PROGRAM, RESPONSIBILITIES, AND PROBLEMS CONCERNING WATER RESOURCES IN OHIO

R. J. BERNHAGEN,
Principal Geologist, Ohio Division of Water

Recently there has been much publicity regarding water shortage in a number of areas throughout the nation.

Most prominent of these of course is the New York situation. Other industrial areas such as Louisville, Memphis, Houston and Youngstown are faced with the same problem.

These are disheartening affairs in a nation such as ours in which technical "know how" seems unlimited. Our engineering and scientific achievements are excelled by no other country in the world, yet we seem to be unable to accomplish a solution to the problems of our water resources.

These recent water shortages, tragic in a way, have been beneficial in one respect to the nation as a whole. The publicity has been helpful in awakening the nation to reconsider the status of one of its most valuable natural resources. At no time in the history of our country have the people been so conscious of water and the problems related to it. Agencies of the Federal government have been studying the problem for many years and most state governments have in recent years instituted programs of study to determine causes and to recommend remedial measures.

In the State of Ohio an active program to study Ohio's water resources has been in effect since 1941 when the Ohio Water Supply Board was created by the General Assembly. Later the organization became the Ohio Water Resources Board and today the work is carried on by the Division of Water in the Department of Natural Resources.

PROGRAM OF OHIO DIVISION OF WATER

Briefly, the duties of the Ohio Division of Water entail the collection, study and interpretation of the available data related to the water resources of the State of Ohio. In the formulation of the law creating this organization it was the intent of the legislators to create an agency that would collect the basic data regarding the status of our water resources, analyze the data and make it available to the citizens of the State so that ultimately a sound water conservation program could be established.

However, before discussing a water conservation program, it is necessary to define what is meant by "water conservation." Unlike other minerals, water as it occurs in Ohio is replenished annually and cannot be saved or conserved by non-use. Conservation of water means obtaining the maximum beneficial use of water and protecting those resources from polluting or deleterious matter which render water unfit for use. It is that concept on which the program of the Ohio Division of Water is based.

The program of the Division divides itself into the following categories:

1) Water resources inventory.
2) Field investigations.
3) Analysis of inventory and field data.
4) Publications and reports of inventory and analysis.
5) Regulation.
6) Assistance to individuals, industries and public agencies.

First on the list is water resources inventory. Mr. C. V. Youngquist,[1] Chief of the Division of Water, has stated "a fundamental conservation measure is a

TABLE I

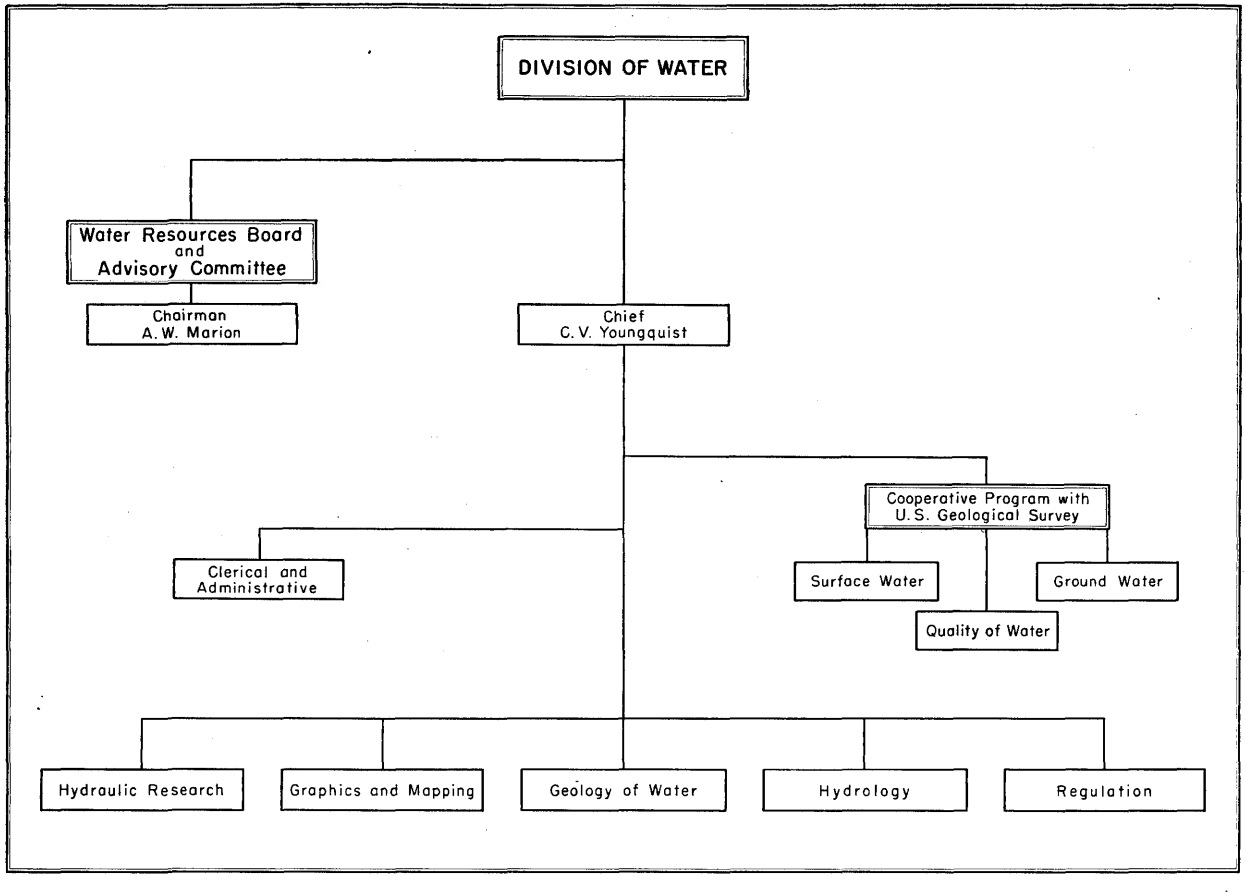
ACTIVITIES OF THE OHIO DIVISION OF WATER

INVENTORY	INTERPRETATION	REGULATION	CONSTRUCTION
A. Stream Flow 1) Gaging 2) Chemical quality 3) Siltation a) Suspended b) Deposits in reservoirs 4) Pollution	A. Statistical Analysis 1) Flood frequency 2) Drought frequency B. Flow Characteristics 1) Flood flow 2) Low flow 3) Relation to soil, geology and land use C. Storage Requirements D. Design of Bridges and Culverts E. Chemical Quality 1) Treatment required 2) Deleterious factors 3) Pollutants	None Common Law of Riparian Rights	A. Building of Dams Financed by Issuance of Revenue Bonds B. Bridge Dam Law C. Farm Ponds
B. Ground Water 1) Gaging (Water table fluctuations) 2) Survey of pumpage 3) Pumping tests 4) Chemical quality 5) Geology of water 6) Processing of well logs	A. Quantities Available (yield) B. Source and Rates of Recharge C. Pump Sizes and Rates of Pumping D. Well Spacing E. Chemical Quality 1) Treatment required 2) Deleterious factors 3) Pollutants F. Extent and Thickness of Aquifers	A. Filling of Well Logs by Drillers B. Rules and Regulations to Prevent Contamination of Ground Water C. Enforcement	None
C. Climatic Factors 1) Rainfall 2) Temperature 3) Evaporation 4) Assemble in available form	A. Rainfall Analysis 1) Frequency and magnitude of intense rains 2) Frequency and duration of drought 3) Trends B. Temperature Analysis 1) Distribution 2) Trends C. Evaporation		

continuing inventory of the supply of water available from streams and underground reservoirs and the chemical and physical properties of those supplies. This

[1]C. V. Youngquist, Annual Report of the Division of Water and Ohio Water Resources Board for the year 1949.

TABLE II


DIVISION OF WATER
Water Resources Board and Advisory Committee
Chairman A. W. Marion
Chief C. V. Youngquist
Cooperative Program with U.S. Geological Survey
Clerical and Administrative
Surface Water
Ground Water
Quality of Water
Hydraulic Research
Graphics and Mapping
Geology of Water
Hydrology
Regulation

inventory is and must be carried on continually to prevent over-development or misuse of Ohio's most valuable resource." The water inventory requires measurement of water in all phases of its occurrence. Principal determinations are precipitation, stream flow, ground-water fluctuations, evaporation and transpiration, soil moisture, and the chemical and physical quality of water.

At the present time quantity of stream flow is measured at 188 gaging stations strategically located throughout the State. Automatic recording gages are maintained on 111 observation wells which are drilled into a majority of the principal water bearing formations. These records give a positive answer to such questions as "Is the water table falling?" During 1949, 262 chemical analyses were made of water from the streams and underground reservoirs. A survey of ground water pumpage of the State indicates that over 500 million gallons are pumped from the ground each day. A pumpage inventory will be conducted periodically to determine areas in which over development is occurring. Approximately 30 pumping tests have been conducted at municipal and industrial well fields. Such tests reveal the hydraulic properties of aquifers and are fundamental in the establishment of pumping rates and in the spacing of wells to obtain the most efficient well field development. The Division receives and processes approximately 9,000 water well logs each year.

The above group of activities is far from complete but it is presented to exemplify the type of work involved in a water resources inventory. Many phases of the inventory are conducted co-operatively with the Surface Water Branch, Ground Water Branch and Quality of Water Branch of the U. S. Geological Survey. For the sake of brevity the activities of the Division of Water are outlined on the chart in Table I and the organization chart is shown in Table II.

Factors Involved in Water Problems

In view of the fact that considerable publicity has been given to current water shortages, both in Ohio and the nation, there has arisen in the minds of many people certain false concepts regarding the status of our water supplies, both present and future. It may be advisable at this time to discuss the causes of water shortages and the possible remedial measures that may be taken, and from that discussion some of the problems of the Division of Water will become apparent.

The causes of water shortages automatically fall into two categories—assumed causes and real causes.

Assumed Causes

1) In the minds of many people it is believed that our climate is changing—that we are getting less and less rainfall every year. This is far from true. Examination of rainfall records from the U. S. Weather Bureau shows this is not the case.

2) A second assumption is that the water tables throughout the country are dropping. One popular writer has made the claim that ground-water levels in Ohio have dropped 50 feet in the last 25 years. In some areas in Ohio, water levels have been rising in the past few years. Ground-water levels are recorded every minute of the day by 111 automatic recording instruments installed on observation wells, and analysis of these records show that there is no continuous decline in ground-water levels. Only one area has experienced critical lowering of water levels. This area will be discussed later.

3) It is believed that water shortages have been brought about by the removal of the forests. Locally under favorable conditions it may have some influence but to say that the removal of our forests and the abuse of our farm lands has created water shortage universally has no basis in fact.

Real Causes

There are two principal causes of water shortages—droughts and over-development.

The source of all water is the atmosphere. Whether it is ground water or surface water, it originates from rainfall. It is rainfall that keeps our streams flowing and it is rainfall that recharges the underground reservoirs. In periods of deficient rainfall our surface water is diminished and our water tables are lowered. In the centuries past, this country, as well as other countries, has witnessed periods of drought as well as periods of plentiful rainfall. The magnitude, distribution and frequency are the factors which affect the amount of water available for human consumption. In the design of water supply systems these variable factors must be taken into consideration.

In the development and use of our water resources, we must recognize certain things.

1) That water resources are limited—there is no such thing as an unlimited water supply. This applies to both surface water and ground water. There is no great difference between a surface-water reservoir and a ground-water reservoir—you can see one but not the other. They both have definite physical limitations and they both behave according to certain established physical laws. Reservoirs will yield just so much water. In the case of a surface-water reservoir, the yield is determined by the design of the reservoir. In the case of a ground-water reservoir the yield is determined by the physical make-up of the aquifer and its hydraulic properties.

Most of the current shortages have arisen, not from natural causes, but because of overpumpage which has come about from the increased demands for water.

2) We must recognize that as our population increases the demands for water will increase. In the past ten years the consumption of water in this nation has about doubled. In another ten years that demand may again double.

Ground-water consumption in the nation is about 20 billion gallons daily. Here in Ohio daily pumpage from the ground is about 500 million gallons. With the expansion of industry, the growth of municipalities and the increase in demand for water for irrigation the above figures will continue to mount.

A majority of the water shortage problems involve ground water, and therefore this discussion shall be confined to ground water. Furthermore a consideration is given to the problem as it affects the State of Ohio rather than the nation.

The following table lists those areas in Ohio where ground-water pumpage exceeds 10 million gallons per day.

INDUSTRIAL AND MUNICIPAL GROUND-WATER PUMPAGE

	Million gallons per day
Montgomery County	93.0
Stark County	66.0
Butler County	50.0
Hamilton County	45.0
Franklin County	30.0
Summit County	28.0
Ross County	27.0
Muskingum County	17.0
Richland County	13.0
Jefferson County	12.0

Of all the heavily pumped areas in Ohio only one is experiencing a critical shortage of water. This is the Mill Creek Valley area of Hamilton County. The ground-water requirements of the industries and municipalities in the Mill Creek Valley have exceeded for years the amount of water available in the underground reservoir. The daily pumpage has averaged about 14 million gallons since 1939. The average rate of recharge over a long period is estimated to be 11 million gallons per day. As a result ground-water levels have been lowered as much as 90 feet below the surface and will continue to decline so long as the pumpage is in excesss of the natural recharge of the aquifer. The hydrograph of observation well No. 265–5 in this area is shown on Fig. 1 and a north-south longitudinal profile of

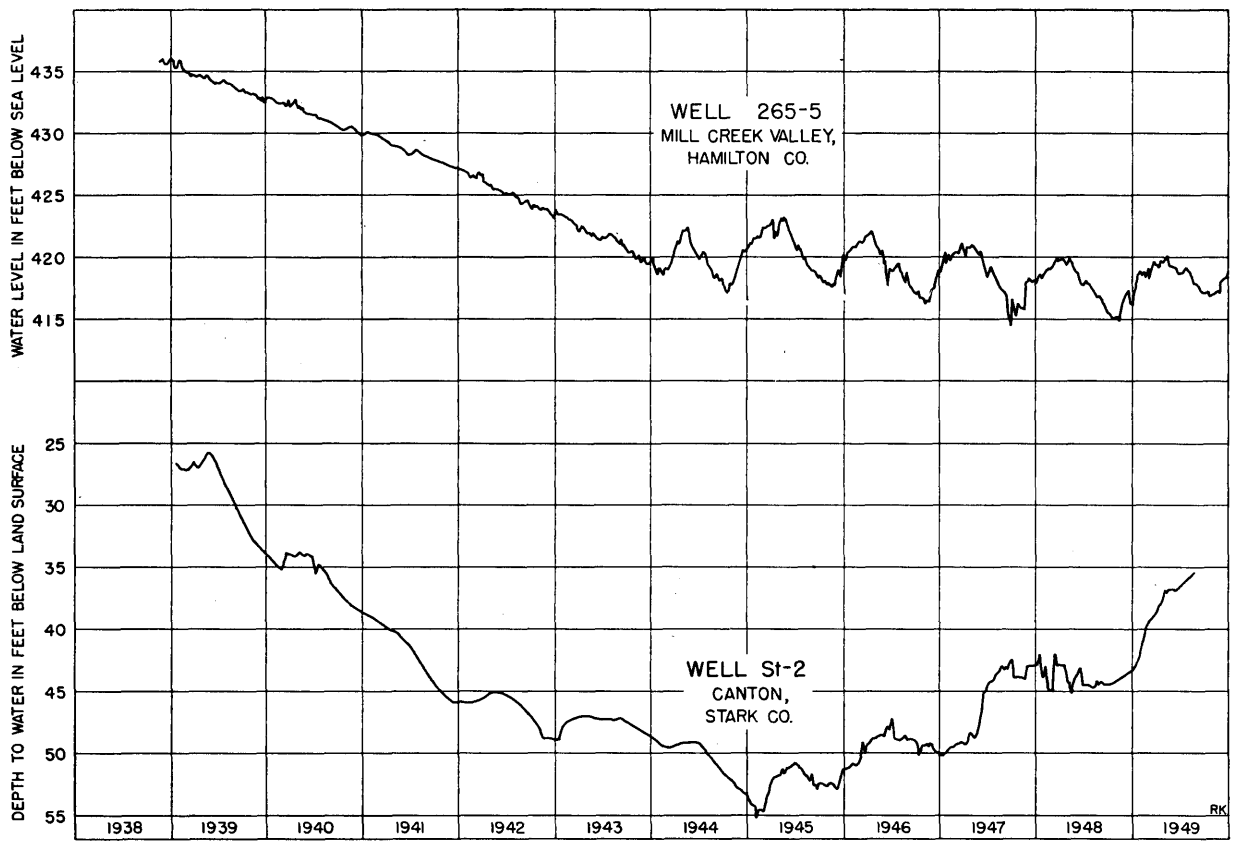


Fig. 1. Hydrographs of observation wells.

the piezometric surface is shown in Fig. 2. Organized efforts of the industries in the valley have resulted in decreasing the pumpage and to some extent slowing down the rate of decline. Conservation methods have been adopted and investigations are in progress to determine the feasibility of importing water from other ground-water areas within the county. Previous to 1945 in the Canton area of Stark County serious declines in ground-water levels were occurring. This is shown by the hydrograph of well ST–2 on Fig. 1. Following the cessation of World War II water demands by war industries decreased and since that time the City of Canton has developed a new well field removed from the area of heavy pumpage. As a result of the redistribution of pumpage, water levels have raised to a point higher than existed in 1940.

Throughout Ohio there are a number of villages and small cities which are experiencing difficulty in keeping up with the increased demands of a growing community. In some instances the geology of the area is such that additional large volumes of ground water are not available and it is advisable in such cases to change the source of supply from ground water to surface water. In other instances it is possible to spread the pumpage over wider areas. A common failing of many municipal well fields is the close spacing of wells; often 3 or 4 wells will be placed on an acre of land. Furthermore it must be borne in mind that there are extensive areas in Ohio where subsurface conditions do not allow for the accumulation of large volumes of ground water. In these areas attempts to develop municipal or industrial supplies should be discouraged and farm and domestic consumers should be informed as to the best type of water supply development to suit the prevailing condition.

Regarding the solution of existing ground-water supplies certain procedures are self-evident.

1) Redistribution of pumpage in some areas.

2) Development of supplementary supplies from other sources.

3) Use of surface water in winter and ground water in summer where temperature is an important factor.

4) Artificial recharge—either by water spreading or by recharge wells. This assumes additional water is available.

5) In certain rural areas where the subsurface material is relatively impermeable additional low yielding wells are advisable and supplemented by farm ponds and cisterns.

It must be borne in mind that ground-water problems are localized and that solutions must be based on careful studies of the local geologic and hydrologic conditions. The application of certain remedial measures may work in one area but fail in another. This may be exemplified by contrasting the situations existing at Dayton and Greenville. At Dayton the aquifer is recharged by the water spreading method. It is effective because the gravel aquifer exists at the surface and continues downward to a considerable depth. At Greenville about 40 feet of clay overlies a gravel aquifer. Water spreading in this area would be ineffective.

Thus far no mention has been made of reforestation as a means of solving water problems. This feature has not been mentioned because of its questionable value. It is important to recognize the effectiveness of forest cover in retarding runoff, reducing soil erosion and increasing soil moisture but as a universal panacea to the solution of water supply problems reforestation cannot be considered as a prime factor but only as a supplement to the overall local picture. Only under ideal conditions of geology and topography will forest cover be beneficial in recharging ground water. Recharge, either by natural processes or man-made devices, presupposes one condition, that a porous and permeable medium is present to conduct the water from the surface to the ground water reservoir. Diller has shown that in level country the effect of forests in flood control and underground storage is of

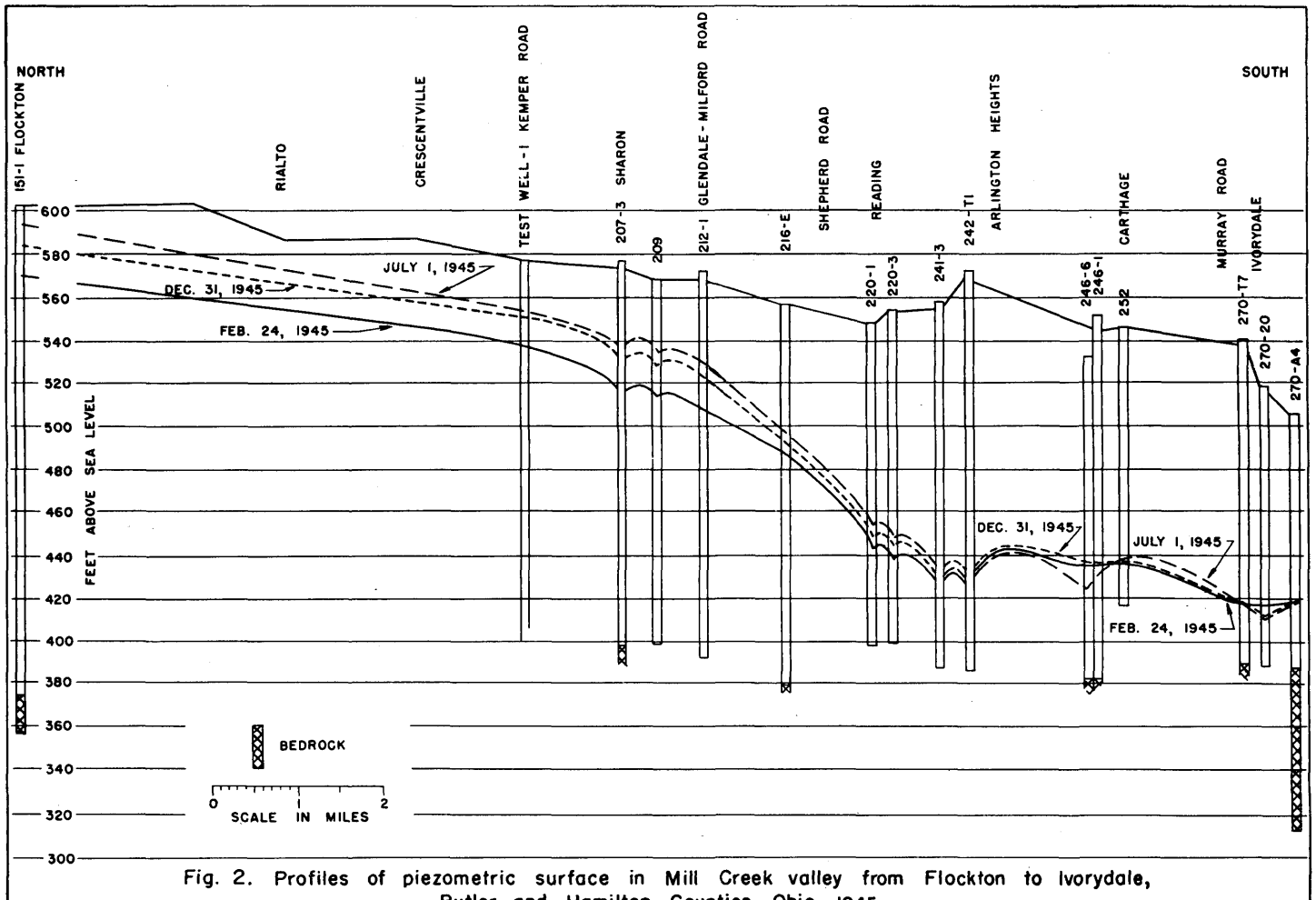


Fig. 2. Profiles of piezometric surface in Mill Creek valley from Flockton to Ivorydale, Butler and Hamilton Counties, Ohio, 1945.

little consequence. In fact, it has beeen demonstrated that in level country forests tend to lower the water table and reduce soil moisture to a greater degree than other forms of vegetation. Diller[2] clearly expresses the attitude of foresters on this subject in the following quotation:

"It is apparent that the water shortages in many parts of Ohio during recent years cannot be attributed solely to the lack of forest cover. Very few foresters claim that forests will maintain a high water level when prolonged dry periods occur and where there is heavy pumpage for industrial uses. Furthermore, most foresters concede that floods which are produced by exceptional meteorological conditions cannot be prevented by forests. But without the mitigating influence of forests, floods are more frequent, more severe and more destructive. It is important that we recognize the beneficial effects which forests have on water relations but that we must refrain from exaggeration. Well managed forests can justify themselves through wood production and erosion control without the necessity of making broad claims about their effect on water tables and floods."

In conclusion it may be said that there is no present danger of depleting the ground-water supplies in Ohio except locally. Water shortages are not a recent development. Temporary and localized shortages have existed since our country was settled. But in the early days there was some excuse for failures. Knowledge of geology, hydrology and hydraulics was in its infancy and errors in judgment were common. In the not too distant past lack of knowledge or poor judgment has resulted in some of the shortages which exist today.

In order to accomplish a sound program of water conservation in the State of Ohio certain long term objectives are imperative. The following objectives have been set forth by Mr. C. V. Youngquist[3], Chief, Ohio Division of Water in his report to the Governor and the General Assembly of the State of Ohio.

LONG TERM OBJECTIVES

1) Action programs on the wise utilization of water must be based on adequate facts on quantity and quality of available water. These facts must be collected now for the expanding use and development of water in Ohio which is certain to occur.

2) Most water problems are unique to an area, and each requires an individual plan. No ready made plan can be applied to a region.

3) Any successful plan for wiser water use will require a combination of methods of engineering, hydrology, geology, soil conservation, and reforestation.

4) Any water resources development should be integrated with an overall basin plan with proper consideration of regional and functional needs in order to insure the best overall use.

5) The river basins of the state should be examined, investigated, and classified as to potential use with sufficient flexibility to permit alterations as conditions require. Such plans will require records of stream regimen, ground-water fluctuations, quality of water determinations, and other basic data.

6) Underground water must be preserved against over development and reckless drilling operations. Experience indicates that additional regulatory authority may be required to obtain the desired results.

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[2]Oliver D. Diller, "Forests and Water," OSU Engr. Exp. Sta. News, April, 1946.

[3]C. V. Youngquist, Annual Report of the Division of Water for the year 1949.