

## SECTION II

### Geology of the Project

Limestones and shales of the Council Grove and Chase Groups are the outcropping rocks along this project. The hill tops and slopes are generally covered with residual mantle except from Station 295/00 to the end of the project which is covered by glacial till that varies in thickness from 5 to about 30 feet. The uppermost rock unit is the Towanda limestone and the lowermost unit above the stream level of the Big Blue River is the Middleburg Limestone.

Plane table mapping indicates the regional dip of the bedrock is to the west at about 12 feet per mile. Locally this dip may steepen to as much as 30 feet per mile. Test drilling between Stations 93/00 and 98/00 indicates reversal of dip of about 5 feet per 300 feet.

Minor deviations from the average dip were noted along the project.

The topography consists of rolling hills underlain by the limestones and shales with most of the limestones forming topographic benches and the shales forming the steeper slopes in between. The maximum relief from the river valley to the crest of the hills is about 280 feet. The lowest area is the Blue River valley at about 1055 feet in altitude and the highest point is near Station 315/00 where the altitude is about 1335 feet. The relief between Station 200/50 and 205/00 is about 130 feet, which is the steepest tributary crossed by this project. The west valley wall of the Blue River has relief of 190 feet vertically in 700 feet horizontally.

#### Pleistocene

Soil.-- The soils along this project consist of both residual and transported. The residual soils are generally clayey, developing from the limestones and shales of the area. Gradational contacts between the clay and bedrock were noted in many instances, indicating the residual nature of the soils. The transported soils are those that have formed on the glacial till near the eastern end of the project and also on the alluvium in the Blue River and larger tributaries of the river. The alluvial soils may be silty in the upper part. The thickness of the

about 7 feet for residual soils near Station 94/00. The soils have been leached to a considerable depth indicating good internal drainage.

Glacial till.-- Glacial till was encountered along this project from Station 295/00 to the end of the project. The till ranges in thickness from 5 to 30 feet. It consists largely of a red-brown to olive drab silty clay, with some limestone and chert fragments. In the thickest sections near Station 304/00, sand and gravel were encountered with some water movement. A well about 400 feet right of this area is producing water from this zone. The till overlies the weathered surface of the Fort Riley limestone in this area.

#### Permian System

Towanda limestone.-- The Towanda limestone is the uppermost bedrock unit along the project and is found capping the hills from Stations 55/00 to 93/00 and from 117/00 to 123/00, 135/00 to 139/00, 231/00 to 239/50 and 246/00 to 269/50. The lower 4 to 8 feet of this unit usually forms a prominent bench and is case-hardened near the outcrop. The upper part of the unit is more chalky and weathers to a clayey limestone. Thin shale partings are evident from the test drilling but are not significant in classification. There is a consistent shale parting varying from one to two feet thick which lies 2.2 feet above the base. This shale is limy and would be classified the same as the remainder of the limestone. The limestone is characterized by its blocky appearance on weathered exposures.

Holmesville shale.-- The Holmesville shale consists of three units which are an upper shale consisting of green and ochre shales that may weather to a limonite stained clay. This zone is approximately 12 feet thick. The middle unit consists of a 2.5 foot thick siltstone that contains a thin limestone zone at its top and base. This particular unit is represented by silty shale between Stations 229/00 and 240/00 and is not as resistant to weathering. The lower unit consists of shale of which the lower 3.1 feet is limy. The overall thickness of the Holmesville shale ranges from about 23 to 25 feet with the exception of the area from Station 134/00 to around 140/00. The upper shale zone at this location has thickened to about 18 feet from the average of 12 feet. The limestone and siltstone zone is about the same thickness as is the lower limy zone. The - 9 -

zone of green and ochre shale just under the Tonawanda limestone is usually highly weathered and the reddish zones may show as limonite-colored clays. This zone along with the lower part of the Tonawanda limestone was found to carry ground water.

Fort Riley limestone.-- The Fort Riley limestone consists of shaly limestone units and the massive (rimrock) limestone unit. The shaly limestone units weather to have the characteristics of a limy shale. The upper part of the Fort Riley limestone is generally a soft, shaly limestone which does not form an outcrop. It weathers to a tan clay along its outer edges where it is near the surface of the ground. The most prominent part of the Fort Riley limestone is the "rimrock" which along this project ranges from 2 to 7 feet in thickness along its weathered outcrop. This unit may be one or two beds that vary in thickness from 2 to over 4 feet. The "rimrock" is underlain by a shaly limestone unit which may have a fairly resistant 1 to 2 feet limestone at its base. The concentration of vegetation at the base of the "rimrock" would suggest the presence of ground water, however, there are only 2 locations along this project where it was noted that there was ground water moving out from the base of the "rimrock". They are at 150 feet right of Station 245/00 and 277 feet right of Station 223/00.

Oneto shale.-- The Oneto shale consists of two units of thin-bedded, hard, limy shale separated by a limestone bed that contains nodules of chert. The total thickness of the Oneto shale ranges from 7 feet on the west side of the river to 14 feet just east of the river from where it thins back down to around 9 feet on the eastern portion of the project. The limestone unit in this shale has a constant thickness.

Florence limestone.-- The Florence limestone is the uppermost of the cherty limestones encountered on this project. The upper unit of this limestone member is unit bedded and generally contains a small amount of scattered chert nodules; however, it may be non-cherty. This upper unit is separated from the principal cherty limestone of this member by a limy shale. The lower 2.5 feet was found to vary from one limestone that contained little or no chert to 3 cherty limestones separated by limy shale. The base was recognized as the lowermost chert-bearing bed. The total thickness of the Florence limestone ranges from 22 to 26 feet.

The Florence limestone appears to be thickest where the Oneto shale is thinnest. This limestone member forms prominent rounded hilltops where it is the uppermost member, otherwise it does not form a prominent outcrop where overlain by younger formations.

Blue Springs Shale.-- The Blue Springs shale consists of gray, green and maroon clay shales which have a total thickness of about 19 to 20 feet. The maroon shales are banded with the green shales in the lower part, while the gray shale is found just below the Florence limestone. The gray shales may be liny and contain local lenses of limestone up to one foot thick. The maroon zones may contain irregular concretions of hematitic material.

Kinney limestone.-- The Kinney limestone, in the area of this project, consists of two limestones separated by a shale. The upper limestone varies from about 1 to 3 feet in thickness, the shale between ranges from 10 to 15 feet and the lower limestone also has a variation of from 1 to 2 feet. The total thickness ranges from 12 to 20 feet. The upper and lower limestone zones vary from chalky limestones to hard, dense limestones. The shale between the limestones is considerably different from the shales above and below, so it is placed in the Kinney limestone member. It is generally light to dark gray and thin bedded, whereas the shales above and below are blocky and vari-colored.

Wynore shale.-- The Wynore shale is similar in characteristics to the Blue Springs shale. The average thickness is about 20 feet. Locally an argillaceous limestone may be found in the middle part which is less than a foot thick.

Schroyer limestone.-- The Schroyer limestone consists of an upper unit bedded non-cherty limestone about 2 feet thick that is separated from the middle cherty zone by about 3 feet of gray shale. This shale zone may thin to a fraction of this thickness. The middle part of this member is a cherty limestone averaging about 3 feet thick that is separated from a lower cherty limestone by about two feet of soft shaly limestone on the west side of the Blue River floodplain. To the east of the river the shaly limestone zone is represented by an 0.8 of a foot liny shale. The 2 cherty limestones also vary considerable in thickness from the one location to the other. The basal zone in this member is a rather weak - 11 -

chally to shaly limestone that varies in thickness from 2.5 to 3.1 feet. The Schroyer limestone is variable in lithology but the overall thickness remains rather constant throughout the project.

Havensville shale.-- The Havensville shale consists mostly of dark gray shales that weather to a tan. The upper portion of this shale member usually contains lensing layers of variable limestone. It may also contain geodes and concretions of calcite and silica as a result of secondary deposition by ground water. In some exposures, a dense unit-bedded limestone occurs in the middle part of this member. This limestone may vary from 1 to 2 feet in thickness. The lower part of the Havensville is consistently a dark-gray shale which weathers to a gray-tan.

Three Mile limestone.-- The Three Mile limestone consists of about 6.0 feet of bedded cherty limestone separated from a lower bed of cherty limestone about 1 foot thick by a limy shale parting that ranges in thickness from 0.2 to 0.6 of a foot.