones in the Kinney member. The shale zone should be placed on a 1:1 or flatter for rock excavation and 1½:1 or flatter for common excavation.

A slope of 1:1 or flatter for rock excavation and 1½:1 or flatter for common excavation is suggested for the Wymore shale.

The upper limestone zone of the Schroyer limestone will tend to stand on a vertical slope. The underlying shale zone, No. 51 in the generalized section, should be placed on a slope of 1:1 or flatter for rock excavation and 1½:1 or flatter for common excavation to protect against undercutting. The remaining zones of the Schroyer limestone will stand satisfactorily on a ¼:1 slope.

Excavation

The lower portion of the Fort Riley limestone is rock excavation except for the shaly limestone that overlies the "rimrock". This zone has weathered to common excavation to a depth of approximately one foot.

The Oketo shale is rock excavation except where it is weathered. It has weathered to a depth of approximately one foot along its outer edges.

The Florence limestone is rock excavation.

The Blue Springs shale is rock excavation except where it is weathered. Its depth of weathering varies from 8.0 to 10.0 feet.

The limestone zones of the Kinney limestone member are rock excavation. The shale zone is rock excavation where it is not weathered. Its weathering depth will average 2 feet.

the Wymore shale is rock excavation where it is not weathered. The weathering depth will average 7 feet.

The Schroyer limestone member is rock excavation with the exception of its upper shale zone which has weathered to common excavation unless it is overlain by the complete upper limestone zone of the Schroyer and 1 foot of the Wymore shale.

Hydrology

There are four zones through this location that are known ground water carriers, throughout the State. They are the base of the Florence limestone, a maroon limestone zone in the Blue Springs shale and the upper and lower limestone zones of the Kinney limestone member. There were no positive indications that any of these zones were carrying ground water at this particular location; however, it is possible that one or all of these zones are carrying ground water back in the hill where they will be cut by the grade line. It is suggested that they be checked after excavation to determine if subdrainage would be desirable.

Seep Location

At Station 216/73, 81 feet left, there is ground water seeping out of the limestone fragments along the mantle-bedrock contact in a gully. It is thought that this water movement originates from the base of the Florence limestone.

Cut Section From Station 226/90 to Station 241/00

The Towanda limestone, Holmesville shale, Fort Riley limestone, Oketo shale and possibly a small amount of Florence Limestone will be encountered in this cut. The bedrock is overlain by a very thin mantle covering.

Backslopes

A slope of $2\frac{1}{2}$:1 or flatter is suggested for the mantle.

The Towanda limestone caps the hill and has a well-developed joint pattern. A slope of $\frac{1}{4}$:1 or flatter is suggested for this limestone.

The complete Holmesville shale has weathered to common excavation here. It has quite a lot of ground water moving through it. A slope of 2:1 is suggested for the Holmesville shale.

A slope of $\frac{1}{2}$:1 for rock excavation and 1:1 or flatter for common excavation

is suggested for the shaly limestone zones of the Fort Riley limestone member. The "rimrock" contains vertical joints and will tend to stand on a vertical slope. Some overbreakage can be expected in the "rimrock".

A slope of $\frac{1}{2}$:1 is suggested for the Oketo shale member.

A slope of $\frac{1}{4}$:1 is suggested for the Florence limestone.

Excavation

The Towanda limestone is rock excavation except where it is badly weathered. There are a few locations over the top of this hill where excessive weathering has taken place. The depth of weathering varies from a few tenths of a foot to an extreme of nearly 3 feet at Station 238/00.

The entire Holmesville shale has weathered to common excavation in this hill. This excessive weathering is caused by ground water movement.

The Fort Riley limestone is rock excavation except where badly weathered. The upper shaly limestone zone of this member has weathered to common excavation to a depth of from 3 to 4 feet along its outer edges.

The limy Oketo shale is rock excavation except where weathered. It has weathered to a depth of approximately 1 foot along its outer edges.

The Florence limestone is rock excavation.

Hydrology

The Towanda limestone has a small amount of ground water moving along its base. This water will probably be cut off by the ditches.

The lower portion of the Holmesville shale, units No. 8, 9, 10, 11 and 12, are weathered and have a fairly high moisture content. There are several water-carrying zones within these units. If the proposed grade line cuts across this portion of the Holmesville, it is probable that subdrainage will be desirable.

Ground water was found moving through and along the top of the Fort Riley limestone in this cut section. It is probable that subdrainage will be desirable for this limestone member depending upon the final grade.

Spring Location

At Station 229/30, 382 feet right, there is a seasonal spring location. The ground water is moving out from the base of the Towanda limestone. A large

share of this ground water moves down the gully through the mantle and comes out at Station 228/50, 195 feet right, in a seep area.

Seep Location

At Station 231/90, 73 feet left, there is seepage in a gully. This seepage carries on down the gully to the left. There is water standing in pot holes down this gully from which cattle drink. The ground water is coming out of the center portion of the Holmesville shale.

Cut Section from Station 245/00 to Station 277/00
Backslopes

The mantle in this cut will vary from a featheredge to about five feet thick and is largely clay. Backslopes of 2½:1 are recommended.

The Towanda limestone ranges in thickness from 4 to 18 feet in this area. The upper 10 to 12 feet is shaly and thin bedded so should have backslopes of ½:1. The lower 4 to 6 feet will be satisfactory with slopes of ¼:1.

The Holmesville shale that is likely to be cut in this area is weathered shale and a backslope of 2:1 is recommended. The lower Holmesville shale may be cut from Station 272/00 to Station 275/00 where it has weathered and backslopes of 2:1 are recommended.

Excavation

The Towanda limestone will be rock excavation below the weathered contact.

The Holmesville shale has weathered and will be common excavation.

Hydrology

Seepage 150 feet right of Station 245/00 from the Fort Riley limestone is supplying water to three small ponds. The area should be outside the construction limits with the present grade line.

A well equipped with a windmill 250 feet left of Station 269/00 has a top hole altitude about equal to the top of the Fort Riley limestone.

Special Situation - Spring Location
Spring 80 Feet Right of Station 280/57

The spring that is 80 feet right of Station 280/57 may be covered by fill across the stream valley. This spring is the main source of water in this pasture

spring supplies a small pond (See Figure I) formed by damming at the fence line. The water issues from a joint in the Florence limestone and apparently moves from the southwest as indicated by water levels in test holes in the vicinity. The landowner is very much concerned and has expressed a desire that this spring be saved.

Cut Section from Station 283/00 to Station 291/00
Backslopes

Backslopes on the mantle and weathered Fort Riley limestone should be no steeper than 2½:1.

The lower five feet of the "rimrock" will stand vertically but the limestone above the "rimrock" should have slopes of ½:1. The weathered "rimrock" is only about two feet thick, but in fresh cuts will average about five feet. The Fort Riley limestone below the "rimrock" is shaly and should have a slope of ½:1 to prevent undercutting.

Excavation

The Fort Riley limestone, except where weathered, will be rock excavation. Overbreakage in the "rimrock" should be anticipated. The blocks in this area are not as large as over the rest of the project.

Hydrology

Seepage from the lower Fort Riley limestone was noted during the investigation after a period of prolonged precipitation in the vicinity of 20 feet right of Station 283/80. The right ditch should intercept this seasonal ground water movement.

Cut Section from Station 294/00 to Station 324/00 (End of Project)
Backslopes

Mantle of glacial till will be the only material encountered in cutting in this vicinity. The nature of the material suggest backslopes of 2½:1 or flatter.

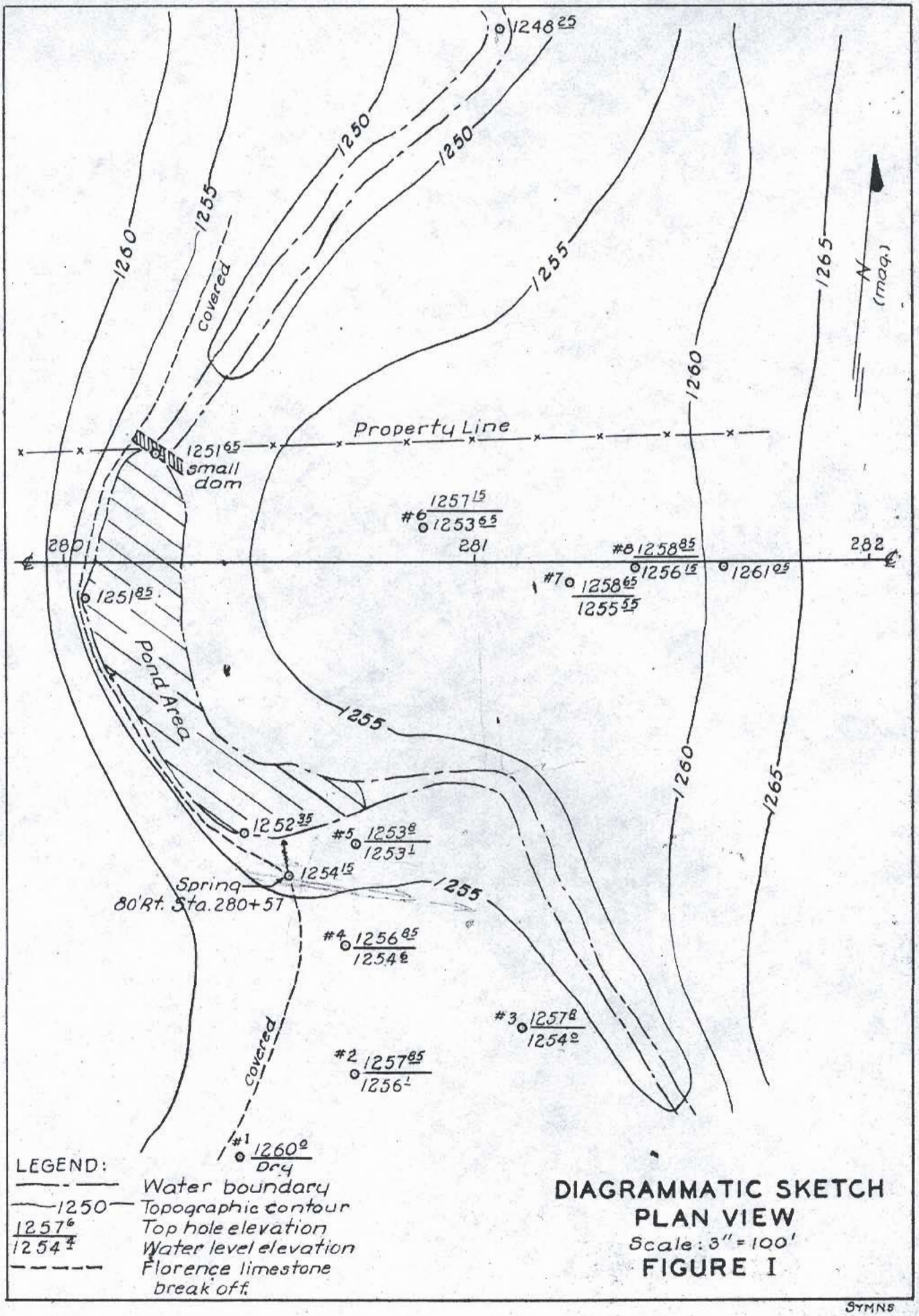
Excavation

All excavation will be common.

Hydrology

The only water encountered in this vicinity appears to be at the contact of the weathered Fort Riley limestone and overlying glacial till. The depth to water is great enough to not be of any consequence.

A well was noted about 400 feet right of Station 300/75 but measuring was impossible. Water is probably being produced from the contact zone of the glacial till with the weathered surface of the Fort Riley limestone in this well. Water [illegible] found occurring in sand and gravel lenses in the till in this area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1252 35
#5 1253 8
1253 1
1254 15
Spring
80' Rt. Sta. 280+57
1255
#4 1256 85
1254 2
#3 1257 8
1254 0
covered
#2 1257 85
1256 1
#1 1260 0
Dry
LEGEND:
Water boundary
1250 Topographic contour
1257 6 / 1254 4 Top hole elevation / Water level elevation
Florence limestone break off
DIAGRAMMATIC SKETCH
PLAN VIEW
Scale: 3" = 100'
FIGURE I
SYMNS