SECTION III.

Cut Section from Station 330/00 to Station 336/00
Backslopes

The Blue Rapids shale and Funston limestone will be encountered in the left backslope. These two formations are overlain by a reddish-brown clay type mantle.

Backslopes of 2½:1 or flatter are suggested for the mantle.

The limestones of the Funston formation will stand on a vertical slope satisfactorily. The shale zone in this formation will stand on a ½:1 or flatter slope when rock excavation and a 1:1 or flatter slope when common excavation. However, as all three units are thin, the recommended slope for the shale should govern for the entire Funston, i.e., ½:1 if the shale is rock excavation and 1:1 if the shale is common.

Backslopes of ½:1 or flatter for rock excavation and 1:1 or flatter for common excavation are suggested for the Blue Rapids shale.

Excavation

The limestones of the Funston limestone are rock excavation. The shale zone is common excavation where it is weathered. It is weathered at this location unless it is overlain by the upper Funston limestone and four feet of the Speiser shale formation.

The Blue Rapids shale is rock excavation where it is not weathered. It is weathered rather badly through this location, especially when it is not overlain by the Funston limestone formation. Its depth of weathering is approximately 12 feet when it is not overlain by the Funston limestone and gradually reduces to zero when overlain by the complete Funston limestone and four feet of the Speiser shale formation.

Hydrology

It appears that the Funston limestone is carrying some ground water through this location. This is indicated by the depth of weathering of the underlying shale and the moist to wet zones within the shale. At Stations 333/00 to 335/00, centerline, there is a zone in the shale at an elevation of 1270.0 to 1268.5 that is wet

and saturated. This wet zone was found to lie at an elevation of 1274.7 at 60 feet left of Station 335/00. This indicates that this source of ground water is from the base of the Funston limestone on to the left of centerline. This source of ground water will be cut by the rock cut and should not present a problem.

Cut Section From Station 339/50 to 348/50
Backslopes

The Three Mile limestone, Speiser shale and Funston limestone will be encountered through this side hill location. The overlying mantle is thin and consists of clay and chert fragments with the exception of Station 348/00 where the mantle is 7.2 feet thick where centerline drops down into a small floodplain.

The Three Mile limestone will be encountered in the top of the left backslope. A slope of $\frac{1}{4}$:1 is suggested for this limestone member.

The Speiser shale formation is weathered rather badly at this location due to ground water seepage. Backslopes of $1\frac{1}{2}$:1 or flatter for common excavation and 1:1 or flatter for rock excavation are suggested.

The limestones of the Funston limestone will stand on a vertical slope. Backslopes of $\frac{1}{2}$:1 or flatter for rock excavation and 1:1 or flatter for common excavation are suggested for the shale zone. See recommendation for Funston, Station 330/00 to Station 336/00.

Excavation

The Three Mile limestone member is rock excavation.

The Speiser shale formation is rock excavation where it is unweathered. This shale formation has weathered rather badly through this location due to ground water seepage. It is weathered to a depth of approximately 15 feet along centerline. To the left of centerline there is a unique situation of having common excavation under rock excavation due to seepage in the lower portion of this shale. For instance at Station 342/00, 30 feet left, the shale is rock excavation between an elevation of 1297.1 and 1291.0 and from 1285.8 on down to the top of the Funston limestone.

The limestones of the Funston limestone formation are rock excavation. The shale zone of this limestone formation has weathered to common excavation unless it is overlain by the upper Funston limestone and five feet of the Speiser shale formation.

Hydrology

There is ground water moving through [illegible] The amount of ground water seepage taking place at this time is very small. It is thought that the ground water originates from the base of the Three Mile limestone and moves down through the Speiser shale where it is weathered. The preliminary grade line falls in the lower portion of this shale formation, therefore it is thought that the left ditch will intercept any ground water movement that would endanger the subgrade of the proposed road. It is suggested that this location should be checked during construction with subdrainage in mind.

Station 354/20, 144 Feet Right
Hydrology

At station 354/20, 144 feet right is the location of a spring that is dried up at this time. The ground water originates at the base of the upper Funston limestone which is quite porous and solutioned.

Cut Section From Station 356/00 to Station 370/00
Backslope

The Three Mile limestone and the Speiser shale that are overlain by a relative thin clay type mantle will be encountered in the right backslope through this location.

The mantle will stand on a 2½:1 or flatter slope satisfactorily.

The Three Mile limestone will stand on a ¼:1 slope satisfactorily.

The Speiser shale has a tendency to undercut the Three Mile limestone, therefore, backslopes of 1:1 or flatter for rock excavation and 1½:1 or flatter for common excavation are suggested for this shale formation.

Excavation

The Three Mile limestone is rock excavation.

The Speiser shale is common excavation where it is weathered. It has weathered to a depth of approximately 7 feet where it is not overlain by the Three Mile limestone. This depth of weathering tapers off to zero when the shale is overlain by the complete Three Mile limestone.

Cut Section from Station 411/00 to Station 417/00
Backslopes

possibly a small amount of Three Mile limestone will be encountered through this location. These formations and members are overlain by a clay type mantle that varies from a few tenths of a foot to 10 feet in thickness.

Backslopes of 2½:1 or flatter are suggested for the clay type mantle that will be encountered.

Backslopes of ½:1 or flatter are suggested for the limestones of the Kinney limestone member. Backslopes of 1:1 or flatter for common excavation and ½:1 or flatter for rock excavation are suggested for the shale zones of this limestone member.

Backslopes of 1:1 or flatter for common excavation and ½:1 or flatter for rock excavation are suggested for the limy Wymore shale member.

The limestone units of the Schroyer limestone member will stand on a vertical slope satisfactorily. The upper shale zone tends to undercut the upper limestone unit of this member which tends to allow it to slide out. Backslopes of 2:1 for common excavation and 1:1 or flatter for rock excavation are suggested for this upper shale zone. This shale zone is composed of five units in the generalized section, two of which are weak limestone zones that generally weather to clay, therefore, the five units are treated as a shale zone that is 3.6 feet thick.

Backslopes of 2:1 or flatter for common excavation and 1:1 or flatter for rock excavation are suggested for the Ravensville shale member as it is a clayey type shale and has a tendency to be unstable and to undercut the overlying Schroyer limestone.

The Three Mile limestone will stand on a ½:1 slope satisfactorily.

Excavation

The limestone units of the Kinney limestone member are rock excavation.

The thick shale unit of this limestone member is common excavation if it is weathered. It has weathered to a depth of 9 feet when it is not overlain by the upper Kinney limestone.

The Wymore shale is common excavation where it is weathered. Its depth of weathering varies from one side of the hill to the other side. Between Sta. 397/00

and Station 400/50 the Wymore shale has weathered to a depth of 10 feet. This depth of weathering tapers to zero at Station 402/50 where it is overlain by 5 feet of the Kinney limestone member. This depth of weathering is the result of ground water which originates at the base of the lower Kinney limestone. The depth of weathering on the other side of the hill is 5 feet at Station 404/00 and tapers to zero at Station 403/50 where it is overlain by the lower Kinney limestone.

The limestones of the Schroyer limestone member are rock excavation. The upper shale zone, which is composed of 5 units, has weathered to common excavation unless it is overlain by the upper Schroyer limestone and 2 feet of Wymore shale member.

The Havensville shale has weathered to common excavation to a depth of 12 ft. at station 379/50. This depth of weathering decreases to zero at Station 381/00 where it is overlain by 6 feet of Schroyer limestone. On the other side of the hill at Station 415/00 this shale member is weathered to a depth of 3 feet where it is overlain by 3 feet of Schroyer limestone. This depth of weathering increases from this location to the top of the underlying limestone unit at Station 415/50, where the limestone is rock excavation.

The Three Mile limestone is rock excavation.

Hydrology

Indications are that the base of the lower Kinney limestone is carrying ground water at Station 401/00. If the grade line cuts this limestone, subdrainage would be desirable.

It is thought that there is a possibility that there has been ground water moving through the upper portion of the Havensville shale member in the vicinity of Station 380/00. In a test hole at Station 379/25, centerline, the shale was found to badly weathered and has a moisture content that varies from damp to moist. Even if there is not any ground water movement at this location, protective measures such as a thickened base course should be taken when the grade line crosses over the unstable weathered Havensville shale to insure against a failure. It is suggested that this location be field checked during excavation to determine if subdrainage would be desirable. As there is no impermeable material to set a subdrain in to intercept any ground water movement, a stair step type subdrain that would give

protection from the [illegible] Schroyer limestone down through the Havensville shale to where the [illegible] type of subdrainage needed.

Between Station 413/25 and Station 416/50 the Havensville shale will also be encountered. There was no evidence encountered that there has been any ground water movement at this location. However any time the weathered, unstable, clayey Havensville shale member is encountered it is suggested that a thickened base course be used.

At Station 373/50, 83 feet left, there is a spring location that is not flowing at this time. It stopped flowing in the Spring of 1956. It is fixed up with a pipe and stock tank. This spring flows from the base of the Three Mile limestone.

At Station 375/91, 54 feet left, there is a good well that has an engine-driven pump mounted on it. The elevation of the water is 1290.26.

Cut Sections from Station 425/00 to Station 506/00

Backslopes

The Wymore shale, Schroyer limestone, Havensville shale and a small amount of Three Mile limestone will be encountered through these cut sections. The mantle overlying these shales and limestones consists predominantly of a clay type mantle that varies from a tan-brown to a reddish-brown color. It ranges from 1.0 to 12.0 feet in thickness.

Backslopes of 2½:1 or flatter are suggested for the mantle.

Backslopes of 1:1 or flatter for common excavation and ½:1 or flatter for rock excavation are suggested for the Wymore shale member.

The limestones of the Schroyer limestone member will stand on a vertical slope satisfactorily. Backslopes of 2:1 or flatter for common excavation and 1:1 or flatter for rock excavation are suggested for the 3.6 foot thick shale and weak limestone zones that underlie the upper limestone of the Schroyer member.

Backslopes of 2:1 or flatter for common excavation and 1:1 or flatter for rock excavation are suggested for both the shale and shaly limestone zones of the Havensville shale member as it is a clayey type shale and has a tendency to be unstable and undercuts the overlying Schroyer limestone.

Excavation

The Wymore shale [illegible] a depth of from 6 to 8 feet through these cut sections.

The limestones of the Schroyer limestone member are rock excavation. The 3.6 foot thick zone of shale and weak limestones that underlie the upper limestone of this member is weathered to common excavation if it is overlain by less than the upper Schroyer limestone and 2 feet of Wymore shale.

The Havensville shale member is rock excavation if it is unweathered. The upper shale unit of this member is weathered to common excavation unless it is overlain by 5 or more feet of the Schroyer limestone. The shaly limestone unit that underlies this shale unit is weathered to a depth of 3 feet on the steep side slopes. At Station 500/00, the bedrock underlying the limestone unit, No. 65, has weathered to a depth of 5 feet at centerline. This depth of weathering increases to 8 feet when the overlying shaly limestone is absent.

The Three Mile limestone is rock excavation.

Hydrology

If the unstable, weathered Havensville shale is encountered in the vicinity of Station 429/00, consideration should be given to increased base strength. There does not appear to be any ground water moving at this particular location, however the Havensville shale is badly weathered and has a high affinity for water.

At Station 457/50 and Station 464/00 it is apparent that the base of the Schroyer limestone has carried ground water in the past. To the left of Station 464/00 in a corral, the owner says that there have been numerous springs, however, they have not been active since 1952. The preliminary proposed grade line indicates that it will cross high enough over the Schroyer limestone base to eliminate any hydrology problem.

There are indications that the Schroyer limestone has had some ground water moving through it in the past in the vicinity of Station 496/00. The weathered shale and joint clay between an elevation of 1336.2 and 1334.2 was found to be wet and soft at 28 feet left of Station 496/05. The weathered shales and shaly limestones below this wet zone had only a slight moisture content. If the basal portion of the Schroyer limestone member is cut by the grade line at this location, -15-

then a stair-step type sub-drain should be considered to intercept ground water from the base of zone 60 and 62 of the generalized section and the upper portion of the Havensville shale member. Consideration should be given to the general low stability of the Havensville shale in designing a base course.

Cut Section from Station 517/00 to Station 523/50

Backslopes

A small amount of Three Mile limestone and Speiser shale will be encountered in this cut section. A small amount of a thick silty clay deposit will also be encountered.

Backslopes of 2½:1 or flatter are suggested for the silty clay mantle.

A ¼:1 slope is suggested for the Three Mile limestone member.

The Speiser shale has a tendency to undercut the Three Mile limestone, therefore backslopes of 1½:1 or flatter for common excavation and 1:1 or flatter for rock excavation are suggested for this shale formation.

Excavation

The Three Mile limestone member is rock excavation.

The Speiser shale is common excavation where it is weathered. It has weathered to a depth of 8 feet at this location where it is not overlain by the Three Mile limestone. It would be completely unweathered if it was overlain by five or more feet of Three Mile limestone.

Hydrology

The upper Funston limestone has carried ground water at its base at various locations along its outcrop edge between Station 522/96, 52 feet right and 524/83, 56 feet left. At the time of the primary field investigation of this area in February the ground water movement was nil or very slight. This location was rechecked during the 1st part of April, 1957, after substantial moisture had fallen and ground water movement of fairly large quantity was observed at three locations. They are at Station 522/96, 52 feet right; 523/97, 21 feet right and Station 524/51, 52 ft. left.

At Station 522/96, 52 feet right, at an elevation of 1276.02, there is a 1¼ inch diameter pipe sticking out from the base of the upper Funston limestone that is carrying a ¼ inch stream of water. This pipe is back under an overhanging bank.

At Station 523/97, 21 feet right, at an elevation of 1274.32, there is a flowing spring. The ground water is coming out of a 3 inch diameter hole in the dirt bank of the gully. There is a ½ inch diameter stream of water flowing out of it on the 8th day of April, 1957. The water comes from the base of the upper Funston limestone whose covered outcrop edge is 10 feet back in the bank or 11 feet right of centerline.

At Station 524/51, 52 feet left, at an elevation of 1277.62, there is a 3 inch in diameter weep hole in the southwest wing wall that has a small amount of ground water coming out of it. The center weep hole in the south wall of the box has a very little seepage coming out of it.

The major flow of ground water is to the right of centerline. This ground water movement could be intercepted and carried out to the right side of the fill section by installing an interceptor drain along the edge of the upper Funston limestone outcrop so that it would intercept the ground water moving at its base and carry it out to the right side of the fill section.

Cut Section from Station 534/00 to Station 546/00

Backslopes

The Schroyer limestone and Havensville shale members will be encountered through this side hill location. The mantle covering consists of a clay with chert and limestone fragments scattered through it.

Backslopes of 2½:1 or flatter are suggested for the mantle.

Backslopes of ¼:1 will stand satisfactorily for the limestones of the Schroyer limestone member. Slopes of 2:1 or flatter for common excavation and 1:1 or flatter for rock excavation are suggested for the shale units in this member.

As the Havensville shale has a tendency to be unstable in a backslope and tends to undercut the overlying Schroyer limestone, backslopes of 2:1 or flatter for common excavation and 1:1 or flatter for rock excavation are suggested.

Excavation

The limestones of the Schroyer member are rock excavation if they are in place. As this is a side hill location the chert bands have slumped down over the underlying Havensville shale in an irregular layer which in some cases appears to be in

The Havensville shale is common excavation if it is weathered. It is weathered rather badly through this location and does have very many shaly limestones in it. The depth of weathering is 10 feet when it is not overlain by the Schroyer lime stone. This depth of weathering tapers off to zero when it is overlain by 5 or more feet of the Schroyer limestone member.

Hydrology

The Havensville shale member was found to be badly weathered and has a moisture content that varies from damp to wet or saturated. There does not seem to be a particular zone that is carrying ground water, however there seems to be a general undirected slow movement of ground water seepage through the clayey shale. This is a general condition that is usually found in this shale member. As this is a side hill location, the right ditch will give fair protection against softening of the subgrade material. However, the Havensville generally has low stability and this factor should be considered in base course design.

Cut Section from Station 549/00 to Station 581/00

Backslopes

The Kinney limestone, Wymore shale and Schroyer limestone members will be encountered in this cut section. The mantle varies in thickness from 1 to 11 feet and is predominantly a clay that is somewhat silty.

Backslopes of 2½:1 or flatter are suggested for the clay type mantle.

The limestones of the Kinney limestone member will stand on a vertical slope satisfactorily. Backslopes of 1:1 or flatter for common excavation and ½:1 or flatter for rock excavation are suggested for the shale zones of this limestone member.

Backslopes of 1:1 or flatter for common excavation and ½:1 or flatter for rock excavation are suggested for the Wymore shale formation.

The limestones of the Schroyer limestone member will stand on a ¼:1 satisfactorily through this cut section. Backslopes of 2:1 or flatter for common excavation and 1:1 or flatter for rock excavation are suggested for the 3.6 foot thick shale and weak limestone zones that underlie the upper limestone of the Schroyer member.

Excavation

[illegible] shale that separates the upper and lower limestone zones of this member is common excavation if it is weathered. It has weathered to a depth of 12.5 feet at 75 ft. left of Station 565/00.

The Wymore shale is common excavation if it is weathered. It has weathered to a depth of from 5 to 9 feet through this location.

The limestones of the Schroyer member are rock excavation. The 3.6 foot thick zone of shale and weak limestones that underlie the upper limestone of this member is weathered to common excavation if it is overlain by less than the upper Schroyer limestone and 2 feet of Wymore shale.

Cut Section From Station 588/00 to Station 596/50

Backslopes

The Schroyer limestone and Ravensville shale members will be encountered in this cut section. They are covered by a thin clay type mantle that contains numerous chert fragments.

Backslopes of 2½:1 or flatter are suggested for the thin mantle.

The upper limestone unit of the Schroyer limestone member is badly weathered, jointed and slumped at this location. It is considered as mantle, however, there may be some limestone blocks of fair size encountered. These limestone blocks and the weathered shale zone that underlies them should be placed on a slope of 2:1 or flatter. The cherty limestones of this member will stand on a ¼:1 slope satisfactorily.

Backslopes of 2:1 or flatter for common excavation and 1:1 or flatter for rock excavation are suggested for the Ravensville shale member.

Excavation

The limestones of the Schroyer limestone member that are in place are rock excavation. The shale and weak shaly limestones that overlie the cherty limestones have weathered to common excavation.

The upper 4.4 feet of the Ravensville shale has weathered to common excavation unless it is overlain by 6 or more feet of Schroyer limestone. The shaly limestone

Hydrology

The ground water [illegible] this cut section. There is a spring at 165 feet left of Station 597/00 which is at an elevation of 1307.7. There is a small amount of ground water flowing from it It is thought that the ground water originates from the base of the Schroyer limest back in the hill. There was no indication that there was any ground water flowing at the base of the Schroyer limestone along centerline at this time, however, the Havensville shale that underlies it was weathered badly. If the ditches of the proposed travelway cuts the base of the Schroyer limestone as is indicated by the preliminary grade line, then ground water movement will not present a problem. The probability of unstable Havensville shale should be considered in base course desig

Cut Section from Station 605/00 to Station 653/00

Backslopes

A small amount of Wymore shale and Schroyer limestone that are overlain predominantly by a clay type mantle will be encountered through this location. The mantle would average around 8 feet thick, however it varies from 3 to 12 feet thick. It varies from a tan-brown to a reddish-brown in color.

Backslopes of 2½:1 or flatter are suggested for the mantle.

The Wymore shale that will be encountered is weathered. Backslopes of 1:1 or flatter will stand satisfactorily.

Backslopes of ¼:1 will stand satisfactorily for the small amount of Schroyer limestone that may be encountered.

Excavation

The Wymore shale member that will be encountered has weathered to common excavation. Its depth of weathering varies from 6 to 10 feet.

The limestones of the Schroyer limestone member are rock excavation. If a shal zone of the Schroyer member is encountered, it will be weathered to common excavatic

Hydrology

At Station 613/40, 90 feet left, there is an old well that has a broken pump and does not appear to be in use.

At Station 656/45, 100 feet left, there is a well that has a windmill sitting on it but it is not being used.

At Station 656/60, 151 feet left, there is a flowing spring in the present gully. The elevation of the water level is 1327.0 and is coming out of the base of the Schroyer limestone. This water is being used for cattle.

Cut Sections from Station 675/00 to Station 727/00

Backslopes

The Florence limestone and Blue Springs shale will be encountered through these cut sections. They are overlain by a thin type mantle that consists of clay with scattered chert fragments.

Backslopes of 2½:1 or flatter are suggested for the thin mantle.

The Florence limestone member will stand on a ¼:1 slope satisfactorily.

Backslopes of 1:1 or flatter for common excavation and ½:1 or flatter for rock excavation are suggested for the Blue Springs shale member.

Excavation

The Florence limestone member is rock excavation.

The Blue Springs shale member is common excavation when it is weathered. It has weathered to a depth of 5 ft. when it is not overlain by the Florence limestone.

Hydrology

At Station 695/92, 62 feet right, there is a well that is being used. It has an electric pump installed on it.

At Station 699/00, 26 feet left, there is a well that is being used.

At Station 699/12, 92 feet left, there is an abandoned well that appears to have caved.

At Station 708/00 there is a deep V-shaped gully that crosses centerline. This buried gully will not present a problem.

Cut Section from Station 735/00 to Station 781/00

Backslopes

A small amount of Florence limestone and a clay type mantle will be encountered through this location. The clay type mantle is predominantly a glacial till type deposit and varies in color from a tan-brown to a red-brown. It is approximately 18 feet thick at Station 773/00.

Backslopes of 2½:1 or flatter are suggested for the mantle.

Backslopes of 1:1 will stand satisfactorily for the cherty Fernvale limestone.

Slopes of 2:1 are suggested for the small amount of weathered shale of the Florence member that may be encountered.

Excavation

The Cherty limestone of the Florence member is rock excavation. The shale zone of the Florence member that may be encountered have weathered to common excavation.