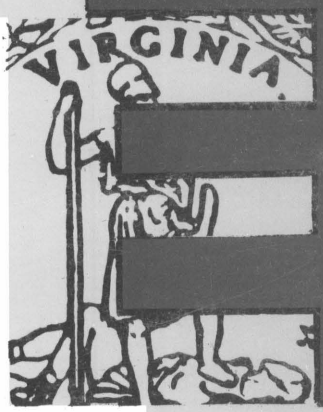
WATER

Water Resources Programs in Virginia



Water Resources Programs in Virginia

Symposium on Water Resources Programs in Virginia, Richmond, 1966.

WATER RESOURCES PROGRAMS IN VIRGINIA

William Byrd Motor Hotel
Richmond, Virginia
October 6-7, 1966

Sponsored By

WATER RESOURCES RESEARCH CENTER

Virginia Polytechnic Institute

PREFACE

A symposium on Water Resources Programs in Virginia was held at the William Byrd Motor Hotel, Richmond, Virginia, on October 6 and 7. The purpose was to bring together representatives from various agencies, commissions, and citizen groups who are actively involved in the planning and executing of water-related activities in the state. It is hoped that with more detailed information regarding the thinking and planning being done in the various private and governmental organizations, better coordinated objectives can be attained, duplication of effort can be minimized, and freer interchange of ideas fostered, resulting in a better utilization of one of the State's most valuable resources - - - WATER.

The papers herein were those presented at the Symposium. In addition reports by the Division of Mineral Resources and by the U. S. Army Corps of Engineers, Nashville District, are included.

William R. Walker, Director

Water Resources Research Center
Virginia Polytechnic Institute
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WELCOME

by

W. B. Harrison, Dean
Research Division
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It is a pleasure to have this opportunity to represent Virginia Polytechnic Institute today and to extend to you a few words of welcome. In my preparation for these remarks, I found that there is an abundance of information related to water resources. In particular, I wish to bring to your attention an article which appeared in the July issue of International Science and Technology. I found it to be quite comprehensive and very readable as it describes the various kinds of the water resources problems which are faced in different parts of the United States. To my amazement, I even found a serious article about the national water problems in a recent issue of a popular "man's" magazine. Thus, the questions which we are to encounter today are timely, and they are questions which are widely recognized as being both serious and important to our national well-being.

There are some who take the view that there is really no water problem in the sense that there is certainly plenty of water to provide for our needs. Undoubtedly, this is a viewpoint we would have if we were to look at the surface of the earth from some distant place such as the view seen by the astronauts. We know there is a tremendous volume of water on the earth, some 97 per cent of which is in the ocean. Nevertheless, there are problems of serious magnitude relating primarily to both quality and distribution of our water resources.

One type of problem is typified by the greater New York area and the greater Los Angeles area in which there are vast requirements for fresh water related to the large population

density. Still other problems are typified by regions in the Southwest, such as Arizona, in which sub-surface water is being used to irrigate the soil, but in the evaporative process, the soil is becoming contaminated with the dissolved salts remaining as solids. An associated problem is that the water table is being lowered in a fashion deemed by many to be practically irreversible. In fact, the water table has dropped so low in some areas that it is no longer economic to pump water to the surface for irrigation.

A variety of local problems relate to water pollution, not only with respect to addition of chemicals or various waste products to the water, but also with respect to the addition of heat which certainly alters the biological and chemical processes which are constantly taking place within the water.

Certain problems which take a long time to develop and to identify tend to be extremely difficult to resolve. A classical example is the problem of Lake Erie which has completely changed its character from a few decades ago. Chemical pollution gradually changed the biological environment, which tended to encourage plankton bloom and algae growth. This, in turn, increased turbidity and decreased light transmission for photosynthesis. Desirable fish began to decline in population and scavengers increased. The process is indeed complex as well as sad, for portions of Lake Erie are now ugly and odoriferous at times. Furthermore, it is difficult to conceive of a project to reverse the processes to bring Lake Erie back to its far more desirable state of years gone by.

These problems that I have mentioned have largely been the consequence of man's aggressive efforts to utilize water supplies without taking into account the responsibility which goes with contaminating or altering these supplies for further uses. To

quote from this article I referenced in a popular man's magazine, "The American water problem is caused by one thing: mismanagement by men. The code of sovereign states, farmers, industrialists, and communities alike is: to hell with the guy downstream. To this precept a new dimension is being added: to hell with posterity." Obviously, this author has chosen his words in order to dramatize the fact that some of our current problems have been contributed by man's lack of consideration for his fellow man. A more scholarly statement has been made in the referenced issue of International Science and Technology, but I believe that you will see that the message is very much the same. Let me quote briefly from this article: "Total water in rivers and in the ground is ample for all future needs. Regional shortages can be alleviated by some optimum combination of pollution control, water reprocessing and reuse, groundwater development, and - as always - diversion of rivers from regions of surplus to regions of deficiency. Whether pollution troubles can be cured at this point is very much in doubt. Man's intervention in natural equilibria - physical as well as chemical, ecological as well as hydrological - has in effect created an entirely new hydrologic system. Man is not allowing this system to reach a new equilibrium; he keeps changing its parameters."

Let's try to bring these comments now a little closer to the Commonwealth of Virginia. Just before leaving Roanoke the other day, I read the following statement in a Roanoke paper: "Only thirteen states have larger population than Virginia. Only Florida among all the states east of the Mississippi is growing at a faster rate." Clearly water problems are very closely associated with population as the needs of the populus are being met for personal consumption and personal use. There are companion needs which relate to community services, to economic growth, to industrial and agricultural expansion, all of which

have interaction with the local demands on water supplies. Thus, the meeting today will confront a number of these problems and it is hoped that, as a consequence of this meeting, some solutions may be found for the improvement of our future water resources outlook.

Examining the program for today, I see that a large number of different organizations and interests are represented. I assume that each of you has come for a specific purpose. In conclusion, then, it is my wish that each of you will accomplish your mission of the day, and that each of you will profit by your attendance here to the extent that we may all work more effectively together for the future well-being of the Commonwealth of Virginia. Thank you very much.

WATER RESOURCE ACTIVITIES - NORFOLK DISTRICT
U. S. ARMY CORPS OF ENGINEERS

by

C. J. Robin, Chief
Engineering Division

I have been asked to discuss some of the water resource activities of the Corps of Engineers in Virginia. I shall confine my remarks to the area under the jurisdiction of the Norfolk District, which covers the major part of the state, and to some general background information.

The planning, construction, and operation of certain Federal water resource projects, and the administration of certain laws pertaining to our navigable waters, have been assigned by Congress to the Department of the Army for accomplishment by the Corps of Engineers.

Since 1824, the Corps of Engineers, through this civil works program, has been the principal developer of the nation's water resources. In that year, the Congress gave the Corps the task of clearing some snags and sandbars from the Ohio and Mississippi Rivers. From this small beginning, there has grown a nationwide development program in which some $18 billion has been invested, and which is now running at over $1-1/4 billion a year.

Navigation

The Corps has developed, by dredging and the construction of locks and dams, some 22,000 miles of inland and intracoastal waterways, including the Great Lakes connecting channels and the United States' portion of the St. Lawrence seaway. About 19,000 miles of these waterways are currently in commercial use and carry approximately 1/6 of the total ton-mileage of the nation's inter-city freight.

The Corps has improved almost all of the coastal and Great Lakes ports and harbors through which the United States carries on its vital waterborne domestic and world trade. In fact, all of our major Atlantic coast harbors are man-made. In addition to some 500 commercial harbors, the Corps has built about 250 small-boat harbors.

Flood Control

Flood protection has been a major part of the Corps' civil works mission since the general flood control program was inaugurated by the Congress in 1936. The flood protection efforts of the Corps primarily benefit urban and rural areas on major streams and urban communities on small tributary streams where most flood damages occur. The flood control program has already saved our country over $14 billion in flood losses, as compared with an actual investment in the flood control function of only $4.4 billion - a savings dividend of $3.40 for every dollar invested.

Major measures taken are the construction of systems of reservoirs to hold back part of the flood waters, and local systems of levees and floodwalls to protect specific areas lying below the levels to which reservoirs can reduce the flood flows, together with the improvement of the river channels. Over 230 flood control and multiple purpose reservoirs now in operation provide almost 79 million acre-feet of storage capacity for the control of floods. Some 600 local protection projects so far completed include about 9,000 miles of levees and flood walls and 7,500 miles of channel improvements.

The Corps' $18.5 billion active authorized program for flood control and multiple-purpose projects is a little over half completed. Although much remains to be done, hundreds of communities have already been relieved of the threat of flood

damage. Whole valleys have been transformed, and lands which our rivers had periodically overflowed have been made useful for industrial, residential, agricultural, recreational, and other types of development. In many towns and cities, areas that formerly were of little use because they were so often flooded have been converted into beautiful parks and playgrounds.

Flood Plain Regulation

One major cause of flood losses is continued unregulated building and occupancy on land exposed to floods. The Federal government has no authority to zone or regulate land use in these vulnerable areas. However, the Corps is authorized to make detailed flood plain surveys to assist local governments in effectively regulating the future development of such areas under their jurisdiction, in order to minimize the flood hazard and the need for expensive control works.

A typical flood plain report may include maps, mosaics, or diagrams showing the extent of flooding to be expected under various conditions; show how existing land uses affect flood losses; suggest ways of building structures which must remain in exposed areas, so that they can withstand flooding with minimum damage; and discuss how zoning ordinances, building codes, evacuation plans, urban renewal programs, subdivision regulations, and other types of local action might be used to reduce flood losses.

Increased recognition is being accorded to flood plain regulation as a major means of reducing flood damages in the future and obviating the need for costly physical preventive measures.

Impoundments - Key Element in Water Conservation

Reservoir impoundment of excess flows, the primary mechanism of flood control, is also the key element of all water conservation efforts. Without such storage, sufficient water of acceptable quality would not be available to meet all of the increasing water-related needs of the American people.

The flood waters which the Corps' reservoirs keep from rushing down toward the sea on a headlong, destructive course, may be stored temporarily and then released as needed to maintain improved river flows during natural low-water periods. Such releases help to assure an adequate supply of water for homes, factories, and farms; for the support of navigation; and for the benefit of our fish and wildlife. The controlled release of water stored in time of plenty is also an important factor in reducing the concentration of pollutants discharged into our rivers.

Most of the Corps' reservoirs are scenic lakes, annually affording more than 168 million visitor-days of outstanding opportunities for swimming, boating, fishing, camping, and the enjoyment of other outdoor recreational pursuits. Forest conservation areas and game preserves have been established at many of these projects.

Many civil works impoundments also provide for the generation of hydroelectric power needed by our power-hungry industrial economy. Installations built and operated by the Corps of Engineers produce about 1/5 of the nation's total hydro power, the largest amount produced by any single agency.

Shore Protection

Increasingly important additional functions of the civil works program include the protection of critical coastal areas against destructive tidal flooding caused by hurricanes, and

the protection of invaluable beach and dune areas against damage by erosion during severe seasonal storms. More than 130 projects in these categories have been authorized so far, and over half are in operation or under construction.

Comprehensive Basin Planning

From the very beginning of federal flood control activity, the Corps of Engineers has had a key role in comprehensive planning for the development of the nation's water resources to serve all beneficial purposes. About 40 years ago, the Congress authorized the Corps to study the water resources potential of the principal rivers of the United States. In carrying out this assignment, the Corps prepared some 200 comprehensive reports on individual river basins outlining the possibilities for their development for flood control, hydroelectric power generation, irrigation, navigation, and other purposes.

On the basis of these reports, the Congress initiated the general flood control program in 1936. These reports provided the foundation for basin-wide plans of development subsequently undertaken in the great river basins.

Today, the Corps is engaged in a new series of studies and comprehensive planning undertakings which, by the time they are completed, will encompass every major region and river basin in the country.

Corps of Engineers Organization

In order to carry out its responsibilities in the prosecution of the civil works program, the Corps of Engineers has developed a highly decentralized organization. The continental United States is divided into 10 regions, or divisions. Each division is further subdivided into smaller geographical areas, or districts.

Because the civil works activities of the Corps of Engineers are organized by river basins rather than state boundaries, the work in any state may come within the jurisdiction of more than one district or division. In Virginia, the Potomac watershed and upper Chesapeake Bay are in the Baltimore District. The remainder of Chesapeake Bay, Hampton Roads, and the Rappahannock, James, Chowan, and York River basins are in the Norfolk District. The Baltimore and Norfolk Districts are two of four districts under the jurisdiction of the North Atlantic Division, with headquarters in New York. The Roanoke River basin is in the Wilmington District which reports to the South Atlantic Division at Atlanta. In the western part of Virginia, the New River, Pound River, and Russell Fork are in the Huntington District which reports to the Ohio River Division at Cincinnati.

Normally, two or three officers of the Corps are assigned to the civil works program in each district on a rotational basis. Under this rotational system, officer personnel of the Corps receive actual on-the-job engineering and administrative experience essential to their military efficiency.

Not all Army Engineers wear uniforms. Bound together by the "esprit de corps" of the Corps of Engineers is a far larger number of civilian members who are the backbone of the organization. A substantial number of our technical staff are graduate engineers from VPI, VMI, and the University of Virginia who entered under our rotational training program and chose to remain with the Corps.

Activities in Virginia

The work of the Corps of Engineers in Virginia is quite varied in scope and complexity. It includes:

1. Establishment of economically justified navigation channels, varying from such small projects as Deep Creek

in Newport News which serves the watermen tonging oysters from the James River, to the large Hampton Roads deep channel projects which permit some of the world's largest coal colliers to load over 50,000 tons of coal at the Norfolk and Western and Chesapeake and Ohio coal piers, and transport the coal to countries in Europe, Asia, and South America.

2. Protection of the navigable waters from the dumping of oil and other pollutants into the tidal harbors and polluting Virginia's beaches and shorefront property. Also, insuring that bridges, tunnels, piers, and other structures in navigable waters are constructed so as not to become a hazard to or adversely affect commercial or recreational navigation.

3. Participation in engineering studies and construction works for the preservation of beaches such as the Virginia Beach shorefront so as to protect shore property and insure an adequate recreational beach for the public.

4. Construction of such projects as the Kerr and Philpott multi-purpose reservoir developments in southern Virginia that control and develop the water resources of the streams on which they are located.

5. Preparation of engineering reports pertinent to the design and economic feasibility of such projects as the Gathright and Salem Church reservoirs and to the proper development of the water resources of an entire watershed such as the James River basin.

6. Review of applications submitted by private utility companies to the Federal Power Commission for licenses to develop hydroelectric power projects, such as the Roanoke Rapids and Gaston projects by the Virginia Electric and Power Company and the Smith Mountain project by the Appalachian Power Company. All of these projects were included in the

comprehensive plan prepared by the Corps of Engineers for the Roanoke River basin. Such reviews insure coordination and maximum efficiency in the overall program of river basin development.

7. Preparation of flood plain information reports to assist local governments in regulating the development of flood plain areas, such as those prepared for the Meherrin River at Emporia, James River at Richmond, and Tuckahoe Creek, North Run, and Gillies Creek in Henrico County.

We have prepared a pamphlet entitled "Water Resources Development by the U. S. Army Corps of Engineers in Virginia," dated 1 January 1965. This pamphlet provides information on the scope and progress of water resources projects within the Commonwealth of Virginia by the Corps. Copies of this pamphlet are available here. The two maps in the back of the pamphlet show all of the federal projects constructed to date in Virginia by the Corps of Engineers. The pamphlet is updated biannually.

Project Development

When local interests feel that a need exists for the development of a water resources project, they may petition their representatives in Congress. The senator or congressman then requests the appropriate congressional committee to direct the Corps of Engineers to investigate and furnish a recommendation on the matter under consideration. The Corps of Engineers, in a sense, acts as a consultant to Congress. Comprehensive surveys of suggested projects are made by the Corps to determine their economic and engineering feasibility and necessity. Considerations which enter into recommendations to Congress for project authorization generally include a determination that benefits will exceed costs, that the

project is engineeringly sound, and that it makes the fullest use possible of the natural resources involved. In making these surveys, the Corps of Engineers cooperates fully with all other federal agencies concerned, as well as with state and local authorities.

Upon completion of the study, the Chief of Engineers requests the views and recommendations of the Governor on the improvements discussed in the report and then transmits his findings to the Secretary of the Army. These include the reports of the District Engineer, the Division Engineer, and the Board of Engineers for Rivers and Harbors, as well as the views of other federal agencies and the views and recommendations of the Governor. Finally, the report is transmitted to Congress. Action is then taken by the Committee on Public Works of the legislative body requesting the study. If authorized by Congress, the project still requires Congressional appropriations to become a reality.

I would like to review briefly the status of some of our recent and current water resources activities in the Norfolk District.

Salem Church Reservoir

We completed our studies and submitted our report on the Salem Church reservoir on the Rappahannock River in December 1965. The Division Engineer issued a notice of report favorable to the construction of the project on 31 May 1966. In accordance with law, the report was referred for review to the Board of Engineers for Rivers and Harbors, an independent body with a separate staff in Washington, D. C. The board has just completed its review and has publicly announced that its findings are favorable to construction of the project. The ultimate approval must be by the Congress.

The resolution authorizing the current report on Salem Church was adopted by the Senate Committee on Public Works at the request of Senator A. Willis Robertson. It provided for a review of a 1946 report of the Chief of Engineers on the Rappahannock River, with a view to determining the latest estimates of benefits and costs of this project and whether any modifications thereof were advisable at this time.

Planning for the development and use of our water resources now goes far beyond the uses and purposes that were considered during the studies on which the 1946 report on the Rappahannock River were based.

In addition to flood control, navigation, and power production, current federal policy places heavy emphasis on meeting emerging needs throughout the country for increased municipal and industrial water supply, and water quality control. A new basic purpose which has come into prominence in all of our planning is recreation, which, as President Johnson has pointed out, is becoming more and more important to the well-being of the American people in this complex and demanding age.

Our review of the 1946 report and reformulation of the project has been based on careful and detailed consideration of current and projected water and related land resources needs in the Rappahannock River basin. The recommended project was selected from a wide variety of alternate means of providing the same services, as the best solution for meeting the water needs far into the future. It would maximize net benefits and fully develop the resources of the site.

Our report recommends the construction of the Salem Church multiple-purpose reservoir and the Fredericksburg re-regulating dam in a single development, combining flood control, water supply, water quality control, salinity control,

recreation, and hydro-power production. We found that the development of this dual reservoir system is economically justified, having an economic ratio of benefits to charges of 2.1 to 1, and would be a significant step in the development of the water resources of the Rappahannock River basin. The report recommends construction of:

(1) A dam at the Salem Church site, located 5.6 miles upstream from the City of Fredericksburg, with a concrete spillway in the river crested by gates, concrete non-overflow sections on both sides of the spillway, and earth wing dikes. The maximum conservation pool would be at elevation 240. The powerhouse would be located immediately downstream from the dam. The height of dam would be approximately 203 feet.

(2) A second dam - Fredericksburg Reregulating Dam - located 2.7 miles downstream from the Salem Church site to reregulate the fluctuating flows discharged from Salem Church Reservoir. The development would consist of a concrete, ungated spillway, and concrete non-overflow sections. The height of dam would be approximately 46 feet.

The estimated first cost of the entire project is $69 million. Of this amount, local interests would be required to contribute $7-1/4 million for water supply and recreational features. An additional $10-1/2 million would be expended for expansion of recreation facilities over an extended period. Half of this cost would be borne by the federal government and half would be contributed by local interests.

Gathright Reservoir

The Gathright multiple-purpose reservoir, to be located 20 miles above Covington on the Jackson River in the headwaters of the James River basin, is now in the preconstruction planning stage.

As planned, the reservoir would have an area of 2,530 acres at the level of the top of the conservation pool which is elevation 1582 above mean sea level and would extend from the dam upstream for a distance of approximately 10 miles. Each year spring rains would fill the lake to the level of the conservation pool. Water stored below the top of the conservation pool would be released during dry periods of the year, increasing low water flows along about 275 miles of the Jackson and James Rivers from the dam downstream to Richmond, Virginia. This increased flow would, in combination with adequate treatment or control of wastes at their source, abate pollution in the streams, and benefit counties and municipalities along the stream involving about a half million people.

During flood periods, flows that would damage property downstream from Gathright Dam would be stored above the level of the conservation pool. By storing these flows, the reservoir would reduce flood damages below the dam significantly along the Jackson and to a lesser extent along the James River for a distance of 131 miles downstream to the vicinity of Lynchburg, Virginia.

The 2,530 acre lake with its conservation pool at elevation 1582 and associated shore areas being planned for development, will provide a recreational area for such activities as camping, picnicking, hiking, nature study, and the water oriented sports of fishing, swimming, boating, and water skiing. Nearby Douthat State Park with its 70 acre lake and the small existing developments in the George Washington National Forest would be complementary to the Gathright reservoir.

The dam will be an earth-rock fill structure with a core of impervious material, transition sections of random earth and rock, and outer blankets of massive rock which provide the weight for stability. The dam will be 257 feet high and its base will be about 1,200 feet wide.

An important feature in the Gathright project is the water intake and discharge system which is being designed to draw off rich oxygenated water from different levels near the surface of the lake as the lake recedes in order to improve the quality of the water in critical areas downstream to meet the minimum water quality objectives which have been established. This water also will be mixed with cold water from the bottom of the lake, which at times may be low in oxygen, to provide a suitable trout fishery environment downstream to Covington.

James River Survey

On 6 August 1964, the Committee on Public Works of the United States Senate adopted a resolution requesting the Corps of Engineers to review its 1946 report on James River, Virginia, published as House Document No. 207, 80th Congress, with a view to determining whether any modification of recommendations contained therein are advisable at the present time.

At a public hearing in Richmond, specific requests were made for increased flow of water at Richmond by the construction of upstream reservoirs. This is a primary objective in our studies for water supply, water quality control, flood control, and the other aspects of water resource development. When water can be stored in times of abundance for release during times of low flow, many water problems become more manageable.

You are well aware, of course, of the existence of the Chesapeake and Ohio Railway immediately along the main stem of the James River. Previous studies have indicated that construction of dams and reservoirs on the main river, as was done on the Roanoke, would be prohibitive because of the cost of relocating the railroad. Our studies will include possible reservoirs on tributaries of the James, such as the Maury, Rivanna,

Buffalo, Craig Creek, and including the Appomattox which flows into the James below Richmond.

The first comprehensive study of the James River by the Corps of Engineers was made in 1934. The Chief of Engineers recommended that, other than the existing navigation project in the tidal estuary below Richmond, no federal improvements be undertaken at that time. No action was taken by Congress.

Shortly after the major flood in 1936, Congress requested the Corps of Engineers to bring the 1934 report up to date. Again a comprehensive investigation was made and a report was submitted blueprinting a series of reservoirs on the James River and its tributaries for the development of the water resources of the watershed. However, it recommended the construction at that time of only the Gathright reservoir development on the Jackson River. Congress authorized the construction of this project in the Flood Control Act of 1946. It is now in the final planning stage, the immediate progress of which is dependent on additional Congressional appropriations.

The comprehensive plan investigations of the 1930's and 1940's did not include consideration of water supply, recreation, fish and wildlife conservation, drainage, irrigation, pumped storage power facilities, and coordination with projects which could be provided under PL 566 to meet the needs of small watersheds. Economic projections of future conditions and water needs were limited and, of course, are now out of date. In an overall sense, the water problems of the James River basin have not yet reached the critical stage. Thus, the opportunity still exists to plan for optimum future development.

To emphasize the problems pertinent to an adequate water supply, the finger can be pointed at the northeastern drought, during the last four years. Today it is the northeast; yesterday, and the day before that, it was the middlewest and the southeast in the 1950's and 1930's.

Much interest has been generated in recent years concerning the quality of water in our streams. There seems to be a considerable increase in public support for water pollution control which, like beauty, has its aesthetic considerations. Perhaps there is a genuine instinctive concern that some few of the thousands of different industrial wastes which are being discharged into the nation's rivers may, in the long run, have a damaging effect on human life. Or perhaps it is the periodic fish kills at various places throughout the country that capture the public imagination. It is likely that a combination of all of these, and other factors, has brought about this present state of affairs.

Water management, therefore, means providing the right quality of water in the right quantities for the purposes to be served at the points where it is needed.

Then again - beauty - for its own sake has been projected into the field of water management. Certain so-called wild rivers are to remain in their natural state. Also, the growing population with a greater personal income, enjoying more leisure time and increased mobility, and living in a rapidly growing urban environment in the megalopolis area extending from Boston south to Washington and even to Richmond, is placing greater emphasis on the use of outdoor water based recreation facilities. This, too, must be considered in any potential reservoir development.

The exact nature of a program to meet the water needs of the James River basin cannot be determined until detailed and comprehensive studies for water resources development are completed. The near-permanent nature of these developments requires a high assurance that they be properly and thoroughly planned. Practically all federal and state agencies, as well as many local agencies interested in the field of water

resources will cooperate in this study. Included will be such agencies as the State Water Control Board, Department of Conservation and Economic Development, Commission of Game and Inland Fisheries, Federal Water Pollution Control Administration, Soil Conservation Service, Bureau of Outdoor Recreation, U. S. Fish and Wildlife Service, Weather Bureau, Geological Survey, and others.

An important phase of the study program is an "Economic Base Study" of the James River basin. Its findings will serve as a basis for projecting future population growth, and the probable industrial and commercial expansion in the foreseeable future. Appropriate local, industrial, and state agencies including, for example, the Commonwealth's Division of Planning will review this information and satisfy themselves as to the reasonableness of the results of the economic base study. The projected population and industrial growth in the James River basin will be translated into water needs for domestic and industrial water supply and for pollution abatement.

Similarly, the flood problem will be established throughout the watershed. The Bureau of Outdoor Recreation, and Fish and Wildlife Service, and appropriate state agencies will determine the present and future water-based recreational needs of the basin, taking into account the report of the Virginia Outdoor Recreation Study Commission. This will pinpoint where there will be a shortage of water-based recreation facilities in the foreseeable future, and will permit an evaluation of the beneficial or detrimental effects of reservoirs and other works under consideration.

Next, the Corps of Engineers will study potential reservoirs; determine engineering feasibility and the cost of each project; determine the potential for water supply, abatement of pollution or water quality control, recreation, hydro power,

control of floods, and other purposes; determine whether the water needs can be met in an economically justifiable manner; and finally prepare an appropriate and orderly program for meeting the needs in the foreseeable future. The Soil Conservation Service will similarly establish the needs for small reservoirs in the headwater reaches of the tributaries of the James, and studies of the Corps of Engineers will reflect the influence of these reservoirs in mitigating flood flows and otherwise reducing water problems. The basic objective will be to provide the best combination of water-regulating features to meet foreseeable short and long term needs in the James River basin.

James River Channel

Many of you are aware of the fact that extensive dredging is accomplished on the James River each year to maintain a channel 25 feet deep from Hampton Roads to the deepwater terminal at lower Richmond and thence 18 feet deep to the upper harbor. The River and Harbor Act of 1962 authorized the deepening of the 25 foot channel to 35 feet, subject to endorsement by the Governor. However, the state wanted time to investigate certain problems concerning oyster beds in the estuary. To do this, the Commission of Fisheries of the state requested our Waterways Experiment Station at Vicksburg, Mississippi, to conduct a model study. The study is being financed by the state and the Corps of Engineers. The results of the tests will be interpreted by the Virginia Institute of Marine Science and will be used by the Commission of Fisheries to establish its position in regard to the deepening project.

I should like to state our position in the event that this model study ultimately results in the withdrawal of all objections to the deepening so that the Governor may endorse the

project as required by law. Since authorization of the project in 1962, two petroleum pipelines have been built into the Richmond area, and some of the oil companies that had been expected to use the deepened waterway are not expected to do so now. Loss of all petroleum benefits would make the project uneconomical. On the otherhand, our report did not evaluate the benefits that would result from the establishment of new industries along the river. In the event that the project is ultimately endorsed by the state, a complete re-evaluation must be made of the economics of the project, taking into consideration the loss of the tanker traffic, but giving close scrutiny to the possible additional benefits to be obtained from new industries.

Hampton Roads

In the Hampton Roads area, we are deepening the present Thimble Shoal, Norfolk Harbor, and Newport News 40-foot channels to 45 feet to accommodate larger vessels. About twenty years ago we began hearing about so-called "supertankers" as big as 27,000 tons. Within the last five years we have witnessed the advent of vessels of 100,000 tons and over. In the past year I have read of a prospective Japanese tanker of 250,000 tons, of a 144,000 ton cargo carrier, and of huge 44-foot draft colliers. Now, shipbuilders have been approached about construction of tankers of 300,000 deadweight tons.

In most major harbors, further channel deepening is no longer just a matter of cutting through shoal areas, but rather one of trenching the entire length of the channel at great cost. At Norfolk, we have been able to make an unusually favorable arrangement for disposing of the dredged material by inclosing an area of some 2,500 acres on the south side of Hampton Roads at Craney Island with sand and rock dikes. Material can be deposited in this area at a cost of about 40 to 50 cents

per cubic yard, compared to a cost of about $1.40 a yard to carry it out to sea. Other interests also may use the area on payment of a fee which will help amortize the cost of the project. When the area is filled, it will provide a 2,500-acre island of made land which is already being considered for various uses.

Current Studies

In addition to the projects which I have previously discussed, we have several additional studies underway. One of these involves a determination of the advisability of deepening the existing channel in the York River to 40 or 45 feet to Yorktown and thence 25 feet upstream to West Point, Va. Local interests desire these improvements to accommodate oil tankers using the lower reaches of the river, and to permit ocean-going vessels handling pulpwood to call at a Kraft paper plant at West Point. Another study involves a determination of the advisability of improving Chincoteague inlet in the interest of the seafood industry. The inlet provides access for the fishing fleet based in the Chincoteague area to and from the Atlantic Ocean. There is an untapped fishery resource in the Atlantic Ocean opposite Chincoteague inlet consisting of large quantities of ocean clams (surf clams) which could be developed into a profitable enterprise if an adequate channel were provided. At Virginia Beach we have initiated a study to determine whether additional protection against damage from storm tides and waves and damage due to erosion is justified. This study will cover the entire shoreline of the city from Little Creek on Chesapeake Bay to the Virginia-North Carolina state line. The James River basin study which has been discussed in detail will continue through fiscal year 1969, assuming funds are made available to permit efficient prosecution of the work. The

western portion of the upper James River basin is located in the Appalachia region. This region is an economically depressed area of relatively high unemployment.

There are two important regional water resources studies underway in which we are participating. The North Atlantic Regional Water Resources Study (NARS for short) was initiated this year and will extend over several years before it is completed. This study is part of the President's program of study of all major river basins which is being implemented by the Water Resources Council. The Corps of Engineers has been designated as inter-departmental leader. The study area encompasses all of the New England states and the states of New Jersey, Delaware, and the District of Columbia, and portions of the states of New York, Pennsylvania, Maryland, West Virginia, and Virginia. The major river basins in Virginia which are included are the James, York, Rappahannock, and Potomac. This study will be a joint effort between federal water resource agencies and the states concerned. The fourth year of drought in the North Atlantic region has dramatically underscored the need for a framework study on a coordinated and cooperative basis among all agencies and states concerned with development of water and related land resources, to determine objectively the overall short and long term needs of the region and how best to meet these needs.

The Northeastern United States Water Supply Study (NEWS for short) was authorized by Congress by Public Law 89-298, 27 October 1965. The authorization directs the Secretary of the Army, acting through the Chief of Engineers to plan major reservoirs, major conveyance facilities, and major purification facilities to assure adequate water supplies for the great metropolitan centers of the northeastern United States. The study area includes in part those river basins of the northeastern

United States which drain into Chesapeake Bay. The area is roughly 1,000 miles long from the northeastern tip of Maine to the southernmost boundary of the James River basin. Extending inland an average of 200 miles from the Atlantic Coast, it covers an area of approximately 201,000 square miles. The major river basins in Virginia which are included in the study area are the James, York, Rappahannock, and Potomac.

I hope that I have been able to give you some idea of the functions of the Corps of Engineers and more specifically what we are doing to develop the water resources in our area.

Thank you.

WATER RESOURCE ACTIVITIES - WILMINGTON DISTRICT
U. S. ARMY CORPS OF ENGINEERS

by

E. G. Long, Jr., Chief
Engineering Division

It is indeed a pleasure for me to participate in this symposium and to outline for you the role of the U. S. Army Engineer District, Wilmington, North Carolina, in the Water Resources Program in Virginia.

First, some of you may wonder what an engineer district in North Carolina has to do with Virginia. So let me hasten to explain that for Civil Works activities, engineer district boundaries generally follow natural watersheds rather than State or other artificial lines. As the Wilmington District has the responsibility for the Cape Fear, the Neuse, the Tar and the Roanoke River basins, its Civil Works boundaries are determined by these watersheds, thus the extension of Wilmington District into southwest Virginia.

The Civil Works program is an important adjunct to the military role of the U. S. Army Corps of Engineers. It began when this Nation began with a handful of military engineers who were used by the new Government for many tasks of internal improvement. The Civil Works mission of the Corps has expanded through the years and covers a broad spectrum of activities which may be classified under the general heading of:

Flood Control
Navigation
Coastal Engineering, and
Operation and Maintenance of Completed Projects.

In 1936 the Congress gave the Corps of Engineers nationwide flood control responsibility. Flood control begins with a comprehensive study of a river basin, such as the study of the Roanoke River basin completed in 1943. Such studies are authorized by the Congress as a result of requests by local

interests to their Congressmen. Since 1936, the flood control program has been progressively broadened to include such related purposes as the development of hydroelectric power, water supply, water-quality control, and pollution abatement, fish and wildlife conservation, and recreation. Water-resource studies for all of these purposes are closely coordinated with all interested Federal agencies and with the appropriate State agencies to determine the plan of development which will provide the greatest benefit to the largest number of citizens. Also, in the flood control category the Corps of Engineers has the responsibility for making flood plain information studies upon application by municipalities or other legally constituted governing bodies. These studies do not result in protective structures or projects, but furnish advice on flood stages and frequency of flooding for use by municipalities for zoning, flood-proofing, and planning. Protective structures or channel improvement to eliminate or ameliorate relatively minor flood problems can be provided under the provisions of Section 205 of the Flood Control Act of 1948, as amended. Under this Act, municipalities, counties, or other legally constituted bodies sponsoring the project must agree to pay their share of allocated costs and all project costs in excess of $1 million.

The Corps of Engineers is more quickly identified in its relationship to navigation and its responsibility for improvement of rivers, harbors, and waterways to aid transportation, both domestic and foreign. New studies or a review of reports on existing projects to provide major improvements to waterways are authorized by Congress as a result of requests from local interests through their Congressional representative in the same manner as large-scale flood control studies. Small navigation projects, small boat harbors, and relatively minor improvements to waterways may be provided under the authority of

Section 107 of the River and Harbor Act of 1960 as in the case of Section 205, Flood Control Projects. Local interests or project sponsors must pay their share of allocated costs and all costs in excess of $500,000.

The Corps of Engineers was given the responsibility for coastal engineering in 1930. This branch of engineering is primarily concerned with beach erosion and coast-protection features. Following the several disastrous hurricanes in 1954, the Congress enacted Public Law 71 which authorized general investigations of the eastern and southern seaboards of the United States to identify problem areas and to determine feasibility of protection. As in the case of flood control and navigation, there is also a parallel authority for small beach erosion projects under Section 103 of the River and Harbor Act of 1962. Again, local interests or project sponsors must pay their share of allocated costs and all costs in excess of $500,000. An information sheet describing in detail the procedure for obtaining a study of either type under each category is included in the appendix.

The Civil Works Organization includes several specialized groups, such as the Board of Engineers for Rivers and Harbors, which is primarily a review authority to judge the engineering and economic soundness of Corps project reports; the Coastal Engineering Research Center which carries out a program of studies of beach and shore phenomena; the Hydrologic Center which conducts research study and training in the problems of water behavior; and the Waterways Experiment Station which does a great deal of the Corps model study work.

Finally, the Corps of Engineers has the responsibility for operation and maintenance of completed projects. Multipurpose reservoirs with or without hydroelectric power are operated, regulated, and maintained by the Corps. Recreational facilities

at these projects are operated and maintained by the Corps for the convenience of the public in cooperation with the states involved. Navigation projects are dredged as required to maintain authorized project dimensions and locks are operated to accommodate traffic moving on the waterways.

So much for the general responsibilities. Now, let's consider the specific program in Virginia. As the Wilmington District covers only the upper portion of the Roanoke River basin in Virginia, the water resources program in Virginia is concerned almost entirely with flood control and related purposes. This program consists of the following studies or activities:

(1) Flood Control Studies. The comprehensive study of the Roanoke River basin, previously mentioned, resulted in the approval by Congress of a plan of development composed of 11 reservoirs and six of these have already been constructed; namely, John H. Kerr and Philpott by the Corps; Smith Mountain and Leesville by the Appalachian Power Company; and Gaston and Roanoke Rapids by the Virginia Electric Power Company. Currently, two review reports of the Roanoke River basin study are authorized, one of which considers the advisability of providing improvements for flood control at and in the vicinity of South Boston, Virginia, while the other considers the advisability of any modification to project plans or operation of Kerr Reservoir with respect to storage and releases required for flood control, power production, pollution abatement, navigation, and fish preservation. The first of these studies is scheduled for completion in 1969 and the second later this year.

(2) Flood Plain Information Studies. The Roanoke Valley Regional Planning Commission, acting through Roanoke County, the Town of Vinton, Botetourt County, the Town of Salem, and the City of Roanoke, applied for a flood plain information study of those portions of Roanoke and Botetourt Counties and

Roanoke City, which lie in the Roanoke drainage basin. Investigations will cover the main channel of the Roanoke River in urbanized areas from west of Salem to east of the City of Roanoke; Lick Run and Peters Creek, Mason Creek, Tinker Creek and Carvin Creek, Mud Creek, Glade Creek and Back Creek. Field investigations have already begun but several years will be required to complete studies for all areas.

(3) Small Flood Control Projects. Under the authority of Section 205 of the Flood Control Act of 1948, as amended, a report covering the lower 6,000 feet of Lick Run in Roanoke, Virginia, has been completed, and the plan has been submitted to the Governor of Virginia for his comment. This project, if approved, will reduce flood stages in downtown Roanoke and complement the improved storm sewer system which is to be constructed by the City. Total estimated cost of the Federal project is about $650,000.

(4) Operation and Maintenance of Completed Projects. The two outstanding completed projects in the Roanoke River basin which the Wilmington District operates and maintains are the John H. Kerr and Philpott multipurpose reservoirs. These two reservoirs have more than fulfilled expectations, and the benefits therefrom have greatly exceeded the estimates.

Flood Control benefits approach the national average of more than $3 in damages prevented for every dollar invested in protection. Gross power revenues for the combined projects now total over $56 million. Fish and wildlife have been greatly enhanced. Of the total 62,199 acres at Kerr and Philpott above the conservation pool level, 17,138 acres have been zoned for wildlife management and State wildlife agencies already have 5,181 acres under license for environmental improvement. During most years, storage releases from Kerr have been augmented during the striped bass spawning season to provide ideal river

stages, and, even during this near drought year, Kerr releases were voluntarily re-regulated by the Virginia Electric and Power Company to provide a steady river stage which, though lower than desired, nevertheless resulted in a very satisfactory spawning season. Recreation has been the real surprise in production of benefits at Kerr and Philpott even though it is not one of the authorized purposes. Since the projects have been in operation, total visitation has exceeded 30 million. Last year, visitation exceeded 3.2 million, and the number grows yearly. Average annual recreational benefits are estimated at over 2 million dollars. Capital improvements for recreational facilities to date combining Federal, State, local and commercial total $2,725,000, and more improvements are being added each year. However, when new areas need to be developed, Public Law 89-72 requires that Federal expenditures be matched by State or local interests.

Water quality is a matter of vital concern to the Corps, and a continuous monitoring program is in operation at Kerr.

One last item, though not in Virginia, may be of interest. At the request of local interests, the Congress has authorized a review of the existing Roanoke River navigation project to determine if a channel 8 feet deep to Weldon and vicinity is economically feasible.

The Wilmington District has been working with the Water Resources Institute of the University of North Carolina, and the Wilmington District Engineer, Colonel Beverly C. Snow, Jr., is a member of the Advisory Committee. We are equally anxious to assist the Virginia Water Resources Research Center in any way possible, and, speaking for Colonel Snow, we pledge our full cooperation to the Research Center and to the Virginia Department of Conservation and Economic Development, Division of Water Resources in full development of water resources in the Commonwealth of Virginia.

CORPS OF ENGINEERS' PROGRAM FOR CONSTRUCTION OF SMALL BEACH EROSION CONTROL PROJECTS UNDER THE AUTHORITY OF SECTION 103 OF THE RIVER & HARBOR ACT OF 1962, AS AMENDED

Authority and Scope. Section 103 of the River and Harbor Act of 1962, as amended, provides authority for the Chief of Engineers to develop and construct small shore and beach restoration and protection projects that have not already been specifically authorized by Congress. A project is adopted for construction under Section 103 only after detailed investigation and study clearly shows the engineering feasibility and economic justification of the project. Each project must be complete, economically justified, and is limited to a Federal cost of not more than $500,000. This Federal cost limitation also includes all project related costs for construction, investigations, inspections, engineering, preparation of plans and specifications, supervision and administration. A small beach erosion control project developed under Section 103 is formulated to provide the same complete-within-itself project that would be recommended under regular authorization procedures. No additional work should be required to assure effective and successful operation of the project. An increment or portion of a larger overall project is not eligible for construction under this program.

How to Request Federal Assistance Under Section 103. An investigation of a prospective small project under Section 103 will be initiated after receipt of a formal request from a prospective sponsoring agency fully empowered under State law to provide all required local cooperation. This request and further inquiries concerning the desired project should be directed to the District Engineer for the concerned area. Upon receipt of a formal request, the District Engineer will initiate action to have the prospective project considered under Section 103.

Project Cost Sharing. The costs allocated to restoration and protection of Federal property are borne fully by the Federal Government. Federal cost participation may be up to one-half the cost of protecting shores owned by non-Federal public agencies. Protection of shores not publicly owned may be eligible for Federal cost sharing up to one-half provided there is significant public benefit arising from public use or from protection of nearby public facilities and provided such work is economically justified. The Federal participation is adjusted in accordance with the degree of such benefits. Under certain conditions, a project for restoration and protection of State and other publicly owned shore parks and conservation areas may be eligible for Federal cost sharing up to 70 percent of the total project cost, exclusive of land costs, provided the area meets specified criteria. Such areas must include a zone which excludes permanent human habitation, including summer residences; provide for conservation preservation and development of the natural resources of the environment; extend landward a sufficient distance to include protective dunes, bluffs or other natural features which serve to protect the uplands from damage; and provide essentially full park facilities for appropriate public use.

Local Cooperation: Formal assurances of local cooperation similar to those required for regularly authorized projects must be furnished by a local sponsoring agency. The local sponsor must be a municipality or public agency fully authorized under State laws to give such assurances and financially capable of fulfilling all measures of local cooperation. As a project is dependent upon local cooperation and participation, the importance of the existence of a legally authorized and financially capable local sponsoring agency warrants special emphasis. The sponsoring agency must normally agree to:

1. Contribute in cash the local share of project construction cost and assume full responsibility for all project costs in excess of the Federal cost limitation of $500,000.

2. Provide without cost to the United States all necessary lands, easements, and rights-of-way.

3. Hold and save the United States free from claims for damages which may result from construction and subsequent maintenance of the project.

4. Assure that water pollution that would affect the health of bathers will not be permitted (applied only in cases where the beach is used for recreational purposes).

5. Assure continued public ownership or continued public use of the shore upon which the amount of Federal participation is based, and its administration for public use during the economic life of the project.

6. Assure maintenance and repair, and local share of periodic beach nourishment where applicable, during the useful life of the works as required to serve the projects' intended purpose.

7. Provide and maintain necessary access roads, parking areas and other public use facilities open and available to all on equal terms.

Specific cases may also warrant assigning other additional local responsibilities, such as providing appurtenant facilities required for realization of recreational benefits.

Local Assistance: Local proponents of a small beach erosion control project can provide valuable assistance in the collection and furnishing of data needed to formulate the project plan and to evaluate project benefits. The District Engineer for the area involved will provide details to interested local groups concerning how they might assist in this respect.

Examples of useful information that local groups can obtain are:

1. A history of all prior actions taken to prevent or control shore erosion and the results secured thereby.

2. Any accurate local surveys which can be used to indicate progressive shoreline and off-shore changes.

3. Statistics on beach use, both for peak days and for the entire recreation season and estimates of prospective use.

4. Past storm and erosion damages experienced along the shore front.

CORPS OF ENGINEERS' PROGRAM FOR CONSTRUCTION OF SMALL NAVIGATION PROJECTS UNDER THE AUTHORITY OF SECTION 107 OF THE 1960 RIVER AND HARBOR ACT, AS AMENDED

Background. Section 107 of the River and Harbor Act of 1960, as amended, provides authority for the Chief of Engineers to develop and construct small navigation projects that have not already been specifically authorized by Congress. A project is adopted for construction under Section 107 only after detailed investigation clearly demonstrates its engineering feasibility and economic justification. Each project selected must be complete-within-itself and is limited to a Federal cost of not more than $500,000. This Federal cost limitation includes all project related costs for investigations, inspections, engineering, preparation of plans and specifications, supervision and administration, and construction operations. Projects resulting from Section 107 investigations are constructed in the order that they are adopted as rapidly as funds appropriated by Congress for this program will permit.

How to Request a Federal Navigation Improvement Under Section 107. An investigation of a prospective small project under Section 107 may be initiated after receipt of a formal request from a prospective sponsoring agency fully empowered under State law to provide all required local cooperation. This request and any further inquiries concerning a small navigation project should be made directly to the District Engineer for the concerned area. Upon receipt of a formal request, the District Engineer will initiate action to consider the prospective project under this program.

Project Scope. A project planned and constructed under Section 107 is designed to provide the same complete navigation project that would be provided for the locality under specific Congressional authorization procedures. An increment or portion

of a larger overall project is not eligible for construction under this legislation. Accomplishment of a Section 107 project completes the Federal participation in the navigation improvement except for routine maintenance operations.

Division of Work Responsibility. The Federal project can provide only general navigation facilities, which may include a safe entrance channel, protected by breakwaters or jetties if needed; protected anchorage basin; protected turning basin; and a major access channel leading to the anchorage basin or locally provided berthing area. General navigation facilities constructed under the Section 107 authority are maintained by the Corps of Engineers at Federal cost.

Docks, landings, piers, berthing areas, boat stalls, slips, mooring facilities, launching ramps, access roads, parking areas, and any interior access channels needed for maneuvering into berths, are entirely a local responsibility and are constructed and maintained at non-Federal expense. Local interests also provide all lands, easements, rights-of-way, spoil disposal areas, utility alterations, as well as all servicing facilities, including policing and other services. Local interests must also assure availability of a public landing or wharf.

Recreation Project Cost Sharing. In addition to the local responsibilities specified above, the present basis for cost-sharing in recreational small-boat projects provides that non-Federal cost participation will be one-half of the first costs of general navigation facilities serving recreational traffic.

Local Cooperation. Formal assurances of local cooperation similar to those required for regularly authorized projects must be furnished by the local sponsoring agency. The local sponsor must be a municipality or public agency fully authorized

under State laws to give such assurances and financially capable of fulfilling all measures of local cooperation. The sponsoring agency must agree to:

(1) Contribute in cash the local share of project construction cost, determined in accordance with existing policies for regularly authorized projects, in view of recreational benefits, land enhancement benefits or other special or local benefits expected to accrue.

(2) Provide, maintain, and operate without cost to the United States an adequate public landing or wharf with provisions for the sale of motor fuel, lubricants, and potable water open and available to the use of all on equal terms.

(3) Provide without cost to the United States all necessary lands, easements, and rights-of-way required for construction and subsequent maintenance of the project including suitable spoil disposal areas with any necessary retaining dikes, bulkheads, and embankments therefor.

(4) Hold and save the United States free from damages that may result from construction and maintenance of the project.

(5) Accomplish without cost to the United States alterations and relocations as required in sewer, water supply, drainage, and other utility facilities.

(6) Provide and maintain berthing areas, floats, piers, slips, and similar marina and mooring facilities as needed for transient and local vessels as well as necessary access roads, parking areas and other needed public use shore facilities open and available to all on equal terms. (Only minimum, basic facilities and services are required as part of the project. The actual scope or extent of facilities and services provided over and above the required minimum is a matter for local decision. The manner of financing such facilities and services is a local determination.)

(7) Assume full responsibility for all project costs in excess of the Federal cost limitation of $500,000.

Local Assistance. Local proponents of a small navigation project can provide valuable assistance in the collection and assembling of data needed to formulate a project plan and evaluate benefits. The District Engineer will provide details to interested local groups concerning how they can assist in gathering needed information. Examples of useful information that local groups can readily obtain are:

(1) Number, type, size, and draft of vessels presently using the waterway or harbor under consideration and reasonably prospective if proposed project is constructed;

(2) Amount of existing and reasonably prospective commerce shipped or received via the waterway or harbor under consideration; and

(3) Hazards and difficulties to navigation with factual history of accidents, groundings, loss or damage to vessels and facilities as well as examples showing the extent that existing conditions restrict full navigational use such as delays in entering or leaving the harbor caused by waiting for favorable tides.

CORPS OF ENGINEERS' PROGRAM FOR CONSTRUCTION OF SMALL FLOOD CONTROL PROJECTS UNDER THE AUTHORITY OF SECTION 205 OF THE 1948 FLOOD CONTROL ACT AS AMENDED

Background: Section 205 of the 1948 Flood Control Act as amended by Section 205 of the 1962 Flood Control Act provides authority to the Chief of Engineers to construct small flood control projects that have not already been specifically authorized by Congress. Each project selected must be complete-within-itself and be economically justified. In addition, each project is limited to a Federal cost of not more than $1 million. This Federal cost limitation includes all project related costs for investigations, inspections, engineering, preparation of plans and specifications, supervision and administration and construction.

Project scope: A project planned and constructed under Section 205 is designed to provide the same complete project and same adequate degree of protection as would be provided under specific Congressional authorization. Flood control projects under Section 205 are not limited to any particular type of improvement and a project may include features for other purposes, such as water supply, when local interests indicate the need as well as the willingness and ability to contribute the project cost representing the cost assigned to that purpose.

Local cooperation: Formal assurances of local cooperation similar to those required for regularly authorized projects must be furnished by a local sponsoring agency. The local sponsor must be fully authorized under state laws to give such assurances and financially capable of fulfilling all measures of local cooperation. As a project is dependent upon local cooperation and participation, the basic importance of the existence of a legally authorized and financially capable local sponsoring

agency cannot be overemphasized. The sponsoring agency must agree to:

(1) Provide without cost to the United States all lands, easements, rights-of-way, utility relocations and alterations, and highway or highway bridge construction and alterations necessary for project construction.

(2) Hold and save the United States free from damages due to the construction works and adjust all claims concerning water rights.

(3) Maintain and operate the project after completion without cost to the United States in accordance with regulations prescribed by the Secretary of the Army.

(4) Assume full responsibility for all project cost in excess of the Federal cost limitation of $1 million.

(5) Prevent future encroachment which might interfere with proper functioning of the project for flood control.

(6) Provide a contribution toward construction costs where special local benefits will accrue in accordance with existing policies for regularly authorized projects.

(7) Provide a cash contribution for project costs assigned to project features other than flood control.

How to request a project under Section 205: A project is adopted under Section 205 only after full detailed investigation and study clearly shows the engineering feasibility and economic justification of the project proposed. An investigation of a prospective small project under Section 205 may be initiated after receipt of a formal request from a prospective sponsoring agency fully empowered under State law to provide all required local cooperation. This request and any further inquiries concerning a small flood control project should be made directly to:

District Engineer
U. S. Army Engineer District, Wilmington
P. O. Box 1890
Wilmington, North Carolina 28402

WATER RESOURCE ACTIVITIES - BALTIMORE DISTRICT
U. S. ARMY CORPS OF ENGINEERS

by

Joseph E. Book, Chief
Flood Control Section

THE COMMONWEALTH AND THE BALTIMORE DISTRICT

The Land

That part of the Potomac River Basin rising within the Commonwealth of Virginia is included within the boundaries of the Baltimore District for water resource planning and development. This northeastern portion comprises about one-seventh of the entire Commonwealth land area, and represents a cross section of coastal plain, piedmont, and ridge and valley topography. This area has produced, over the years, a significant share of the important historical human events of both the Commonwealth and the Nation. For the future, northern Virginia will continue to hold an important position within the Commonwealth.

The People

While the Baltimore District includes only about 14 percent of the entire Commonwealth land area, some 22 percent of its people are now living within the District's boundaries. This percentage can be expected to increase, along with the importance of northern Virginia, to an estimated 25 percent of the total Commonwealth population by the year 2010. The focal point of this growth will be the Washington Metropolitan Area, where today more than 62 percent of the Baltimore District's Virginia citizens reside, and by 2010 over 65 percent. Clearly, this entire area is one requiring careful and thorough planning if its water and related land resources are to be developed and used wisely.

Based on numerical estimates, rather than percentages, the water resource requirements of some 960,000 persons in the District portions of the Commonwealth must be adequately met now, and before 2010 we must somehow develop the means to provide for a population of more than two million. The significant increase in the water-using population, together with an increase in the individual water-use requirements and the advent of new demands, will assure that today's demands on the area's water resources will be expanded severalfold by the year 2010.

Table 1

POPULATION ESTIMATES, COMMONWEALTH OF VIRGINIA

	1965	2010
Total Commonwealth	4,400,000	8,200,000
Baltimore District Portion	960,000	2,100,000
Washington Metropolitan Area	600,000	1,370,000

THE WATER RESOURCE REQUIREMENTS

General

The water-use requirements of the Virginia residents within the Baltimore District encompass, to a greater or lesser extent, the full spectrum of uses. The Potomac River, in Maryland, and its major tributary system - the Shenandoah in Virginia and West Virginia - provide the northern Virginia population a substantial natural water-resource base adequate to meet many of the current demands on surface water most of the time. There are deficiencies in the time and area dispersion of its water resources that limit effectiveness and underline a need for planning and development to allow more widespread use and beneficial return. Before a program is developed to meet both current and future water needs, there must first be an analysis of the needs. Each water need will be summarized herein under general requirement categories, to include water storage, water-associated recreation, control of water damage, and navigation and commercial fisheries developments.

Water Storage Requirements

Foremost among the needs for stored water in this District is to augment low streamflows during drought periods. The primary purposes for this low-flow augmentation are to meet demands for adequate municipal and industrial water supply, and to improve the overall quality of drought streamflows. With the notable exceptions of the Washington Metropolitan Area of Virginia, and the southern portion of the Shenandoah Valley, existing surface raw water supplies are generally adequate and dependable from a quantity standpoint, and will continue to be so, with local exceptions, for some years to come, But when we examine the qualitative aspects of this same supply, new problem areas arise, particularly during low-flow periods, that

cannot be solved effectively and economically without some development of water storage for low-flow augmentation.

Agricultural demands on summer streamflows also must be considered when examining the need for low-flow augmentation from reservoir storage. This need, while almost wholly consumptive, is not expected to compete seriously with municipal and industrial uses or to affect stream quality significantly. Hydroelectric power generation, even where it may prove to be economically feasible, is in limited demand at present and cannot be considered a prime purpose for storage at reservoir projects.

Water-Associated Recreation

Related directly to the overall quality of existing surface waters is their use for general recreational purposes. If quality can be improved, where required, and maintained at an acceptable level for recreational use, many of the water-associated general recreation needs of northern Virginia residents can be met. This could diminish considerably the required development of new water surface, except where adequate water areas are lacking or where suitable access cannot be developed economically. Recreational use of water stored primarily for low-flow augmentation purposes and integrally planned for each project can help meet general recreational demands in water-surface-deficient areas.

The fishery and water-associated wildlife resources of the Baltimore District within and adjacent to the Commonwealth are of high value and receive considerable use for both recreational and commercial purposes. Their enhancement and better use to provide recreational benefit is a developmental need, requiring integral planning with each water-associated project of this District.

Recreational boating, a fast growing requirement for use of existing and future water surfaces in the northern Virginia vicinity, will require considerable development of marina facilities and small channels for larger craft, and adequate access to public waters for trailer-towed craft. Areas deficient in surface waters of any extent, or where boating use already has reached the resource capacity, will require development and opening of new surface waters for such use.

Control of Water Damage

Another primary requirement is the reduction of damage from both fluvial and hurricane tidal flooding. Considerable areas of flood plain throughout the Virginia segment of this District have some degree of development subject to flooding. A few localities, particularly in the Washington Metropolitan Area of Virginia, are suffering serious flooding due mainly to drainage area change to an urban-suburban condition. The pressure in these areas to use all lands for development remains high.

Lesser but still important requirements, principally on the Coastal Plain, are to reduce erosion damage along shorelines and to improve drainage in low-lying agricultural areas.

Navigation and Commercial Fisheries

Commercial boat use of the waterways in northern Virginia is limited to small-boat traffic in inlets of the Potomac River in the tidewater area. The Potomac River in adjacent Maryland, however, serves as the main connecting waterway from the mouth of the river up as far as Alexandria and the Washington Metropolitan Area. This waterway serves the tidewater Virginia navigation needs, as well as commercial fishery operations, for a distance of more than one hundred miles. Within the Commonwealth itself, development requirements mainly include small

boat channels, turning basins, and similar small-boat harbor facilities, the only port of significance in this area being Alexandria.

MEETING THE WATER RESOURCE REQUIREMENTS

Completed Projects

Developmental activity by the Corps of Engineers in the water resources field has been relatively light in the past in the Commonwealth portion of the Baltimore District. The abundant water resources of the area, so far at least, have generally supported economic growth with only a minimum of Federal investment to fulfill water resource requirements. To date, perhaps the most consistently effective Corps of Engineers service to the area has been the provision of treated water supply for distribution by several Washington Metropolitan Area communities in Virginia, particularly Arlington County. This supply is provided on a contract basis as an adjunct to the supply of treated water to the District of Columbia, and has allowed the recipient communities to distribute the needed supply at minimum cost to their consumers.

Following disastrous flooding and loss of life on the North River in the Shenandoah Valley in June of 1949, a partial flood-control project was completed at Bridgewater in 1952. The project will prevent severe damages and loss of life at Bridgewater resulting from a recurrence of the 1949 flood. In addition, following the flood, certain private farm levees were restored and repaired in 1950, using emergency funds and authorities.

A number of small-boat harbors and channels serving the smaller communities and commercial fisheries have been constructed by the District in the tidewater area. They include, as typical examples, the Little Wicomico River channel and jetties in Northumberland County, the Branson Cove and Lower Machadoc River projects in Westmoreland County, and the Upper Machadoc Creek channel and turning basin in King George County. Channel work in the Potomac River, particularly to Alexandria, has

also benefitted larger commercial boat traffic serving Commonwealth communities near the river.

Active Programs

Most notable of the current programs is the preparation of flood plain information studies under the authority contained in Section 206 of the 1960 Flood Control Act. This program will greatly assist local planning agencies in the northern Virginia area, and could be a means of arresting the continued growth in the damages caused by floods. Now underway are studies of the Shenandoah River in Clarke County, and of Fourmile Run in Arlington County and the City of Alexandria.

Continuing efforts to improve the quality of recreational and commercial boating activities on tidewaters accessible to the Virginia residents in the Baltimore District have included the removal and control of water-chestnuts, a former hindrance to navigation on the Potomac River and its estuarial inlets. This program, since it was begun in 1939, has resulted in virtual control of this small-boat menace. A program was initiated this year for the removal of drift from the Potomac River estuary near Washington. This will improve the safety and appearance of waterways receiving substantial recreational boat use by Virginia residents in the Washington Metropolitan Area from Mount Vernon upstream to the limit of tidewater.

Planning Efforts In Progress

Scheduled to begin construction next fiscal year, for completion by 1974, is the Bloomington Reservoir Project in the headwaters of the Potomac River on the North Branch. This project, while not itself within the Commonwealth, will benefit Virginia residents who are served by the Potomac River at any point adjacent to the Commonwealth. The basic benefit derived by the lower Potomac River from the Bloomington Project will be

increased streamflow during drought periods. The availability of this added flow would have avoided the near-crisis in the supply of raw water for the Washington Metropolitan Area early last month, when voluntary water-use restrictions were placed upon communities drawing upon the Potomac. Construction may not begin, however, unless the necessary guarantees to repay the Federal Government the cost of water supply storage at the project are furnished by the several states involved and the District of Columbia.

The Potomac River Basin Report of February 1963 recommended construction of three reservoirs entirely within the Commonwealth on smaller tributaries west of the Blue Ridge. Also recommended was the Seneca Project, on the main stem of the Potomac just upstream from the Washington Metropolitan Area, in both Virginia and Maryland. These projects would meet most of the water supply, water quality, recreation, and flood-control needs of the Commonwealth portion of the District for many years to come. The three reservoirs west of the Blue Ridge are primarily intended to meet water-resource needs originating in that area, whereas the Seneca Project is planned to meet the Washington Metropolitan Area requirements.

Before the District Engineer's report was submitted to the Congress by the Chief of Engineers, the President, in his message on "Natural Beauty" on 8 February 1965, asked that the Potomac serve as a model of scenic and recreation values for the entire country. He requested the Secretary of the Interior to review the report of the Corps of Engineers and to work with the affected states and local governments, the District of Columbia, and interested Federal agencies to prepare a program which will clean-up the river and keep it clean, protect its natural beauties and provide adequate recreational facilities.

The Federal Task Force created for this planning purpose submitted a "Potomac Interim Report to the President" on 6 January 1966. The interim report recommended that the key Seneca Project not be built at this time, but that the lands within the Seneca Reservoir site be preserved at about their present level of economic development. Further, it recommended immediate action toward authorization for construction of three water supply and recreation reservoir projects on small tributary streams in Maryland and West Virginia to meet immediate needs.

To implement the Task Force recommendations, the Chief of Engineers recommended, in a subsequent report, that the Town Creek, Little Cacapon, and Sideling Hill Reservoirs be authorized for construction and preservation of the Seneca Reservoir site. This latter report is under review by the state and Federal agencies concerned.

It is also appropriate to mention at this point that the District is continuing its planning studies of new or reactivated small-boat harbors and channels in the Virginia tidewater area. Included in such studies is the Neabsco Creek, Prince William County, channel and turning basin for restoration to full recreational use.

NEW PLANNING STUDIES TO MEET CHANGING NEEDS

The Interdepartmental Task Force on the Potomac plans to release a final report early in 1967. At present, the member agency representatives and state representatives are continuing their efforts to adopt a coordinated and comprehensive program recommendation that will meet the water resource needs of the Potomac Basin, particularly at Washington, and will be acceptable to the conflicting viewpoints on water resource development of the basin population. If their recommendations are acceptable, it will mark a milestone in the developmental history of the Potomac River Basin.

There are several other new broad-based comprehensive studies which are or shortly will be underway and will include the northern Virginia area. One of these is the North Atlantic Regional Water Resources Study, under the overall guidance of a Coordinating Committee composed of Federal and state agency representatives. The North Atlantic Division of the Corps of Engineers is directing the framework study which will identify, in general, all water resource developmental needs to the year 2020. The framework plan formulated during the study would serve to guide the timing of future development and to specify the areas requiring early detailed planning investigations.

Public Law 89-298, of the 89th Congress, authorized two additional major water resource studies. Section 101 of the Act authorized the Chief of Engineers to prepare plans to meet the long-range water needs of the northeastern United States. The study will make a regionwide assessment of the water-supply problems of major metropolitan areas, including the entire Washington Metropolitan Area, now and into the future. The study will be coordinated through the existing North Atlantic Regional Coordinating Committee and by field-level contact with

interested agencies. In this case, plans for major reservoirs, major interbasin conveyance facilities, and major purification facilities could result from the study.

Section 312 of Public Law 89-298 also authorized a comprehensive study of water use and control of the entire Chesapeake Bay Basin, including construction of a hydraulic model. The model will be in Maryland, but will be available to Virginia agencies. Baltimore District will make significant contributions to all of the major studies mentioned insofar as the District's Virginia portion is concerned.

At first examination, it would appear that there is considerable overlap (and potential confusion) in the numerous broad planning programs underway within the Baltimore District alone. However, each such study works toward fulfilling one or more categories of water resource needs, both now and for the fifty-year future, in each region of the District.

WATER RESOURCE ACTIVITIES - HUNTINGTON DISTRICT
U. S. ARMY CORPS OF ENGINEERS

by

C. W. McIntyre
Engineering Division

Extent of Responsibility

The Huntington District, as a part of the Ohio River Division of the Corps of Engineers, has a responsibility for water resources development in the part of Virginia that drains into the Ohio River by way of the Big Sandy and Kanawha River Basins.

Big Sandy River Basin

The part of Virginia within the Big Sandy River Basin covers 988 square miles which is 23 percent of the basin. The area, consisting of all of Buchanan and parts of Dickenson, Tazewell and Wise Counties, is extremely rugged and mountainous.

Two multi-purpose reservoir projects, John W. Flannagan on Pound River and the North Fork of Pound, have recently been completed within Virginia.

John W. Flannagan Reservoir

The Flannagan Reservoir (named for the late Congressman) is near Haysi, Virginia, with the dam being 1.8 miles above the mouth of Pound River. The dam is rock-fill type, 916 feet long and has a maximum height of 250 feet. A gated spillway is located in a saddle about 0.3 mile south of the dam. The outlet works consist of a 16 foot horseshoe type tunnel through the left abutment with a gated intake structure on the upstream end. The reservoir controls the runoff from an area of 222 square miles.

The reservoir will have a permanent winter pool with storage capacity of 12,000 acre-feet and 310 acres surface area. A seasonal pool available to the public for recreational use will

have a pool area of 1,143 acres and a shore line about 39 miles long. The primary purpose of the project is flood control for downstream areas along Pound River, Russell Fork, Levisa Fork, Big Sandy River and the Ohio River, with 95,100 acre-feet of storage being available for this purpose during the winter and 78,600 during the summer. It should be noted that the project is credited with preventing almost $16,000,000 of flood damages since it was placed in operation. Most of the damages prevented were for the 1963 flood when the project was only partially complete. Flood control benefits already exceed the project costs allocated to that purpose. Another purpose for which the project will be operated is low-flow augmentation to improve the water quality of the industrialized areas along Levisa Fork and the Big Sandy River during low flow seasons.

North Fork of Pound Reservoir

The North Fork of Pound Reservoir in Wise County has been completed recently. The dam is located 1.1 miles above the mouth of North Fork and controls a drainage area of 17.6 square miles. The rock fill dam is 600 feet long and has a maximum height of 122 feet. An uncontrolled spillway is located in a ridge about 1,000 feet southeast of the dam. The outlet works consists of a 7.5 ft.-diameter horseshoe tunnel with a gated intake structure on the upstream end.

The reservoir has a minimum (winter) pool with 1,895 acre-feet of storage capacity and a pool area of 106 acres. A seasonal (summer) pool with a shore line about 13.5 miles long, and a surface area of 154 acres will be available for general public use for recreational purposes. The project will provide a high degree of flood protection to the town of Pound.

One additional authorized reservoir project, the Haysi Reservoir is located on Russell Fork upstream from the town of

Haysi. The project was considered in a survey of water resources developments for the Big Sandy River Basin that was completed in 1965. The project was found to be economically infeasible and has therefore been placed in an "inactive" status.

One application has been submitted for a flood plain information study within the Big Sandy River Basin. A study for providing information regarding flood frequency and magnitude along Levisa Fork in Buchanan County has been approved although work has not been scheduled.

Kanawha Basin

A comprehensive study is being made of the Kanawha River Basin. This is one of 16 such comprehensive studies currently in progress in the Nation.

The Huntington District is responsible for directing the study and preparing the plan and report. The Federal Power Commission and agencies of the Departments of Agriculture, Commerce, and Interior are actively participating in the study and are represented on a Coordinating Committee. Since the Kanawha Basin encompasses portions of the States of West Virginia, Virginia, and North Carolina, studies are also being coordinated with authorities and agencies of these states, and they too are represented on the committee.

The Kanawha Basin consists of 12,300 square miles of which 3,080 or about 25 percent is in Virginia. The basin's rugged topography has restricted most development to the stream valleys. Basin population is about 900,000 with less than 20 percent being in the Virginia part of the basin.

Previous Corps of Engineers studies of the basins water resources problems and needs have resulted in the construction of 3 major reservoirs, 4 local protection projects, 3 channel

snagging and clearing projects, and canalization of the lower 91 miles of the Kanawha River. All three of the reservoirs are located within West Virginia although part of the flood control pool of the Bluestone Project extends into Virginia.

Bluestone Reservoir

Seasonal impoundment of water at Bluestone Reservoir provides a lake with 1,970 surface acres which is readily accessible to Virginia residents. The Bluestone Reservoir, together with the dam and the public use facilities, attracted 626,000 visitors in 1965. The project provides a high degree of flood protection for downstream areas and contributes to reduction of flood stages along the Kanawha and Ohio Rivers. The Bluestone Reservoir has penstocks installed for authorized hydroelectric generation, but utilization of storage capacity for power purposes has been deferred pending completion of additional flood protection storage elsewhere in the basin.

A local protection project located at Galax was completed in 1951. The project consists of 13,700 feet of channel improvement along Chestnut Creek and provides a dependable degree of flood protection for the town of Galax.

Other water resource projects in the basin include small watershed projects developed under the Department of Agriculture's Public Law 566 program and several hydroelectric projects which have been developed by non-Federal interests. The largest of the private power projects is the Appalachian Power Company's Claytor Dam and Reservoir on New River near Radford.

While the present developments in the basin have solved many critical problems, significant requirements for additional flood control, low flow augmentation and water oriented recreation exist. Also, demands for additional and better quality sources of water supply are increasing. Our present study encompasses these and all other water related requirements.

The study is being conducted in three overlapping phases. Phase I, which is nearing completion, entails determination of the magnitude of the Basin's water related problems and needs and preliminary evaluation of potential solutions. The second major phase was initiated early this year and will continue through 1967. During this period, alternate projects and plans will be subjected to more detailed study and refinement with the view of eliminating alternates and selecting the best overall plans for further study. Phase III of the study will be reached in 1968 when the plan of development will be selected.

During this phase, projects selected for detailed analysis will be studied on a system basis to insure optimum utilization of the resources.

Since the Kanawha Basin encompasses a relatively large area, our investigations were initiated by individual consideration of the basin's six major drainage areas. The planning objective in each sub-basin is to satisfy its specific water management problems and a portion of outstanding downstream needs. The major sub-basin in terms of size is the Upper New River area. This sub-basin consists of the area controlled by the existing Bluestone Reservoir and comprises 37 per cent of the entire Kanawha Basin.

Upper New River Sub-Basin

Studies in the sub-basin have been accelerated to provide a basis for evaluating the effects of the hydroelectric power project proposed by the Appalachian Power Company. This project which is designated as the "Blue Ridge Development" is located on New River near Galax, Virginia, at the same site as the Corps' authorized Moores Ferry Reservoir project.

The importance of this reservoir site and the scope of the power company's proposal has necessitated consideration of

all possible near-future water resource developments in the sub-basin.

Preliminary consideration has been given to potential reservoir sites on every significant stream and a group of the most outstanding projects has been determined by completing progressive cycles of evaluation, comparison and elimination. Preliminary cost estimates and benefit evaluations have been completed at these potential sites. These studies have provided a basis for determining a basic sub-basin reservoir system which produces maximum net benefits for a combination of sub-basin and downstream needs. An interim plan has been formulated and an interim report was scheduled for completion this year. However, several study participants became involved in the Department of Interior's intervention in the proposed Blue Ridge Project and were unable to meet the interim report schedule which has resulted in indefinite deferral of interim report submission.

Projects in this interim plan are reservoir sites 59 on Little River, 61 on Big Reed Island Creek, 66 on Reed Creek and either the Blue Ridge or the Moores Ferry Project. These projects would provide flood control, water quality control and water oriented recreation. Hydroelectric power would be a major feature of either the Blue Ridge or Moores Ferry Project. In addition, the flood control storage in these projects would permit a reallocation of some flood control storage in the existing Bluestone Reservoir.

The need for augmentation of low-flows in the Kanawha River in the vicinity of Charleston to improve the water quality to acceptable standards will require substantial releases from storage from May through November for most years. It is recognized that releasing large amounts of water from a reservoir for low-flow augmentation purposes will adversely affect pool

stability and cause drawdown that will be incompatible with proper utilization of the recreational potential of a reservoir. With a system of reservoirs, an operational plan can be developed to designate some projects to have minimum recreational development and to be utilized for providing augmentation releases during the recreational season. This procedure will permit other projects to have significant recreational development by maintaining pool stability during the period of primary outdoor recreation activity. Birch Reservoir in the Elk River Sub-basin in West Virginia and Big Reed Island Creek Reservoir in Virginia are among those currently considered to be utilized primarily for low-flow augmentation purposes. Reed Creek and Little River Projects in Virginia are among those expected to be developed extensively for recreational purposes.

The comprehensive study is scheduled for completion in 1969. The study is expected to result in a comprehensive plan formulated to provide optimum utilization of the water and related land resources of the Kanawha Basin to most efficiently solve or alleviate the water-related needs and problems within the limitations of economic feasibility and existing legislative regulations. In addition to the Blue Ridge-Moores Ferry Project, (final use dependent on decision of Federal Power Commission relative to licensing for private power development) at least four sites in Virginia will be subjected to detailed analysis in final selection of projects for the comprehensive plan.

Appalachia

All of the part of Virginia within the Ohio River Division (except Montgomery County) is also within the area designated as Appalachia. Projects in Appalachia are eligible for consideration under provisions of the Appalachian Regional Development Act of 1965 where such projects can be expected to contribute

to economic development of the region. Projects that may be considered under special criteria being developed by the office of Appalachian studies include reservoir projects in Kanawha Basin, the Haysi Reservoir Project on Russell Fork and a local protection project for Bluefield, Virginia.

WATER RESOURCE ACTIVITIES - NASHVILLE DISTRICT
U. S. ARMY CORPS OF ENGINEERS

by

F. P. Gaines, Chief
Engineering Division

The Nashville Engineer District encompasses the relatively small tip of Virginia within the Tennessee River watershed, comprising all or portions of the following counties: Lee, Wise, Scott, Russell, Washington, Tazewell, Smyth, and Bland.

Under the division of responsibility within the Tennessee River basin between the Corps of Engineers and the Tennessee Valley Authority, TVA has jurisdiction for overall basin development; whereas, the Corps operates and maintains the navigation locks and channels and exercises flood control functions only as related to local protection problems. In consequence, the activities of the Nashville District within Virginia have been limited to the conduct of studies of reconnaissance scope for several communities - Raven, Doran, Richlands, and Coeburn - with the view of alleviating local flood problems under outstanding authority providing for construction of small flood control projects within certain monetary limitations (Public Law 685, 84th Congress).

The towns of Raven, Doran, and Richlands are situated within an approximate 8-mile reach of Clinch River in the extreme western portion of Tazewell County. The most logical and economical solution to the flood problem was found to be channel improvement extending from the upper limits of Richlands to a point some 1.8 miles downstream from Raven a distance of about 40,000 feet along the present stream. It was designed to afford protection against a flood of the magnitude of that of January 1957, the most damaging of record. Losses from that flood were estimated as in excess of $300,000 for the three

communities, exclusive of approximately $50,000 expended by the Red Cross on relief and rehabilitation of flood victims in Tazewell County. Benefits creditable to the improvement on an annual basis, however, in terms of flood damages preventable and enhancement of property values, were far from sufficient to justify Federal participation in the project. Study of the flood problem at Coeburn, situated at the confluence of Little Toms Creek and Guest River, Wise County, Virginia, likewise indicated channel improvement as the most likely means of providing a reasonable degree of protection commensurate with the cost. In avoiding duplication of effort, however, the investigation was discontinued short of determining the economics of improvement in detail, at the request of the mayor of Coeburn upon inclusion of flood relief for the community under the regional program of water resources development being pursued by the Tennessee Valley Authority.

No further action is contemplated at this time with regard to these or other problem areas; and, with possible exception of unusual circumstances or at the direction of Congress, Corps activity in the field of flood control within the Nashville District portion of the State may well be precluded with expansion of the Authority's Tributary Area Development Program.

WATER QUALITY CONTROL IN VIRGINIA

by

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State Water Control Board
Richmond, Virginia

The five-member State Water Control Board is charged by the State Water Control Law with the responsibility of preventing and controlling pollution (managing the quality of) Virginia State waters.

"Pollution" is defined by the Law as the discharge or deposit of sewage, industrial wastes or other wastes "in such condition, manner, or quantity" as may degrade the quality of State waters to such an extent as to render them unsuitable for their reasonable and necessary uses.

Having defined pollution, the Law charges the Board with the duty of carrying out the two prime objectives of the Law, to

(1) Improve the quality of State waters that were polluted on July 1, 1946, when the Law became effective, and

(2) Prevent the degradation of the quality of State waters subsequent to July 1, 1946, so no new pollution will be created.

The primary authority for accomplishing these objectives is found in Section 62-23(3) of the Law, which permits the Board

> "To establish such standards of quality for any waters in relation to the reasonable and necessary use thereof as it deems to be in public interest, and such general policies relating to existing or proposed future pollution as it deems necessary to accomplish the purposes of this . . . (Law), to modify, amend or cancel any such standards or policies established and to take all appropriate steps to prevent pollution contrary to the public interest or to standards and policies thus established."

The other sections of the Law set forth the specific administrative and legal machinery for achieving the Board's water quality objectives.

Discharges of sewage, industrial wastes and other wastes may be made only in accordance with stipulated conditions as set forth in permits, or certificates, issued by the Board. Sewage and industrial waste discharges existing on July 1, 1946, were permitted to be continued under conditions existing on that date, but any pollution they were causing had to be reduced as required by the Board. Wastes from new industries, or from existing industries which expand or employ new processes, may be certificated for discharge only after the Board is satisfied no new or increased pollution will occur. Certificates remain valid until revoked by the Board.

The Board is required to approve plans for new sewerage systems or sewage treatment works or for material changes to existing ones, after review of such plans by the State Department of Health.

The Board may call a hearing and issue a special order requiring any owner to obtain certain operating results with respect to meeting the Board's stream quality requirements. If the owner fails to comply with the order, the Board may seek to obtain compliance in the courts through injunctive or mandamus proceedings. On the other hand, the owner may appeal orders of the Board to the courts.

The Board is authorized to employ an Executive Secretary and other technical and clerical personnel to collect facts, make scientific determinations and investigations regarding pollution problems, to enforce the Board's decisions, and to keep the Board's records.

Virginia's Approach - Round One

In the first 15 years of its existence the Board established few specific numerical standards for any State waters. Rather, it generally wrote its requirements in terms of broad

objectives, concentrating its efforts on the most pressing and obvious pollution problems, which it was usually able to evaluate on the basis of sight and smell and the exercise of judgment.

For instance, it was obvious to all concerned in 1946 that a certain large industry on a medium-sized stream, would have to reduce the biochemical oxygen demand (B.O.D.) and solids in its industrial wastes to the minimum possible amounts, in order to maintain any semblance of dissolved oxygen (D.O.) in the stream. It would have been useless to establish a D.O. limit at that time when there was not even a practical treatment method for removing B.O.D. from the waste. Therefore, the Board directed the industry to begin, without delay, a program with the objective of improving the situation. Through research, the industry developed practical technology for treating the wastes, and treatment facilities were eventually installed. After several years of successful operation, it became evident that a certain minimum concentration of D.O. could be maintained in the receiving stream, and this value was eventually adopted as an official standard of quality.

Variations of this approach could be cited in many other cases. Its value lay in the fact that it did not delay doing what obviously could immediately be done while plans were being developed for what should ultimately be done. The result was an immediate improvement plus the purchase of time, during which the owner involved and the Board could make studies aimed at coming up with data that would permit the setting of final objectives or standards.

This type of program pursued relentlessly but patiently by the Board during the past 20 years has succeeded in reversing the trend of stream degradation in Virginia. Complete recovery has been effected in a number of instances. Substantial improvement has been made in most places. There are, fortunately, only

a few cases where unavailability of treatment methods has permitted little improvement. But it can be said, in each of these cases, that there has been no further degradation. Some 100 wet-process industries have located new plants in Virginia since 1946, or have made major expansions of existing plants, without adding to the pollution problem. This is true also of the hundreds of new (post-1946) sewage discharges that have sprung up from new schools, institutions, subdivisions, shopping centers, and the additional sewage from population growth of municipalities.

Progress during Round One has been relatively easy to obtain. Much of it was effected, or at least started, during the early days of the Board on the basis of correspondence plus the expenditure by a very small staff of only a moderate amount of effort in travel and stream survey activities. The time of such "cheap" progress has long since passed. To monitor and hold the line on what has been done, and to evaluate and solve the problems that remain, will require the expenditure of a disproportionately much greater amount of effort by the Board's staff. On top of this, attention must be given to new problems that are constantly arising incidental to population and industrial growth.

The Future - Round Two

The program of "Round Two," which has already begun, entails

(1) Making detailed surveys of streams to assess accurately the water quality improvement made during Round One,

(2) Determining in each stretch of stream what ultimate water quality is in the public interest; that is, what further improvement - if any - needs to be made, and

(3) Enforcing and maintaining surveillance over water

quality objectives and standards that have been and will be established.

Stream Surveys

There are many stretches of streams in Virginia where the load of wastes discharged has been greatly reduced since 1946. In most instances there is evidence that the streams have improved, but in many cases sufficient data regarding present water quality is not available, or has not been processed in usable form. The Board faces a rather large order in getting the additional stream data necessary to make an accurate assessment of present water quality, as well as to determine desirable future water quality goals. This is true not only in the stretches of streams previously referred to, but in many other stretches as well. Some of these "other stretches" are below waste discharges that now have only a minor impact on water quality. In addition, many stretches of streams now receiving little or no man-made wastes will become very important as the State's accelerated industrialization program proceeds, and they are considered to receive the wastes from potential new industrial establishments.

To obtain this data means that the Board's Stream Survey Section will need to be strengthened with considerably more personnel and, to a lesser extent, more equipment.

The use of analog and digital computer methods for processing data is now being investigated and the first item of equipment is scheduled to be purchased in the near future. Such methods promise to permit more rapid completion of reports on surveys and investigations.

Closely paralleling the Stream Survey Section's needs are those of the Board's Laboratory Section. The laboratory serves not only the Stream Survey Section, but other sections as well.

Even under present conditions these sections can easily generate a great deal more work than the laboratory can do. It is obvious, then, that any stepping up of activities in other sections will automatically call for more laboratory facilities.

The chief need is for additional equipment, especially in the line of infra-red and chromatographic analyses, and automating and instrumenting a number of other analytical methods. As in other fields of endeavor, the trend in laboratory facilities associated with water pollution control agencies must be toward sophistication. The ability, for instance, to find the tiny amount of an elusive economic poison that caused a fish kill, or the exotic chemical that is causing a taste and odor problem in a water supply depends on more and better laboratory equipment and personnel. Conventional wet methods of analysis must gradually give way to instrumental and automatic methods, in order to permit the maximum amount of laboratory work output with the minimum number of people. Funds were appropriated by the 1966 General Assembly to buy some of the necessary equipment, but since the Board has acquired practically no new equipment since 1956, there is quite a bit of "catching up" to do. It will probably cost another $200,000 to upgrade the Board's laboratory to take advantage of latest technology.

Establishing Standards

As was mentioned previously, the Board established few formal standards until some five years ago. Two influences have accelerated this trend.

One is the state's economic growth. New industrial and residential developments have created a need to discharge wastes into so-called "clean" streams. The other is the Federal Water Quality Act of 1965, which stipulates that if the states do not adopt water quality standards on all interstate and coastal

streams on or before July 1, 1967, the Secretary of the Interior is empowered to do so. Whereas the Board has been following for some time a program of establishing standards on those State waters where a demonstrable need exists for doing so, the 1965 Federal Act makes this job mandatory on many stretches of streams where the need to do so at this time is questionable.

Establishing water quality objectives or standards is a fundamental first step to administration of a water pollution control program. However, the job of making standards truly meaningful and enforceable is not an easy one, both from the technical and administrative standpoints.

The first step in establishing standards is to determine what uses of the stream are to be protected, since the Law stipulates that the Board shall establish standards on streams "in relation to the reasonable and necessary use thereof as it deems to be in public interest." Determining the "public interest" usually requires the Board to hold a public hearing, at which all persons using or having an interest in a particular stream may appear and make their views a matter of record.

Practically, water pollution control often resolves itself into a struggle to obtain and maintain the best possible water quality consistent with the use of streams for both waste disposal and other existing or potential uses. A reservoir used as the source of a city's public water supply is usually an invitation to swimmers, boaters, fishermen and water skiers, whose unrestricted use of the lake may so contaminate the water as to abrogate the primary purpose for which it was constructed.

An example will illustrate that water quality tolerable for some use of streams may differ markedly from that quality which is needed for another use. The Water Control Board faced the problem several years ago of deciding whether a certain industrial waste could be discharged into a stream used for both

oyster production and recreation. It appeared quite feasible for the industry to treat its waste and maintain recreation water standards which would have satisfied the owners of summer cottages. However, treatment by the industry to maintain the much more rigid oyster water standards appeared destined to put it out of business. Yet, to allow the waste discharge to continue untreated, or treated only to the extent that recreational waters could be maintained, seemed just as destined to put the oyster producers out of business. Fortunately, research turned up a satisfactory means for satisfying nearly everybody comprising all three interests, but the solution is not always so equitable.

The ideal objective, of course, would be to strive for a policy of maintaining the same equally high quality of water in all streams, but even if man had not come into the picture to degrade the quality of streams with his wastes, such a policy would be unattainable even in virgin country. God made the streams to drain the land of its impurities, and these impurities differ depending on geographic locations. A swamp stream is usually highly colored, may be acidic, and contains the lignins and other leachings from leaves and other decaying vegetation. A crystal clear stream flowing through uninhabited arid land may be alkaline, and contain high concentrations of dissolved mineral matter. In both examples, the "natural" waters, untouched by man-made wastes, are of highly differing quality, and each is unsuitable for certain uses.

When the Board has made a decision regarding which stream uses it considers to be in the public interest to protect, the engineers and other technical people can take over and recommend standards of quality consistent with these uses. This job requires considerable knowledge and the exercise of judgment. Of the literally thousands of foreign substances that do, or may,

find their way to streams in wastes from man's activities, the limiting amounts of many of these that may safely be allowed in water consistent with various uses are not known. One of the crying unmet needs in the pollution control field is more study and research to obtain data that can be used to establish sound standards of water quality on these many potential pollutants. Also, for many of these pollutants there are no fast and practical methods of chemical or other analysis to isolate and identify them and determine their concentrations in streams. In such cases we must rely on indirect methods of detection to insure that substances in streams stay within safe limits.

Enforcement and Surveillance

After standards have been duly established on any stream, anyone that discharges waste into the stream must comply with them.

The amount of any substance that a municipality or industry may safely discharge to a stream, consistent with duly established standards, depends on

(1) The volume of stream flow

(2) The amount of the substance already in the stream

For instance, if a stream standard specifies that the amount of a certain substance in a stream flowing past a given point shall not exceed 10,000 pounds per day, and if the stream already contains 6,000 pounds per day, an industrial waste discharge cannot add more than 4,000 pounds per day. If the plant has to dispose of, say, 12,000 pounds per day of the substance, it obviously must remove 8,000 pounds per day of it by treatment or other means, to limit the discharge to the stream to 4,000 pounds per day.

Most cases involving correction of pollution can be boiled down to the same simple essentials as the foregoing example, but

developing, designing and financing the necessary sewage and industrial waste treatment works or other facilities for trimming down waste loads to comply with stream standards is sometimes not so simple. In 1946 there were a number of places in Virginia where there existed no known technology for treating industrial wastes. It is to the credit of several industrial plants that they developed, through laboratory and pilot plant studies, full-scale treatment facilities to alleviate very bad stream conditions.

There are still two or three cases where it appears that technological breakthroughs toward the development of economically feasible waste reduction facilities will be a long time in coming, if ever. Until then, the only way to obtain desirable water quality is to shut these plants down.

In this connection, it is important to note that while the Law gives the Board the authority to issue an order to any owner to comply with stream standards, such standards must be "reasonable and practicable of attainment."

Actually, the Board has not had to issue a great many formal orders. By far the greater number of pollution problems in Virginia have been worked out on the basis of informal agreements between representatives of the owners and the Board. By "informal agreements" we do not mean "word-of-mouth," but rather "gentlemen's agreements," which are usually, but not always in written form. These informal agreements do not make the owner legally responsible for carrying out his end of the bargain. When the owner is cooperative, and assumes the responsibility of being a good neighbor, such procedures are adequate. For the uncooperative or recalcitrant owner, the Board must resort to the issuance of formal orders, or instituting court action.

To determine whether waste dischargers are complying with the Board's requirements dictates that it must maintain

surveillance not only over the waste disposal facilities themselves, but over the streams as well.

The Board now has a network of some sixty monitoring stations on streams from which samples are taken at least once a month for analysis. This number is governed largely by limitation of laboratory staff and facilities. Radioactivity analyses, particularly, have been neglected because of personnel and equipment limitations. The number of monitoring stations and the frequency of sampling need to be greatly increased.

But the manual collection and analysis of samples, even on a frequent schedule, is not sufficient in many cases, where only a continuous record of quality will suffice. To answer these needs, a long-term program of investing in stream monitoring instrumentation needs to be started. Many states have already begun such programs, which include, in some cases, the long-distance transmission of data from the field to a central recording point. With the Federal emphasis on maintaining interstate water quality standards, it is the staff's opinion that Virginia cannot any longer delay starting such a program, and that the expenditure, over a ten-year period, of $300,000 to $500,000 is needed to finance it.

For the past six summers the Board has handled a very troublesome surveillance problem in the menhaden fish processing industry by the hiring of "inspectors," the bulk of whose salaries and traveling expenses were paid by industry. Despite the fact that evidence the industries paid for might be used against them in court suits instituted by the Board, the four plants involved have preferred to employ the inspectors rather than to install additional waste handling facilities and instrumentation, which would otherwise have been necessary in lieu of policing, to keep certain of the plants "in line."

Additional inspectors need to be hired to police other areas and industries. For instance, in 1963 the Board employed a coal industry inspector who lives in the Southwestern part of the State, and who has been successful in reducing pollution from coal preparation plants.

The Law specifies that data is to be submitted to the Board regarding the operation of sewage treatment plants. While hundreds of sewage treatment plants have been built in the past 18 years, operation has not kept pace. The Board needs more personnel to step up compliance by owners with the provision of the Law.

As stream quality requirements are being refined and standards established, there is an ever-increasing need for technical and administrative dealings with the waste dischargers who are responsible for complying with such requirements.

To facilitate the execution of such dealings, the Board, about four years ago, split the State into three regions. On July 1, 1966, two additional regions, for a total of five, were established. An Area Representative is in charge of each region and has the direct responsibility for dealing with the municipalities and industries in the region. These Area Representatives are responsible, respectively, to the directors of the Sewage and Industrial Wastes Pollution Control Sections for guidance and direction with respect to general policy and specific requirements applying in each case. Four of these regional men are based in Richmond. The fifth, who serves the Southwestern Region, is based in Blacksburg.

At this time, three of the four Area Representatives now based in Richmond should be moved out to their respective regions. The fourth would serve an area centered around Richmond.

The Road Ahead

State water pollution control agencies today stand at the crossroads. The Federal Government, already in the field of water pollution control for about 18 years, has reached the point of no return with passage of the strong Water Quality Act of 1965. This act authorized the Secretary of Health, Education, and Welfare to promulgate standards of water quality on interstate waters and to enforce such standards. As defined in the Act, "Interstate Waters" include all streams that form or cross state boundaries, and all coastal waters in Virginia. The states are required formally to develop acceptable water quality standards for interstate waters and submit plans for enforcement of these standards before June 30, 1967. This is a mammoth undertaking.

The ink was hardly dry on the 1965 Act before the Federal water pollution control activities were transferred by Presidential directive to the Department of the Interior, and the Secretary of the Interior immediately served notice on the states that if they did not take firm and aggressive action Uncle Sam would take over and do it for them. Then, the Secretary asked for stringent new federal legislation which would substantially supercede the State's authority and duties in water pollution abatement and endow the Secretary with almost complete and dictatorial power in the control of all streams and rivers and the use of the land adjacent thereto. This would almost certainly destroy the underlying policy of Congress to recognize, preserve, and protect the primary responsibilities and the rights of states in preventing and controlling water pollution.

Water pollution control must be founded on mutual respect and cooperative effort between the Federal Government, the states, the municipalities, the citizens, and industry, but the winds that blow southward across the Potomac seem to be more

and more Federal, and less and less local.

With Virginia continuing to grow, disposing of wastes consistent with clean streams will become an ever more perplexing and complex problem. To do this job adequately, we should further step up the Board's operating tempo with more staff and a great deal more equipment and instrumentation. With an enlightened and enthusiastic public back of it, the Board will have no difficulty doing so.

Q. Is automatic sampling and monitoring definitely planned or is it just something that you feel is coming and want to be prepared for?

A. Well, it depends on money, of course, and up to this time, we have not received the money. We know that this has got to be done. It is the only way to really get the job done, and it is our intention to continue to request and press for the necessary wherewithal and attempt to get it. Of course, we want to do this as soon as possible. We have discussed this with the Board on a number of occasions. It is an expensive undertaking, and it will take a considerable amount of money over a period of years to do this job. We have a scarcity of man power; but even if we had the man power, the more satisfactory job can be done with instrumentation. Automatic sampling and monitoring is really the only way that we can go. Not to press for and not to strive to go in this direction I think is just not in the cards.

Q. Other than the Press, where have you published or presented the information from your work?

A. Most of it is in our files, unfortunately. Aside from occasional appearances before groups of this type, civic clubs or others, we have not had a public relations program to disseminate information to a great extent. We do not have a regularly constituted public information program.

Q. Can you give us any information on the review procedures for water quality criteria? Have any been set up? Are there to be periodic reviews on a continuous basis?

A. We might go into that a little bit. As a result of the Federal law and in accordance with the Board's decision

to comply with the Federal law, the first thing that was done was to have the staff develop a water quality criteria to be used in judging the quality of water. The Board held a hearing on these July 11. A transcript of the hearing was prepared for those attending. For others who are interested, there are still a limited number of copies available. The final criterial will probably be adopted late this year - at the November meeting of the Board. The revision of these criteria which have resulted from the information presented at the hearing and other information is now being set up and is under staff review. Those who attended the hearing will receive copies of these revised criteria and will be given an opportunity to suggest further changes. It is hoped that a final document will be ready for the Board to adopt at its November meeting. Criteria and standards, which are set on specific stretches of the state's waters as a result of these criteria will be subject to review, upgrading or change continuously as the need for them exists. The standards will not be a static proposition. They will have to be flexible and change with the needs of the times and technological knowledge.

Q. At the present time, you are talking about stream standards. I would like to know if in the foreseeable future there is any requirement going to be put on effluent discharges?

A. The present thinking of the staff is no. The law stipulates that stream standards should be set. Now the minute you set a stream standard you have automatically set an effluent standard for any industry or municipality that discharges into that particular stretch of stream. Stream standards naturally relate back to effluent standards; but the effluent standards are not going to be written into the

certificates, only stream standards. I don't anticipate that we will adopt an universal set of effluent standards because each situation has to be judged on its own merits and effluents from an industry or municipality that is suitable for discharge at one location will not be at another location and, therefore, an universal effluent standard just isn't in the cards really.

Q. Under these circumstances, might some industries feel they have been discriminated against where they discharge into the stream a better quality water than that of a competitive industry upstream?

A. Well, I think I can answer it the same as I said before. Each condition has to be judged on its own merits; and if the public interest requires an industry in one place to treat to a greater extent in order to make stream quality requirements than an industry in another place, I guess that is just how it is going to have to be. Industries in other phases of their operations have inequities with respect to one plant location compared to another. You can expect that there will be inequities with respect to water quality requirements.

Q. Will these new criteria affect some of the unsolved problems such as those that existed prior to 1946?

A. That is a real ringer. There are several places in Virginia where technology has not advanced to the point where we see a substantial hope for water quality improvement. In these instances, the only answer that we can see is to shut the plants down. Now this is a situation that involves a public interest and these are questions that in the final analysis are going to have to be answered by the Board. The law says that the Board sets standards to protect uses that it deems to be in the public interest to protect; and if

there is a place where it appears that fishing, recreation, or a water supply is more important than an industry, then it can set the standards accordingly and issue the plant an order to comply. If there is no technological way it can treat the waste to discharge an effluent that will meet these quality requirements, then the industry has two choices - it can fill the order or it can shut its doors.

Q. What is the attitude of industry in the last several years? Have they been more cooperative or less cooperative?

A. Industry has been most cooperative as far as complying with the Board's requirements and the requirements of the law concerned. I think we can best illustrate this by the fact that the number of formal orders that the Board has issued to industries you can count on the fingers of one hand. Most of the work of the Board has been accomplished on an informal basis; that is, industry and municipalities have assumed their responsibility as good neighbors and good cooperating citizens under the law and have come to the Board with programs which would accomplish the objectives of the Board and the objectives of the law and have thus avoided the necessity for any formal action on the part of the Board. The cooperation has been good, and the Board's relation with industry has been good. I want to repeat that new industry moving into Virginia has been met with a sympathetic staff, and I think I can say also a sympathetic Board. Every attempt is made to solve problems with relation to potential stream damage from such new discharges so the industry can in fact come into Virginia. As I said a while ago, I don't really think that if you came down to the wire that there has been a single place in Virginia where industry has had to locate somewhere else because the stream situation could not be satisfactorily solved.

WATER RESOURCE ACTIVITIES - VIRGINIA DEPARTMENT OF HEALTH

by

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As might be expected, the Water Resource Activities of the State Health Department are and have been principally in the field of water supply and sewage disposal. So far as I know, the Department's future activities in this area will carry somewhat the same emphasis.

It might be interesting to this group if I were to review briefly the beginnings of the Health Department, which coincides fairly closely with the beginning of its activities in the water resources field.

For some years prior to 1908, there was in Virginia a Board of Health which had, as near as I can determine, a Secretary, who was, apparently, a practicing physician, but little or no permanent staff and very little in the way of any authority over matters concerning public health. The Board did from time to time issue reports and bulletins on subjects of general interest in the public health field. It is interesting to note that in a bulletin dated June 1898, the opening article is on the subject of typhoid fever contracted from rivers and streams and, since it is rather short, I will quote it exactly as written, "Reports are coming from various sources showing that typhoid fever has been produced from using water from certain rivers and streams. In no case should water be used either for drinking or for cooking purposes from any contaminated or suspicious source, be it river, well or spring, especially streams into which sewage is emptied or privies are liable to drain, and particularly does this apply to the rivers of Virginia, for most of them have towns or cities situated near their banks into which sewage is emptied and privies drain. This being the case,

it is dangerous to use water from such streams for any purpose before boiling it, and if used for drinking purposes, it should certainly be boiled and, if possible, filtered.

Cases are on record where typhoid fever has been contracted from bathing in streams by taking the infected water accidentally into mouth or drinking it to relieve thirst. This should be guarded against. All persons are especially cautioned and advised not to bathe in a river or stream just below any village or city where sewerage or privy drainage is emptied or this dreadful disease may be contracted."

This indicates to me that even at that early date, there was quite a good understanding of at least one of the manners in which the disease, typhoid fever, was transmitted and in those days, it was an exceedingly serious disease.

In another bulletin dated September 1898, there is another rather long article on typhoid fever, its prevalence, cause and prevention. This article again points out that one of the common means of transmission of the disease is through the drinking of polluted or contaminated water. As mentioned above, however, the Board of Health as it existed at that time had little or no authority and, even though its functions were somewhat enlarged right around 1900, it apparently continued without any real authority until 1908.

At the legislative session of the Virginia General Assembly in 1908, legislation was enacted to retain a State Board of Health, but to establish also a State Department of Health, with a State Health Commissioner and at least the beginning of a technical staff.

The Department was organized in July 1908, with a Health Commissioner, an Assistant Commissioner, a bacteriologist, and a clerk. It was stated in the first Virginia Health Bulletin put out by the Department and this was in July 1908, that the

laboratories would be equipped and ready to begin functioning by August 1st. One of the services to be offered was the chemical and bacteriological examination of water upon the request of county or town health authorities to determine its sanitary qualities.

One of the very early requests to the new Department came from the Secretary of the Elizabeth City County Medical Society and asked that the Department investigate the matter of oyster infection with typhoid bacilli and to determine if the oyster beds of the State were a probable means of typhoid dissemination. A report of this investigation was published in the Virginia Health Bulletin of May 1909. The investigation is interesting from the standpoint of water resources in that it includes sanitary surveys of the principal oyster growing areas and pinpointed a considerable amount of pollution entering waters used for the production of oysters from a number of different sources. In addition, a limited number of bacteriological examinations of the growing waters were made, though the indication is that the bulk of the bacteriological work was confined to the oysters themselves.

It is quite interesting to note that in the State Commissioner's report to the Governor for the year 1909, the matters of supervision of water supplies and sewage disposal are given rather prominent treatment. It was also mentioned quite emphatically that the Department needed a sanitary engineer and I wish to quote that portion of the report referring to this matter, "Very early in the work of the Department, it was recognized that the proper solution of many problems that presented themselves demanded the assistance of an experienced sanitary engineer. The Department has available bacteriological, chemical and epidemiological assistance, but no competent engineer to consider the many problems which present themselves in this connection.

Owing to the fact that sanitary engineering is yet in its infancy in Virginia, this assistance is not to be had readily and it is imperatively necessary that a competent sanitary engineer be attached to this Department regularly to take up the many questions which will come to him for solution. It is hoped that funds will be available during the coming year for securing such an officer."

Apparently, funds were made available, for in May of 1910, Richard Messer was employed as a sanitary engineer with the Department and, I might add, was the Chief Sanitary Engineer of the State Health Department from that time until he retired in 1955. This marks, I believe, the real beginning of the involvement of the Department in matters of water resources and, here again, principally in the field of water supply and sewage disposal.

In the engineer's report for the year 1910, it was mentioned that there was only one municipal sewage disposal plant in the State, but he went on to say that in his opinion, water supplies were at that time the most important line of investigation and should have for its ultimate objective, the protection of all the water supplies in the State. It was noted too at that time that the only powers which the Department had in the field of water supply were advisory, in that there were no statutes by which they could make regulations for the sanitary control of water supply. In the State Code at that time, there were three sections dealing with the protection of water supplies for cities and towns. These were, however, considered to be somewhat antiquated and didn't actually give any authority to the Health Department. They are still there.

The first tabulation of water supplies and sewerage systems which I have been able to find was prepared for the annual report of 1912. In connection with the tabulation, it was noted

that during the year 1912, seven new water supplies were constructed and nine sewerage systems. There were at the close of the year, some 83 municipalities with public water supplies serving an estimated aggregate population of almost 550,000. There was only one municipality with population of more than 1500 that did not have a water supply. There were 43 other municipalities in the population range of 500 to 1500 which did not have a water supply. The population in these 43, plus the 1 of over 1500 population, was approximately 35,000 people. This report also listed 43 places with definite sewer systems, and a number of others for which the information is somewhat vague. With regard to water supplies, there were 14 places with filter plants, one with coagulation of the water and sedimentation, but no filters and several with either sedimentation basins or reservoir storage.

In the announcement of the appointment of the sanitary engineer, the matter of sewage disposal was pointed out as one of the great factors in the spread of disease and that its proper regulation was a matter of serious concern to the State's health officers. As has been noted above, the engineer himself soon came to the conclusion that the matter of water supplies was more important at that time than that of sewage disposal. The fact remains, however, that he was also very much interested in the matter of sewage disposal at this time because of an investigation and a test program which was carried on in the Hampton area in connection with the growing of oysters in the area known as Hampton Flats, which lies between Old Point and Newport News Point. The work to which I have reference was an investigation of the pollution of Hampton Flats carried on during the year 1912 and, as a part of it, it was decided to make a thorough test of the process of operating a temporary sewage disinfecting plant at what was then called the Hampton Normal and Agricultural

Institute. I am rather doubtful that this work has ever been reported anywhere except in the State Health Department annual report, but it seems to me that it was of sufficient importance that it be covered briefly in this report.

The Hampton Normal and Agricultural Institute, now known simply as the Hampton Institute, is situated on the east side of Hampton Creek, opposite Hampton. In 1912, the sewerage system was complete with storm drainage separated from the sanitary sewage. The latter flowed by gravity to an intake chamber from which it was pumped to two concrete storage tanks, each having a capacity of 50,000 gallons, with the elevation of the bottom of the tanks about seven feet above high tide level. Two automatically controlled centrifugal pumps were provided for lifting the sewage into these tanks, which were emptied once or twice a day with the sewage being discharged shortly after high tide. An apparatus for mixing and feeding a solution of chlorinated lime was set up and the chlorine solution fed into the intake well at the pump station. Chlorine dosages ranged from about 9 to 18 ppm, except for one of two periods when the apparatus clogged. Samples were taken for bacteriological tests, which were in the nature of total bacteria at 37°C., rather than coliforms. The test was carried on for about a week, with bacterial counts being made on the raw sewage, the sewage after application of chlorine and one hours contact, and from the storage tank before final discharge. The result indicates that from 95 to 99 per cent of the bacteria were destroyed when the amount of chlorine added ranged from 10 to almost 18 ppm, with somewhat higher removals at the higher level of chlorine application.

This work is mentioned at this time because out of it came a series of recommendations, which I presume were transmitted

to the authorities of the cities and towns then situated on the north shore of the Hampton Roads area. The gist of the recommendation was that all sewage discharged into the water of Hampton Flats from these areas be disinfected by the application of a solution of chlorinated lime and, so far as I know, it is the first concrete recommendation by anyone connected with the Health Department for treatment of sewage in that particular area.

Apparently, nothing came of the recommendation at that time, but this is a recurring matter in the records of the Department which will be referred to from time to time as developments took place.

By the end of 1915, the total number of water supplies had increased to slightly more than 90 municipalities and sewerage systems to almost 60 places. In addition to this, very substantial improvements had been made to a considerable number of the existing water supplies. These improvements had been in the form of filtration plants, chlorination installations, and in some instances, works for the protection of springs, wells, and reservoirs. At this time, that is, the end of the year 1915, the Department of Health had been in existence for a little over six years and the sanitary engineering division for about five. It is amazing to note the progress which was made during these periods in the reduction of typhoid fever. There had been a steady decline with the exception of one year during the entire period since the Health Department was formed, until in 1915, the number of cases in the State was estimated to be only 40 to 45 per cent of those which had occurred during 1908. While this reduction was due to a number of approaches in the field of sanitation, a substantial part of it can be attributed to improvement in water supply protection and treatment, which

had been accomplished largely through persuasive and advisory means.

In 1916, there occurred an event of tremendous importance in the field of public water supply in Virginia. This was the enactment by the General Assembly of the Public Water Supply Law. The principal features of the Law was to make the State Department of Health responsible for general supervision and control over all public water supplies in the State, insofar as the public health was concerned. It established a system of permits for new waterworks and improvements to existing water works and set up an enforcement procedure by means of special orders, hearings, and if necessary, court action. This Law was quite effective in the early days of its existence in getting action from municipalities that had been holding back from making very much needed improvements. It remained in substantially the same form, with only minor changes, until the Assembly of 1964, when it was amended rather extensively and reenacted.

Until 1918, there was only one sanitary engineer employed by the Department. In that year, however, an assistant was employed, though as it happened, the Chief Engineer left very soon thereafter to enter the Armed Forces for approximately a year during World War I. On his return however, and in the early 20's, another assistant engineer was added to the staff, all of which permitted a considerable expansion of activities in the water and sewerage works fields.

In the early days of the Department, discussions of stream pollution and sewage disposal appear in reports from time to time, but the primary emphasis appeared to be on safe disposal of sewage or human excreta from the standpoint of individual safety and treatment of water subject to sewage contamination. The State Health Commissioner in his annual report of 1927, in discussing the progress made in the elimination of typhoid as a

serious health menace, makes the following statement: "Cities with typhoid rates under 5 per hundred thousand are not rare. Several cities of the country each year show in the banner column of less than one death to the hundred thousand. These records are not attributable to vaccination, but to sanitation, safe water supplies and safe disposal of human excreta."

During the 20's, however, this emphasis began to change somewhat and more attention began to be given to the control of stream pollution with regard to both sewage and industrial waste discharges. In 1927, an investigation of pollution of Hampton Roads was made and again with particular emphasis on the oyster growing areas on Hampton Flats. This investigation resulted in recommendation for the treatment of all sewage entering this area. While the work of the Department up to this time had been concentrated on the north shore of Hampton Roads, this 1927 effort might be called the beginning of a fairly continuous effort for sewage treatment in the Hampton Roads area, which finally culminated in the passage in 1938 of the Sanitation District's Act for Tidal Waters, which in turn was followed by the formation of the Hampton Roads Sanitation District Commission, whose function was the abatement of pollution in the area. Construction of treatment facilities was somewhat delayed by World War II, but the first plant was put into operation in Norfolk in 1947 and was known as the Army Base Plant. During the next two to three year period, a second plant was built in Norfolk at Lamberts Point and one in Newport News at the Small Boat Harbour. The City of Portsmouth, which had elected not to participate in the Hampton Roads Sanitation District Commission, also built a plant during this period.

There were other happenings and events during the period from the late 20's up through the 30's that had considerable impact on the progress of both water supplies and pollution

abatement, and I feel that they deserve at least brief mention.

In the late 20's, sufficient interest had been generated in the matter of stream pollution to result in what was known as the Cooperative Committee on Stream Pollution. This was a committee made up of representatives of certain industries in the State and certain State Agencies and its operation over a period of several years was financed partly by the State agencies involved and partly by contributions by the industries having membership on the committee. A small staff was assembled with the Chief Engineer of the State Health Department serving as Executive Secretary. Some valuable work was performed by the Committee and it is unfortunate that it did not continue to function for a longer time than it did. I had joined the staff of the Bureau of Sanitary Engineering by then and to the best of my recollection, the Cooperative Committee disappeared from the scene in 1932 and I suspect largely because of the depression which was becoming rather severe by that time.

Mention has been made of the investigation of the pollution of Hampton Roads in 1927. In 1933 and 34, a much more comprehensive investigation was made, this time as a cooperative venture between the U. S. Public Health Service and the State Health Department and I feel quite sure that this investigation added considerable emphasis to the movement for sewage treatment in the area.

Following the construction of the sewage treatment plants in Norfolk, Newport News, and Portsmouth during the period 1946 - 1949, still another study was made of the Hampton Roads area. This also was a cooperative venture between the U. S. Public Health Service and the State Department of Health. This study was rather extensive and it was found that conditions relative to pollution of shellfish growing areas had improved to such an extent that large areas previously condemned for the taking of

oysters and clams were released from condemnation and again made available to the industry for production and harvesting of shellfish for direct marketing. The areas opened were Craney Island Flats on the south side of Hampton Roads west of Elizabeth River, a portion of Willoughby Bank in Chesapeake Bay and a portion of Hampton Flats. Additional areas could perhaps have been opened, except for the influence of large vessels in the Harbor area and the overflows of untreated sewage which occur from time to time during periods of storm and heavy rainfall.

During the early years of the depression of the 1930's, construction of water supply and sewage works improvements fell off rather drastically. Beginning about 1933 or 1934, however, the several Federal Assistance Programs that came into being about that time caused a marked acceleration in construction of public works facilities, including new water works systems, purification plants, sewerage systems and sewage treatment plants, so that in the final analysis, it is quite likely that more work of this nature may have been done than would have been the case under normal times with a reasonably good economic situation. As a matter of interest, during the five year period from 1934 to 1939, the aggregate expenditures by municipalities, counties, and sanitary districts for water and sewage works construction totalled about twelve and a half million dollars. Of that total, about half was for the construction of reservoirs, water lines and the enlargement of existing water and sewerage works. The remaining fifty per cent was for new systems and for sewage treatment and water purification facilities. At the end of the five year period or in 1939, there were something over 400 public water supplies serving an aggregate population of close to a million persons. At this time, also, there were approximately 90 sewage treatment plants serving a population of close to 200,000.

A big step forward in the field of stream pollution control and abatement came in 1946 with the enactment of the State Water Control Law and the formation of the Water Control Board. Since Mr. Paessler has presented to you a report on the Water Control Board, I will not go into any detail except to state that those of us in the Engineering Division of the State Health Department have been very pleased to participate in the activities of the Water Control Board in helping to carry out the functions for which under the Law we have a joint responsibility. This joint responsibility is wholly in the field of sewage collection and treatment and involves the review and approval of plans for new or expanded works by the Health Department and the supervision over the operation of existing installations. This for me has been a most pleasant relationship and I have every hope that it will continue to be the same in the future.

There have been some changes or, perhaps we should call them trends, that have developed in the water supply and sewage disposal field which I think deserve some comment. When the Department first began to be involved with the matter of public water supplies, the bulk of those in existence were those serving municipalities, with a few serving some of the larger institutions that were not located within the confines of a municipality with a water supply system. This state of affairs continued for a considerable period of time and, in fact, the original Public Water Supply Law enacted in 1916, was aimed almost entirely at municipal water supplies. However, beginning I would say in the late 20's and continuing on through the 30's, there began to be considerable numbers of non-municipal public supplies. Some of these were county owned, through the formation of sanitary districts; others were privately owned, serving comparatively small communities or subdivisions outside the confines of a municipality. Following World War II, there has

been a tremendous increase in the number of non-municipally owned public water supplies. A considerable number of these are publicly owned by counties operating either on a county-wide basis, through sanitary districts, or by utilizing the water authority route. The latter, of course, is open to municipalities as well as counties.

A tremendous number of the additonal supplies, however, are comparatively small, privately owned installations serving small towns, unincorporated communities, and subdivisions. There are at present something over one thousand public water supplies under supervision by the Department, which serve about two-thirds of the total population of the State.

In the sewage works field, a similar pattern has developed, the only difference being that it started considerably later and the construction of comparatively small non-publicly owned facilities did not really get going good until after World War II and actually most of it has been during the past 10 or 15 years. The total number of sewage treatment plants serving municipalities, counties, sanitary districts, sanitation districts, other established communities or subdivisions and institutions is now approximately 430. This figure is much less than the number of public water supplies, but the population estimated being served is about 55 per cent of the entire state population and the difference in this respect is not so great.

In the water works field, it appears that there may be some tendency for the total number of supplies to level off and I believe this tendency has been evident for several years now. The reason for this is that development of an area may result in several small water supplies in areas that are close together, but not necessarily contiguous. As these areas grow, however, the small supplies become inadequate and are eventually replaced by one larger supply serving the entire area. This has been

going on for some time and it appears that the number of new ones that come into existence are pretty much balanced by those which disappear as a result of consolidation.

In the field of sewage treatment, we have here again a somewhat similar situation, but not as far advanced and I suspect that we will see considerable increases in the number of small plants before a balance occurs whereby the small ones disappear as fast as new ones are built.

In recent years, the rather considerable population growth of the State and the tendency for it to concentrate in urban areas has changed the situation with regard to both water supplies and sewage disposal. In Virginia, where there are sizeable concentrations of population in urbanized areas, it is generally true that ground water is inadequate as a source of water supply and the water must be taken from surface streams and reservoirs. I might get some argument on that statement, but with certain exceptions, it appears to be true for Virginia. It is becoming increasingly evident, however, that the natural flow of the surface streams are themselves becoming inadequate as sources of supply for our concentrations of population. This was brought home with something of a shock a few weeks ago when for several days the City of Fredericksburg was unable to get sufficient water from the Rappahannock River to supply its normal needs. In Washington, D. C. the flow of the Potomac reached the lowest level on record and the City was taking more than three-fourths of it to supply the needs of the metropolitan area. Fortunately, very heavy rainfall relieved both situations, which would have become critical in a short period of time.

As a result of the conditions that have and are continuing to develop, it has become necessary to construct impoundments on streams which may be located below or downstream; that is, from centers of population, industry, and areas of intensive land use

for agricultural purposes. This brings in a new factor; that is, the effect of discharges of waste effluents and land run off on the water stored in impoundments and under low flow conditions in tidal estuaries which under such conditions, have some similarities to inland impounding reservoirs.

When surface water supplies were largely obtained from flowing streams or reservoirs upstream from population centers, the problems of water quality were simpler. In the former case, the flowing stream did not permit the concentration of constituents inimical to water quality and, in the latter, the contributions from the activities of limited populations did not pose any serious problem.

There are now three impoundment situations in the State where serious concern is being felt with regard to the future quality of water in the impoundment as sources of public water supply. There are a number of others where adverse effects could occur with increasing development and still others that are in the proposal stage and which may be constructed in the future. There is also at least one water supply taken from a tidal estuary where severe taste and odor problems have developed, but I do not believe that the cause has been definitely pinpointed.

The problems which have occurred and are anticipated in water supply impoundments are, fortunately, not of major public health significance, but more a matter of the general suitability of the water as the raw product from which an acceptable public supply may be produced. It would appear, however, that a great deal of effort by Health Department and water control agencies will need be expended in the future to find solutions to the problems of water supply brought on by heavy concentrations of population and the water resources development which are necessary to supply those populations with an adequate water supply.

In addition to the problems referred to above, there are other problems of water supply of fairly recent origin and these do have very definite public health significance. In this connection, I am thinking of the expanding use of economic poisons, such as the insecticides, herbicides, and others. There is also the possibility of contamination of our water supply by radionuclides, and in this connection, I am not thinking in terms of a nuclear war, since that requires a completely different set of ideas, but more along the line of accidental spills or the possibility of a buildup or concentration of radioactive material to levels that might be harmful if ingested.

Getting back for a moment to the matter of sewage disposal, there are a number of problems aside from any affect on downstream water supplies which I think should be mentioned briefly. In the process of people getting concentrated into urbanized areas, it has happened inevitably that developments have taken place where adequate and satisfactory disposal of sewage has become a problem of considerable magnitude, including the economic considerations. When there is a considerable volume of sewage to be disposed of on a very small stream, the matter of adequate treatment to prevent local nuisances and sometimes public health hazards can become exceedingly difficult. This is compounded by the fact that sewage strength and volumes do not remain constant, but fluctuate over fairly wide ranges, with little or no control by those responsible for the collection and treatment. There is also the matter of reliability of both the human and mechanical element in sewage treatment and this can be quite troublesome in critical areas. This is a particularly serious problem where sewage treatment effluent may be discharged into waters used for the growing of shell fish. A very short time lapse in effective treatment can cause contamination of the

animal itself which may persist for several days or weeks after treatment is restored to its normal level of effectiveness, and this is the reason why we seem to have a paradox in the areas adjacent to waters in which shellfish are grown. There have been complaints and I think with considerable justification, that the construction of a sewage plant adjacent to a shellfish growing area usually results in the condemnation or closing of some additional area. This is a real problem and one which has to be solved if the oyster and clam industry is to survive in much of our coastal areas.

The brief discussion of problems which confront us in connection with water supplies, sewage disposal and production of shellfish appear to indicate reasonably well some of the areas toward which the efforts of our sanitary engineering staff should be directed in the future. There are other areas of interest, such as continuing work in connection with the operation of existing water purification and sewage treatment facilities; the promotion of and design of new or expanded water and sewage works; and the encouragement of the development of new or improved methods of water purification and sewage treatment. Not the least of future activities that should be emphasized is that of increasing the competence and reliability of water and sewage works operating personnel by providing training opportunities, by the attraction of more people to this field of a caliber commensurate with our better operators and perhaps by the establishment of mandatory qualification standards.

In closing, I shall not attempt to summarize this rambling and somewhat disjointed account of Health Department activities in the field of water resources. I have touched very briefly on some happenings and activities partly because of the time and effort required to dig out the detailed information and partly because I am doubtful that too much of it would appeal to this

group. However, if there are any questions, I shall be pleased to try and answer them and, if I cannot, maybe I can get the information for you.

WATER RESOURCE ACTIVITIES - COOPERATIVE EXTENSION SERVICE

by

E. W. Mundie
Virginia Polytechnic Institute, Blacksburg

The State Land Grant College had its beginning in 1862 with the passage of the Morrell Act. The 3 arms of the Land Grant College are Resident Instruction, Research, and Cooperative Extension Service. The Cooperative Extension Service, the last of the 3 to be added, is the result of the Smith-Lever Act of 1914.

Section One of the Smith-Lever Act establishes the purpose of the Cooperative Extension Service. It reads in part as follows:

> "In order to aid in diffusing among the people of the United States useful and practical information on subjects relating to Agriculture and Home Economics, and to encourage the application of the same, there may be continued or inaugurated in connection with the college or colleges in each state, territory, or possession agricultural extension work which shall be carried on in cooperation with the United States Department of Agriculture."

Section Two of the act sets forth some of the means of carrying out the objectives of the Cooperative Extension Service and reads in part:

> "Cooperative agricultural extension work shall consist of the giving of instruction and practical demonstrations in agriculture and home economics and subjects relating thereto to persons not attending or resident in said colleges in the several communities, and imparting information on said subjects through demonstrations, publications, and otherwise and for the necessary printing and distribution of information in connection with the foregoing."

A recent United States Department of Agriculture publication under a section entitled "The Long Arm of Education" rather aptly puts it this way:

> "Cooperative extension is a native American idea . . . a countrywide service that carries ideas and information from laboratory and classroom . . . directly to the people on the land. Family progress . . . community development . . . are the goals."

How Extension Works

The Cooperative Extension Service is a partnership. Three levels of Government - federal, state, and local - share in financing as well as in helping plan and carry out educational programs serving local people's needs.

The state partner, the land-grant college, actually conducts the work. Through its state extension service, the university employs a staff of county Extension agents. These employees are located in every county and four cities and extend the campus boundaries of V.P.I. to the far corners of the state.

Extension agents work with local people to identify and solve problems. They teach people the reasons for and how to apply scientific information to improve their families, homes, and communities. They encourage and help people to use this information.

Backing up the off-campus staff are state extension staffs. Extension specialists are the connecting links. Working at the college, these specialists are in close touch with research programs. They keep the field staff informed of new scientific findings. Specialists also serve as the channel for Extension agents to relate local people's problems to the scientists so research can work on those that are unsolved.

During the 1966 session, the state legislature passed a bill which created a university-wide Extension Division and a university-wide Research Division. This in effect enables the university to greatly expand its off-campus educational and research services to the people of Virginia. The organizational structure is currently being developed to implement this legislation.

Thus, Cooperative Extension programs and agricultural research are like soil and water - inseparable.

Extension projects relating to the management and use of water resources are based on certain established facts. Some of these facts are:

(1) Water is the source of all life.

(2) Proper planning and programming must take into account that water resources must be shared by all segments of the population: (a) municipalities, (b) industry, (c) recreation, and (d) agriculture.

(3) Food and fiber crops are very inefficient users of water.

(4) Water is the most important single factor affecting or limiting crop production.

(5) In spite of Virginia's relatively high rainfall, many years a state of drought exists during the growing season.

Based on the above information, the Cooperative Extension Service has directed much of its energies toward getting the most efficient production from available water. From an agricultural viewpoint, this means continuous study of soil characteristics, land use practices, cropping systems, and selection and management of crops in an effort to obtain the combination that will yield the greatest economic return, utilize the available water efficiently, and preserve the basic resource - the soil.

Our research and educational programs in the water resource field through the years have been concerned with (1) the conservation and beneficial use of our soil and water resources on the land and (2) in developing and promoting farming systems which will insure a more efficient use of rainfall and other available water resources; and at the same time, prevent the loss of soil and plant food resources through erosion. These efforts have attempted to incorporate improved engineering, agronomic, and forestry practices in our production systems. New crops and new varieties of old crops aimed at increasing

production and at developing growing habits better adapted to available local resources have received intensive study and development. Dozens of effective engineering practices such as terraces, diversions, contour tillage, contour strip cropping, land forming, irrigation, drainage, and many others have been developed to meet various local conditions. All of these are aimed at more efficient use of the soil and water resources of our land. Likewise, new forestry practices have been developed which will insure both good conservation and use of local resources and also provide a large portion of our total income from the land.

With frequently recurring agricultural droughts and our constant efforts to intensify agricultural production, the question of the efficient development, use, and conservation of our water resources are even more important and indeed are, in most cases, rapidly becoming the limiting factors to further progress in this direction. Therefore, we are directing much of our research and educational effort towards the more efficient use of water. How to achieve these goals is being studied by specialists in many fields. The plant physiologists are trying to learn more about the transpiration rates of plants and how to control them without adversely affecting yields. The agronomists are looking for new varieties and new crops which will be more efficient in their use of water. Agricultural engineers are working on reduced and no-tillage procedures which utilize chemicals to kill the stubble of the preceeding crop so as to leave it as a mulch on the surface to reduce direct evaporation losses from the soil, thereby retaining the available soil moisture for transpiration through plant tissues. Research and education programs in all of these areas are being intensified rapidly and can be expected to continue this trend in the foreseeable future.

The rapid increases in animal and poultry numbers necessary to feed the exploding population require entirely new management and production methods which will permit the production of much greater numbers in concentrated feed lot arrangements. The disposal of wastes from these and other agricultural operations resulting from greatly intensified production techniques is posing an enormous problem which has not yet been solved. How much these agricultural solid wastes, together with fertilizer and other chemical residues, are contributing to the pollution of our streams is an extremely important but, as yet, unanswered question. It seems safe to assume that these contributions are sizeable and that enormous research and educational effort will be directed increasingly towards the solution of these problems.

In the area of soil fertility and management, much of the research done under the auspices of V.P.I. deals with the maximum economic productive capacity of the soils of the state. In general, the productive capacity of most Virginia soils is limited by the ability of the soil to supply water to plants. There are many factors affecting the process. Involved is the ability of the soil to take in water, the storage capacity of the soil, the characteristics of the plant grown, and many other factors. The use of fertilizer and lime, while formerly one of the big costs in crop production, is now one of the less costly. Fertility studies are conducted primarily to determine the amount of plant food required to produce maximum economic return from the available water. The major factor in research in minimum tillage and no-tillage of certain crops is water conservation, although it also has an implication in reduced cost of production.

The actual management of crops for the most efficient use of water is another phase of research and education which is

under continuous study. Such studies involve selection of crop varieties and management of selected varieties to determine their behavior under various conditions. Some of these studies include such things as row spacing, sequence of crops, placement of fertilizer, and adaptation of certain crops to specific soil types.

In addition to efficient use of water in crop production, another phase of research studies is providing information on water purity for Extension educational programs. These projects are concerned with the ability of certain soils to absorb and purify effluent from individual sewage disposal systems. The effects of seasonal fluctuation of water tables and certain behavioral characteristics of the soil on water purity are likewise included in the studies. Presently, additional studies are getting underway to determine the effects of agricultural waste on water quality.

Other water resources development studies presently underway or which have been studied include fishery management, wildlife management, watershed management, water quality, outdoor recreation, and industry.

Several studies are currently being conducted in the field of fishery management and the related field of water quality studies. The effects of abandoned manganese strip-mining spoil areas on certain trout streams is presently being studied. This project is mainly concerned with identifying the problems involved and making recommendations as to how best to correct the situation.

Another project currently in progress is a study on the effects of a pump-back reservoir, Smith Mountain and Leesville lakes, on the water quality as it is related to fisheries. Also in this connection, the limnology of Smith Mountain Lake is being studied.

Plans are being finalized to study the mineral metabolism and other water quality measurements on striped bass as it relates to the management of this fish.

In the field of wildlife management, several projects related to water management are either in progress or planned. Most of the projects are related to water-fowl management or other water related mammals, such as beaver and muskrat.

Projects involving all recreational phases of water utilization, including fisheries, wildlife, and water sports, are in various stages of progress. A state-wide survey was completed in 1965 on all recreational facilities in the state including water related activities. This survey was the basis of a report of projected outdoor recreational needs and facilities. Also, an inventory of undeveloped existing waters and potential impoundment sites is cooperatively planned with the Soil Conservation Service in a pilot study of Giles County. The survey specifically includes fishing waters and water sports areas, as well as considering water as an asset to ten other outdoor recreation enterprises. The inventory will be expanded later to other Virginia counties.

There is also a continued educational program in the field of outdoor recreation including water related activities.

State and county extension staffs often disseminate research results and pertinent information secured from other sources through cooperative programs with other agencies and groups. Included in such cooperative projects relating to water have been state-wide water resource conferences conducted in cooperation with Soil and Water Conservation Districts, 11 years of conducting conservation courses in natural resource conservation for public school teachers, state-wide conservation needs inventories, Governor's Conference on Natural Resource Conservation, and other related programs of the Virginia Resource Use

Education Council, and programs of the Land Committee of the Interstate Commission on the Potomac River Basin.

The Extension Conservationists assisted landowners of Virginia in organizing the Soil and Water Conservation Districts. County and city Extension agents have served as members of the official boards of each of the districts since 1938. Both Extension agents and Extension specialists have given counsel and assistance to boards in the conduct of educational programs of districts.

Many 4-H projects sponsored by the Cooperative Extension Service include studies of water and water management. Notable among these are (1) Land Appreciation project, (2) Natural Resource Demonstrations, and (3) Forestry projects.

Mass media, including publications, news, radio, television, and demonstrations, are used extensively in Extension programs in disseminating information pertaining to water use and management.

Assistance in developing and maintaining water supply and water quality for individual households have received much attention from the Extension Service. Likewise, community water supply systems have in recent years been growing in their demands on Extension time. Paralleling these requests for assistance has been the requests for assistance in design and use of irrigation systems for watering community golf courses. Requests for assistance in irrigation, pond sealing, and other water conservation projects for farm lands continue to occupy an important place in service to landowners in water utilization and management. Likewise, disposal of waste from agricultural projects as well as community commercial establishments is receiving assistance from the Cooperative Extension Service.

We can summarize by saying that research and educational effort in water resources as it pertains to the agricultural

economy will continue to stress more efficient use of the water available for plant and animal production and better conservation of surface and ground water supplies to the end that surface erosion will be minimized. Also there will be a rapid build-up of research and educational emphasis in the direction of safe and more effective waste disposal systems, with particular attention to all other aspects of the agricultural economy which could in any way affect the purity of the streams and underground water supplies of the country.

The water resource phase of the Cooperative Extension Service Program in the years ahead will be shaped to meet the need of changes which occur as the result of a shifting, exploding population and the demands placed upon water resources in a growing economy. The Extension Service role in meeting these needs will remain one of helping to determine the needs and carrying ideas and information from laboratory and other sources directly to the people. Family progress and community development will be our goal.

VIRGINIA SOIL AND WATER CONSERVATION COMMISSION

by

R. Leland Crouch, Director
Richmond, Virginia

Accomplishments and Future Plans

It is a pleasure to meet with you today to participate in the Symposium on Water Resource Programs in Virginia.

Before presenting accomplishments and future plans of the soil and water conservation program of our agency and the 32 Soil and Water Conservation Districts in Virginia, I think it appropriate to briefly explain our organizational structure.

The Virginia Soil and Water Conservation Commission and the Soil and Water Conservation Districts were created under the Soil Conservation Districts Law by the General Assembly in 1938. The law has been amended to make it more applicable to changing conditions but its essential principles remain the same. The declaration of policy as defined in the act provides for "the conservation of soil and soil resources of this state and for the control and prevention of soil erosion, and for the prevention of flood water and sediment damages, and for furthering the agricultural phases of the conservation, development, utilization and disposal of water and thereby to preserve the natural resources, control floods, prevent impairment of dams and reservoirs, assist in the navigability of rivers and harbors, preserve wildlife, protect the tax base, protect public lands, and protect and promote health, safety, and general welfare of the people of this state."

Included duties of the Commission are to keep soil and water conservation district supervisors informed on activities and experiences of other districts; to coordinate the programs of the districts so far as this may be done by advice and consultation; to secure the cooperation and assistance of state

and federal agencies in district work and to furnish financial and other assistance to supervisors of the districts.

Moving to phases of our program relating to water, I will take each under a separate heading in order to simplify the explanation of our methods of planning and accomplishments.

Small Watershed Development

The Commission is the agency designated by the Governor to review, approve or disapprove applications requesting planning assistance under the Watershed Protection and Flood Prevention Act, Public Law 566, as amended. The Governor has also requested the Commission to make comments and recommendations to him on watershed work plans under Public Laws 534 and 566. Soil and Water Conservation Districts must be sponsors or co-sponsors of all projects carried out in Virginia under these Acts. Fifty-six applications have been approved to date. Only two have been disapproved. The total acreage included in approved applications is 1,112,450.

To assist in accelerating the small watershed programs, state funds administered through the Commission are available to districts for employment of technical personnel and clerks. The Commission is also furnishing a second planning party who works with the Federal Soil Conservation Service in designing and planning for the projects. The appropriation for the current fiscal year for these purposes is $115,000.

Tile Drainage

The Commission has the authority to purchase and make available to Soil and Water Conservation Districts necessary machinery and other equipment for promoting and maintaining conservation practices on farm lands. The practices of installing tile for farm land drainage is one of the outstanding accomplishments under our machinery program. Only one privately

owned tile ditching machine was available to do farm tile drainage in the entire state in 1946. Four of these machines were purchased by the Commission in the next several years. Over 300 miles of tile were installed through the operation of this equipment. The Commission no longer owns or operates ditching machines, as private contractors have purchased sufficient equipment to do the work. Today, over 3,950 miles of tile have been installed in Virginia. Twelve to fifteen machines are available for this work.

Open Ditch Drainage

Open ditch drainage is widely used in Virginia. Over 7,200 miles of ditches have been dug in recent years. Our machinery program included this practice. As in the case of tile drainage, open ditch drainage often allows concentration of cultivated crops on level, more productive land, making it possible to leave hilly land in good cover for effective soil and water conservation.

Development of Seeps and Springs

Seep or spring development is another practice rapidly spreading over the state. On many farms, the water supply for both people and livestock presents a problem. Sites for farm ponds are not always available. When this is the case, seeps or springs can often furnish an ample supply of water. A trickle of water as little as two quarts per minute can be harnassed and stored, supplying enough water for 35 head of cattle.

The Commission purchased the first set of steel forms for constructing concrete watering troughs used for storage of water from seeps or springs. This was done more or less as an experiment. Soon requests were coming in from districts to purchase more forms. There are now 17 sets of these forms being used by various districts. Two districts have two sets

each. Indications are that more districts will buy these forms as the demand for water storage by this process is increasing.

In the future, as it has been in the past, it will be the policy of the Commission to furnish machinery and equipment to Soil and Water Conservation Districts only when the local contractors do not have the needed equipment and are not willing to purchase same until it is proven it will be a profitable venture for them. From their point of view, this is only sound business.

Riverbank Erosion

The Commission, in cooperation with the Federal Soil Conservation Service and the Virginia Agricultural Experiment Station, conducted a survey on riverbank erosion problems in Virginia. The purpose of the survey, in addition to tidal erosion, was to make economic appraisal of the problems and develop appropriate recommendations. The Northern Neck Soil and Water Conservation District initially requested the survey. In accordance with the recommendations of the committee assigned to study the problems for developing and executing a program to combat the shore erosion, an engineer has been assigned to the area by the Federal Soil Conservation Service to assist the local people in their riverbank erosion problems.

The Commission will continue to assist the districts in carrying on this work.

Rurban Development

Soil and Water Conservation Districts in which congested areas are located are being called upon for assistance in solving the problems arising from surface water run-off, siltation of streams and reservoirs, sedimentation and erosion of farm fields below new housing projects and shopping centers. Pollution of the streams from these causes is also of great concern.

Conservation districts have the authority and opportunity to perform a valuable public service in this field. The Commission believes the districts can assume leadership in influencing future developers to consider their planning for soil and water conservation. We have made available for districts a Rurban Cooperative Agreement Form for use between the district and the landowner(s) seeking technical advice. This agreement form which serves also as an application affords the district supervisors an opportunity to study each individual request in detail, as the applicant must state his problem for which specific assistance is requested.

Planning

Remarkable progress has been made in soil and water conservation in Virginia in the last 28 years. Much remains to be done. More efforts must be made to store our rainfall to meet the demands for water in the future. More ponds, lakes, and reservoirs on farm lands are needed to store water in times of plenty to meet the shortages during drought periods.

The Commission and the Soil and Water Conservation Districts will continue to stress these needs in their long-range Programs and Plans of Work.

RESEARCH AS AN AID TO DECISION MAKING

by

E. D. Eaton, Associate Director
Office of Water Resources Research
Washington, D. C.

The Virginia Water Resources Research Center at VPI has earned commendation for organizing this symposium whose purpose is "to bring together representatives from various agencies, commissions, and citizen groups who are actively involved in the planning, and executing of water-related activities." Its success is evidenced by the broad participation of the groups represented here, and this assures that the two-day session will contribute significantly to sound development and conservation of the water resources of the State and the region.

There is, of course, a long record of experience with water resources in Virginia. As early as the 18th century, colonial laws for protection of navigation use of inland waterways regulated construction of dams and other channel obstructions. The State and private interests were actively engaged in canal construction during much of the 19th century; and in the 20th century, Virginia, through the Potomac River Compact, was one of the first of the Eastern States to deal with water resources on a regional basis. A measure of the attention given to Virginia water resources is the inventory compiled by Professors McJunkin and Walker and published by the Water Resources Research Center (1). Over 800 publications by more than 1,000 authors are included in that inventory of printed information on Virginia water resources.

In Virginia, as in other States, water resource problems come to focus as a consequence of population and economic growth. The Virginia Committee on Water Resources pointed out in a 1959 report that the population of the State was expected

to grow from the then 3.9 million persons to 5.7 million by 1980, and that the need for additional municipal and industrial water supplies would grow correspondingly (2). The 1959 forecast is amply confirmed by 1966 experience. Virginia is blessed with an abundance of water but, even so, increasing water requirements brings competition for water.

Such competition is acutely manifest in two important but incompatible uses of water: recreation and waste disposal. Although there are also many other water resources problems facing Virginia and the Nation, the relation of waste disposal to recreation may be a useful one for examination. Recreation requires maintenance of high-quality in-channel water for fishing, swimming and other body-contact sports. Waste disposal depends on the opportunity to discharge wastes into a conveniently located receiving water that will carry them away. Both uses are important to the economy and welfare of the people of Virginia, but they do not readily accommodate to each other. Development of practical means for such accommodation is among the most urgent tasks of water resources planning; it is also among the most difficult. In two respects research can be of assistance in this.

One way in which research can assist is through improving the technology of managing water and wastes. Already there is impressive technical capability - waterways engineering makes possible regulation of flow and, through releases from impoundments and channel control, it is possible to modify significantly the quantity and quality of streamflow. Similarly, existing technology for treatment of wastes can significantly ameliorate adverse effects on receiving waters. But there is need for enormous improvements throughout the entire range of both technologies.

In order to deal with the tough problems of water resources management, we need much better technologies than are now available. This is because when a method is developed to do something

more effectively or at less cost, then a new alternative is available for choice in dealing with a problem, and for solution of the problems involved in accommodating recreation and waste disposal, we need as many choices as possible. Provision of the scientific and engineering knowledge that is basic to improved technology presents some of the great challenges and opportunities of research.

A second way by which research can aid in the task of accommodating use of water for recreation and for waste disposal is through improvements in the planning process. It is appropriate here to note that, as D. F. Peterson remarks (3), planning goes on at all levels of activity. It is, of course, essential that there be planning of entire river basins, and this involves several States and the Federal Government. But counties and municipalities also engage in planning because they have important responsibilities for water resources in relation to the welfare and prosperity of their constituencies. Planning, in fact, extends to private enterprises and individuals - successful management of an industrial plant, a farm, and even residential property all involve planning for water supply and waste disposal. At all levels, there is need for planning to be more effective.

Planning, whether for a river basin or for a municipality or for an individual enterprise, consists of analysis of relevant information, identification of available alternative means of dealing with the problem, and decision on which alternative to choose. With the current increased planning effort consequent to increasingly urgent problems, it becomes evident that we are relatively poorly equipped with technologies for carrying out each of those three aspects of planning water resources. This is exemplified in a recent Bureau of the Budget Task Force study of flood control (4) which highlights shortcomings of

present planning technology in relation to the complexities of water resources problems. In the matter of analyzing relevant hydrologic and economic information, we lack both adequate data and also proven analytic methods. Identification of alternative means of dealing with water resources problems has been undertaken in systematic fashion only quite recently, and the alternatives identified only rarely include adequate information on costs.

Perhaps we are least well equipped with methodology for deciding which alternatives to choose in formulating plans, at least those plans in which public agencies such as counties, municipalities, and States have important responsibilities. Here, as was pointed out in the recent VPI Water Resources Research Center symposium on multidisciplinary research and public policy formulation (5), unlike many of the problems faced by industrial management, choices among alternative means of water management and waste disposal often are determined by values that are difficult to measure. Public support for protection of recreation sites, attractive landscapes, and urban environments, although often elusive and difficult to quantify, frequently appear to be strongly held and may be decisive for public action. As brought out in the recent report of a National Academy of Sciences panel (6), how to provide for timely expression of public preferences in the formulation of water resources plans is a major problem in the decision-making process.

Even this very cursory summary underscores the need for improvements in water resources planning technology. It is reassuring that throughout the Federal agencies there is a widespread research effort directed at water resources problems, and equally reassuring that the VPI Water Resources Research Center, and like centers in each of the other States, are marshalling scientific and engineering competence to find new and improved

means for dealing with the water resources problems of the several States and regions and the Nation. Through the cooperative program of the Interior Department and the universities, begun in 1964, some 600 new water resources research projects are now being carried on (7).

That cooperative research engages the entire spectrum of academic competence - physics, chemistry, biology, all of the physical and life sciences and engineering, and the social sciences, economics, public administration and law. Later this afternoon, Professor Walker undoubtedly will discuss in detail the program of the Virginia Water Resources Research Center which includes a number of research projects that promise to contribute significantly to solution of important water resources problems. Some of the on-going work in other States may also be of interest to you. This includes a wide range of projects such as one in North Carolina on the effect of low-flow regimes on water quality management, or the New Jersey analog computer simulation of stream pollution dispersion models, or the one in New York on water law and political institutions, or the economic analysis of water utilization in Pennsylvania. I find it difficult to name any one of the 600 research projects that might not be of interest to those professionally engaged in water resources planning or management. Rather, I suggest that you consult the catalog of current research projects published by the Office of Water Resources Research so that you can watch for the final project reports or communicate directly with the principal investigators of projects that may be of special interest to you.

In accordance with Congressional authorization (8), extension of this research program is expected to reach non-academic as well as academic competence to enlist research institutes, industry, and state and local government agencies that have research capability.

Today's symposium, and comparable activities in 50 other water resources research centers, encourage confidence in research as an effective aid in decision making on water resources problems.

References

1. McJunkin, Frederick E. and William R. Walker. Water Resources of Virginia, an inventory of printed information and data. 1966. pp. 108. Water Resources Research Center, Virginia Polytechnic Institute, Blacksburg, Va.

2. Johnson, W. Martin. Letter to Hon. Robert S. Kerr, September 17, 1959. Committee Print No. 6, Select Committee on National Water Resources; 86th Cong., 2nd sess. U.S. Senate; Washington, D. C.

3. Peterson, D. F. Research Needs for Practical Water Planning. 1965. Proceed. 10th Ann. Water for Texas Conference. Texas A&M Univ., College Station, Texas.

4. Task Force on Federal Flood Control Policy. A Unified National Program for Managing Flood Losses. 1966. House Doc. No. 465, 89th Cong., 2nd sess. Gov. Print. Office; Washington, D. C.

5. (McJunkin, F. E., James M. Wiggert, and William R. Walker) Multidisciplinary Research as an Aid to Public Policy Formation. 1965. pp. 68. Water Resources Research Center, Virginia Polytechnic Institute, Blacksburg, Va.

6. Committee on Water, Alternatives in Water Management. 1966. pp. 52. National Academy of Sciences - National Research Council. Publ. 1408. Washington, D. C. 20418

7. Office of W. Res. Res. (annual and intermittent topical reports and catalogs of current water resources research). 1965 et. seq. U. S. Interior Dept; Washington, D. C. 20240.

8. Public Law 88-379 as amended by Public Law 89-404.

DIVISION OF WATER RESOURCES

by

J. M. Alexander, Commissioner
Richmond, Virginia

We are aware of the fact that Virginia currently is experiencing a rapidly expanding population, and urbanization and an advanced industrial production, all of which are imposing great demands on and competition for water in sufficient quantity and in sufficient quality to meet the needs of an expanding economy.

The General Assembly, being aware of the vital importance of water to the health and well being of Virginia, during its 1966 session, inacted into law, provisions for cooperative planning for the development, use and management of the states water resources, with leadership at the state level.

Reference to certain provision of Chapter 561 of the 1966 Acts of General Assembly would appear to be in order at this point. This graphical illustration (Chart 1) will emphasize certain provisions of the new law to which reference has been made.

We will note that:

> "The Board (of Conservation and Economic Development) is assigned the responsibility for planning the development, conservation and utilization of Virginia's water resources . . .
>
> "The Board shall proceed to study the existing water resources of this state and existing and contemplated uses and needs of water for all purposes . . .
>
> "Based upon such studies the Board shall form a coordinated policy for the use and control of all the water resources of this state . . .
>
> "The Board shall devise plans for the development of the water resources of this state . . .
>
> "These plans may include comprehensive water and related land resource plans for each major river basin of this state . . .

"In this connection, the Board may cooperate with all branches or agencies of the Federal Government, with all branches or agencies of the government of any state . . . (and) with the political sub-divisions of the state . . .

"In all matters directly related to conservation or use of the state's waters . . . the Board is authorized to speak and act for the state in all relations with the Federal Government or with the government of other states . . .

"In order to assist the Board in carrying out its functions as provided by law, the Board may call upon other agencies and political sub-divisions of this state . . .

The Board of Conservation and Economic Development has accepted the additional duties and responsibilities placed with it under the provisions of the new legislation and has embarked upon a course in accordance with the legislative directive.

The Division of Water Resources of the Department of Conservation and Economic Development has been designated by the Board as its investigatory and planning staff to act in an advisory capacity to the Board.

The Division of Water Resources has been re-organized to provide a staff structure with competent professional personnel which personnel would function as a unit in assisting the Board in carrying out its new assignment as directed by the General Assembly. The following charts (Charts 2 through 8) graphically display the organizational structure of the Division of Water Resources and its relationship to the Director of Conservation and Economic Development, the Board of Conservation and Economic Development, and to the Chief Executive of the Commonwealth. You will note that the parent organization of the Division of Water Resources, the Department of Conservation and Economic Development, is governed by the Board of Conservation and Economic Development which consists of 12 members. A "Water Committee" has been organized from the membership of the Board. That committee will concern itself with water matters and make recommendations to the full membership of the Board.

Currently, the Division of Water Resources consist of six functional sections: the Commissioner's Office and Administrative Section: The Surface Water Investigations Sections: The Quality of Water Investigations Section: The Geology and Ground Water Investigations Section: The Planning, Reports, and Review Section: and the Mapping, Drafting, and Reproduction Section.

The Commissioner of Water Resources, and his immediate staff, plans and directs the entire effort of statewide scope to render advisory services and to formulate policies, plans, and programs for the investigation, development, conservation, utilization, and management of the water resources of the state. Direction is received from the Board of Conservation and Economic Development and the Director of Conservation and Economic Development on major policies. Work within the division is managed by the Commissioner of Water Resources with an appreciable degree of latitude for independent decisions and actions.

The Surface Water Investigations Section is to be engaged in the maintenance and operation of stream gaging stations for the collection of quantitative data on surface waters of the state. Information gathered includes, but is not limited to, continual records of stream flow with reference to its distribution in time and in space. Such data are analyzed and published in usable form for the benefit of the state program as well as for the benefit of any state agency, political subdivision, or others interested in and engaged in the use and development of the state's surface waters.

The Quality of Water Investigations Section is to be engaged in the technical and administrative work involved in the analyses of the waters of the state for the determination of their chemical and physical character. Such determinations are necessary in planning for the multiple use of the state's waters.

The data collected are to be analyzed and published in usable form for the use of the Division of Water Resources as well as for the use of individuals, engineers, industries, municipalities, and other state agencies.

Pending a Board decision on the matter, the Geology and Ground Water Investigations Section's detailed function has not been decided at this time. However, work in the Department of Conservation and Economic Development would involve the making of a variety of geologic and geohydrologic investigations necessary to the contemplated overall program of the Division of Water Resources. These would involve the making of test wells to be of such construction as to provide for the geohydrologic exploration of the entire stratigraphic sequence to basement rock, where applicable, for quality determination, and for test pumping to establish yields of individual and collective aquifers, respective drawdowns, zones of piezometric depressions, and related interference with levels in and yields of other wells. Geohydrologic work would be initiated relative to the hydrologic cycle as pertains to both surface water and ground water. Work would be done relative to the implications concerning structural foundations and reservoir retention capabilities, all related to the overall program of the Division of Water Resources.

The Planning, Reports, and Review Section is engaged in the preparation of the state's comprehensive water resources development plan and in the maintenance of coordination and cooperation with other water resources and related planning agencies, state, local, and Federal. This section is responsible for the review of proposals which relate to the use of the state's waters whether such proposals originate at the state, local, or Federal level. Recommendations to the Board relative to such proposals are prepared in the Planning, Reports, and

Review Section. River basin development studies and planning therefor are carried out in this section. Such planning is based on detailed inventories, and assessments of current and projected needs. The work embraces the cooperation with and furnishing of assistance to community and regional planning agencies and to any other entity concerned with the use of the state's water resources.

The Mapping, Drafting, and Reproduction Section concerns itself with the preparation and reproduction of graphic and other illustrations necessary to perform the work of the division. Such work includes the preparation of topographic and site maps, engineering designs, and other varied miscellaneous maps, tracings, and sketches, which are used in continuing studies and for inclusion in reports prepared in the division for publication. The referenced work embraces activities from initial sketches and text leading to the preparation of a finished product in suitable form for publication and distribution.

We note that the Division of Water Resources is fairly well staffed now with some exceptions. The authorized positions vacant are notably in the Quality of Water Investigations Section and in the Geology and Ground Water Investigations Section.

One may critically review the organizational structure and staffing pattern of the Division of Water Resources as presently established and thereby see another "layer" among those existing agencies, both state and federal, which are concerned with water resources matters, which agencies may be organized in a fashion somewhat similar to that just outlined.

A great number and variety of state and federal agencies have evolved throughout the years and have attempted to deal with water resources problems on a "piece meal" basis. Such is inefficient, ineffective and would be confirmed by a serious student of the time as generally unworkable.

One might advance the thought that another "layer" at the state level would serve to confuse further, the current efforts now directed toward treatment of a critical situation.

The existence of competent agencies in the Federal establishment, not withstanding, the planning of water resources development can not be construed as being truly comprehensive or coordinated without a more than superficial analysis from those at the local, regional and state level. There must be at the state level an organization equipped to determine local and state needs; to coordinate these efforts and to insure that the local and state interests are fostered, promoted and protected.

Many plans for the development of water resources have all but left the state out of the consideration except through the possible veto power of the Governor. This is especially true in view of the fact that many of the earlier water resource development projects were proposed, planned, and implemented by the Federal establishment without an effective state voice in the undertaking. It is paramount that local and state attitudes, interest, needs, and wants be reflected in any development plan which would affect the localities and the state as a whole.

Heretofore the state has not been in a strong position to deal effectively with proposals originating at any level of government. Duplication of effort is not intended here, but there is a definite intention to take a look at the matter from the state and local view-point. Such a state organization as outlined will provide for the coordination of efforts at the state level and will provide a real opportunity to insure that the states responsibilities are met and that the states needs and interests are protected.

A glance at this chart will give some idea of the need for a single state agency to be concerned with all phases of the water resources situation. The chart being illustrated at this time indicates a few of the water resources coordinating activities engaged in by representatives of a number of state and federal agencies.

The work of the Division of Water Resources will encompass all facets of water resources investigations and planning, such to be coordinated with the investigatory and planning efforts of now existing local, state and federal agencies.

The Board through its Division of Water Resources has embarked upon a plan for the preparation of a plan for the development of the water resources of the Commonwealth.

The chart now displayed indicates the sequence of events which would follow from the point of departure of study efforts to the completed water resources plan. You will note that the study units are eight in number and that each unit represents a river basin or a combination of river basins. "A river basin, from its headwaters to its mouth, is a highly sensitive system which under the stress of many and conflicting demands can be effectively developed only as a unit." Therefore, studies and planning to be directed toward the development and management of the resource will be conducted with the river basin as the basic hydrologic unit.

First efforts in the study and planning program would embrace an inventory of existing water resources developments to include current uses both from the quantitative and qualitative standpoint. Existing available data would be collected and reviewed to determine its worth and applicability in the current effort. Such would include data in open files of existing agencies as well as reports of study pertinent to the areas which would be affected. Such data would be reviewed and

analyzed with a view toward minimizing the duplication of effort whenever practicable. Too, the initial effort would involve an analysis of overall development potential with a cataloging of potential needs, areas, and potential development works.

Economic base studies would be made with a view toward projecting the nature and level of future economic activity to be expected in the affected areas, all to be based on resources available in the affected areas, as well as those influential resources without the specific area.

Projections would be made of population numbers and distribution. Such projections of population numbers and distribution with the projections of the nature and level of economic activity would be translated into quantitative and qualitative water needs.

The hydrologic characteristics of the resource would be investigated to include hydrologic data collection and analysis, all of which would be concerned with the occurrence, availability and distribution in time and in space, of both surface and ground water, with a consideration of quality as well as quantity.

Detailed investigations would be made into the requirements and demands which would be imposed upon the basic resource. This would include considerations for domestic and industrial water supply, agricultural irrigation, water quality control, fish and wildlife, recreation, hydroelectric power, navigation, and flood control.

Alternative plans which would be designed to develop the resource in a manner such as to assure meeting the projected needs would be formulated to include proposals for physical plant with costs for such. An analysis would be made of the various alternative plans evolved. Recommendations would be

forthcoming relative to the nature and extent of the required development works.

Consideration would be given to means through which plans formulated could be implemented. Such would include implications relative to investments by government and by private enterprise in water resources development works.

The initial phase of the investigations and planning effort envision a period of ten years, with funding to be forthcoming from state appropriations as well as grant-in-aid funds under the provisions Section 701 of the Federal Housing Act of 1954, and under the provisions of Title III of the Water Resources Planning Act of 1965.

Too, cooperative programs have been reestablished with the Water Resources Division of the United States Geological Survey. It is anticipated that such cooperation will continue into the foreseeable future.

A number of state agencies are currently involved in water resources investigations, the results of which should be utilized by the Board in its efforts. The professional talents which exist currently in the various state agencies should be drawn upon in a manner such as to prevent duplication of effort as well as to insure effort leading to the formulation of a unified coordinated and comprehensive program which would ultimately result in a development plan which would satisfy the local, state and national needs.

The task that lies ahead of us is of such magnitude as to not exclude any interested party, should efforts yield results which are necessary, desirable, and vital to the well-being of our citizenry.

The question is raised as to the mechanics which would be involved in carrying out the task that lies ahead of us.

Again we refer to the legislation under the provisions of which we will be working and note that no extremely rigid inflexible rules are set forth. It is envisioned that the process would involve a concerted, consolidated effort on the part of all who would be affected. There is no duplication of effort envisioned, but that of sharing data, technical expertise, advice, and professional opinion. Consideration would be given to the overall view without undue emphasis placed on any single project or any single project purpose. The investigatory and planning effort would not be designed to defer or to alter any projects or plans now considered for development. Neither would the purpose be to review in detail every proposal made at all levels of interest.

Those who have been and are now engaged in water resources activities affecting Virginia have performed in a noteworthy manner, which agencies include both local, state, and federal, including local drainage districts, sanitation districts, Departments of Public Health, Departments of Public Works, and local planning commissions: State interests and agencies include circuit courts, The Virginia Institute of Marine Science, the Department of Highways, the Ports Authority, the Corporation Commission, the Commission of Game and Inland Fisheries, the Commission of Fisheries, the Department of Health, the Water Control Board, the Soil and Water Conservation Commission, the Water Resources Research Center, state educational institutions, the Commission on Outdoor Recreation, and the Department of Conservation and Economic Development. Those federal agencies involved include the Federal Power Commission, the Weather Bureau of the Department of Commerce, the Farmers Home Administration, the U. S. Forest Service, the U. S. Soil Conservation Service, the Bureau of Sport Fisheries and Wildlife, the National Park

Service, the Water Resources Division of the United States Geological Survey, the Department of Health, Education, and Welfare, the Federal Water Pollution Control Administration, and the Corps of Engineers, Department of the Army.

It would appear that we should look into the water resources matter with a view toward the resolution of problems based on a unified effort with contributions from all and with consideration of all interests.

It might be mentioned here that the policy for the use and control of the state's water resources which would be formulated by the Board of Conservation and Economic Development cannot logically be developed overnight and without extensive knowledge of the resource which would be managed by the policy developed. The development of the management policy will, of necessity, be a deliberate step-by-step procedure first giving due consideration to existing policy and its adequacy or inadequacy to do the job.

A most important consideration in the matter of water resources development is that of implementing the plans which would be developed. Implementation connotes a need for funding. It appears reasonable to consider contributions from the local government, the state government, private enterprise, and the Federal government. Answers to the question are not provided here but mention is made of the question of funding since the planning effort will ultimately lead to the implementation of plans and funding of projects which would be proposed in those recommended plans.

GROUND-WATER PROGRAM

by

James L. Calver, State Geologist
Virginia Division of Mineral Resources
Richmond, Virginia

The ground-water activities of the Division of Mineral Resources are confined principally to basic research and investigation, to field service calls involving new field investigations and research, and to the dissemination of information generally and in response to specific requests. The Division conducts field investigations and research relative to the occurrence of ground-water, its potential quantity, quality, depth, and geologic associations. All records - Water Well Completion Report forms, quality of ground-water data, pump test data, drillers logs, geologic logs, special logs such as electric, resistivity, gamma ray, etc., and drilling samples of strata penetrated, are maintained by the Division of Mineral Resources. Reports of ground-water geology including laboratory studies are prepared and published by the Division.

The Division of Mineral Resources is charged with the systematic investigation of the geology of the Commonwealth, including the structure and characteristics of the rocks, the exploration for and examination of earth resources including ground water; the preparation of reports and maps. A major function of the Division is the consultation with individuals, municipalities, industries, and agencies throughout the State on specific problems of ground water and raw material availability and a wide variety of hydrogeologic questions. Many hours of work are often involved in assessing individual requests.

Data on wells drilled for public water supplies and for industry are filed with the Division of Mineral Resources. The rock cuttings obtained during drilling are examined by a staff

geologist and a detailed geologic log is prepared. This information is supplied the driller and the owner of the well. These records are extremely useful in preparation of geologic maps and prediction of availability of water in other areas that have similar rock formations.

The ground-water research work carried out by the Division is recorded in two easily obtainable references. The projects are listed annually in the April issue of the State Geologists Journal. This journal is devoted to the dissemination of information concerning the organization, facilities, activities, accomplishments, and publications of the various geological survey organizations and mining bureaus of the states. This information is also filed with the Science Information Exchange of the Smithsonian Institution, Washington, D. C. These sources of information are readily available and should be used by individuals pursuing research in the natural resources field. The Division of Mineral Resources has underway ten ground-water research projects and four continuing research projects:

1-4. Detailed studies that combine an inventory of all wells in an area and relate the occurrence of ground water to the various rock formations, rock structures, and topographic conditions that exist in the area of investigation.

a. Ground-water resources in eastern Albemarle County.
b. Ground-water resources in Augusta County.
c. Ground-water resources in Rockingham County.
d. Ground-water resources in Henrico County.

5. Ground-water conditions in the Shenandoah National Park. This is a cooperative study in which the Division is reimbursed for the work conducted in the Park area.

6-10. Ground-water conditions in State Parks.

a. Mt. Rogers State Park.

b. Douthat State Park.

c. Claytor Lake State Park.

d. Hungry Mother State Park.

e. Fairy Stone State Park.

Four continuing programs on a state-wide basis include the evaluation of ground-water potential by county units; an observation well program to measure static water levels to determine natural fluctuations of the ground-water levels throughout the State; geophysical studies - electric and gamma-ray log correlations and electrical resistivity profile correlations; hydrogeologic studies including geologic log preparation and correlations with pump-test data.

The work load with the present staff is at a maximum. Requests for assistance in ground-water matters during the past several years have been from the western two-thirds of the State, primarily.

Earlier work done in the Coastal Plain by the Federal Geological Survey under former cooperative agreements resulted in publication of 22 ground-water studies, 21 published by the Division of Mineral Resources and one by the U. S. Geological Survey. In recent years four studies have been prepared and published by the Division of Mineral Resources. Because large quantities of water have long been known to exist in the Coastal Plain, and because only a few major water users existed in that part of the State, there was no real concern. With the recent large increases in ground-water removal, the need for more detailed information has been expressed. This need can be filled by instituting several programs:

1. By expanding the existing observation-well program to determine the natural fluctuations of the water table

and the pressure systems of the artesian aquifers. These would measure regional changes.

2. By establishing an observation-well program to determine the effect of withdrawals of ground water near large users. These observations would be closely related to water use and would show local changes.
3. By establishing observation wells from which water samples would be taken periodically to establish quality-of-water changes. In coastal areas the fresh water-salt water interface should be monitored at several horizons.
4. Establish a well-inventory program in which all wells would be located, their surface elevation determined, and records of static water level, size of casing, etc. be recorded.
5. All water data could be assembled from all agencies. This would include the coding and recording of chemical analyses for publications of quality-of-water data, and coding of current well-inventory data for use by digital computer.
6. Because the Coastal Plain contains aquifers that are capable of yielding large quantities of water and a number of high-capacity wells are now in use, studies could be initiated to establish more precisely the quantity of water that is available. A test-drilling program to determine the thickness of the sedimentary strata and the water-bearing characteristics of the strata could be undertaken. Perhaps four wells could be drilled to bedrock in the area south of the James River and four or more similar wells north of the James River. Evaluation of each aquifer encountered should

be made at the time of drilling.

7. Research on the occurrence of ground water by statistical analysis by use of digital computer, electric analog model construction, and analyses and quantitative determinations of recharge of the artesian systems in the Coastal Plain could be undertaken.

COMMISSION ON OUTDOOR RECREATION

by

FitzGerald Bemiss, Chairman
Richmond, Virginia

The problem of providing ourselves with the quantity of water and quality of water adequate for the increasing and varied needs of our society is one which is being discussed all over the United States. It is high time that it should be, for, as in the case of all of our natural resources, we only take alarm when we have nearly depleted or destroyed the resource. There may be some argument as to the degree to which we have depleted or destroyed our water resources, but there can be no argument that this vital matter commands positive attention. It is a fine thing that this Symposium has been arranged not only to bring before the people of Virginia the general problem of water quality and water quantity, but to initiate a discussion of the specific aspects of supply and demand.

I am glad to talk from the point of view of one specifically concerned with conservation of water resources for their recreation value. It is well established that water - not just water, but clean water - is perhaps the number one recreation magnet. This magnet comes in many forms and Virginia happily has its share of each - the Atlantic surf, the magnificent tidal rivers flowing into the Chesapeake Bay, the ponds and lakes (little soil conservation ponds and great impoundments), and an endless variety of mountain streams and fast-moving rivers. No state has even a comparable variety and wealth of water.

It is for this reason, no doubt, that we have only recently begun to focus serious attention; indeed this wealth has seemed quite inexhaustible. But my purpose is not to bemoan what has gone by. I mean to speak with enthusiasm about the opportunities which we have at hand for conserving and

developing water resources for the lasting pleasure and profit of the people of the Commonwealth.

The Report of the Virginia Outdoor Recreation Study Commission, in the chapter entitled, "Water Resource and River Basin Studies," had the following to say:

> "With population and economic growth, the demands are many and conflicting. They include:
>
> Water for metropolitan populations
> The vast requirements of industry
> Sewage and industrial waste disposal
> Recreation - boating, fishing, swimming
> Commercial fisheries
> Agricultural irrigation
> Power dams and navigation projects
> Transportation lanes
>
> "As these demands have created problems, a great variety of State and Federal agencies have been directed to deal with each as if it were separate and independent from other water problems. As previous studies and experience in this and other states have shown, this proliferation of agencies treating fragments of a deeply interrelated complex is inefficient and ineffective.
>
> "A river basin, from mountain spring to delta, is a highly sensitive system which, under the stress of large and conflicting demands, can be effectively studied, planned, conserved, and developed only as a whole.
>
> "A striking example of conflicting demands on a single basin is seen on the James between Richmond and Newport News. They include carrying off industrial, human, and agricultural waste while thousands seek water-based recreation; increasing industrial water needs while commercial and housing developments lower surrounding water tables; historic preservation while speculators buy colonial plantations expecting an improved shipping channel to attract heavy industry. Clearly the development of one potential threatens another.
>
> "As major engineering projects are undertaken for flood control, water supplies, and recreation, it will be important for the State to have the governmental machinery to bring together all of the arguments for and against a proposed treatment of a major river basin and to consider alternate proposals in the light of the long-range common benefit to Virginia. These are Virginia rivers, and whatever we do or fail to do about them will affect all Virginia for generations to come.
>
> "There is, however, no State long-range planning agency to consider the pros and cons of these projects and to relate them to all aspects of the development of a major river basin and to other major concerns of the state.

"The Commission recommends that consideration be given to the creation of a Water Resource or River Basin Commission for these basic purposes:

1. To provide a single State office through which all studies, plans, proposals, and programs must be cleared.

2. To assist the Governor and the General Assembly in comprehending all the values involved for effective long-range attention to water resources."

Immediately following the delivery of this Report, Governor Harrison created a special committee to develop these general recommendations in specific terms. This five man group, of which I was Chairman, delivered in fairly short order the Report of The Governor's Special Committee on Water Resources. Out of this came Senate Bill 399, to provide the State with a Division of Water Resources equipped to carry out comprehensive river basin studies and to develop coordinated policy for the use and control of the State's water resources. This, in my opinion, was an indispensable first step. The Division of Water Resources, as it develops, will provide us with the degree of understanding which we do not now have of these intricate and interdependent water systems. Decisions can be based on fact with some knowledge of overall consequences.

I emphasize this because, in my opinion, all State and local agencies concerned with water should lean very heavily on these professional analyses. Without this there is substantial risk that thoughtless or greedy depletion, pollution, or diversion by one place or special interest will deny the benefits of an essential common resource to an entire basin and millions of people. I can assure you that the Commission of Outdoor Recreation will do so. Because unless the basic resource is broadly and wisely treated, then our specific plans for providing recreation opportunities will amount to very little. The VPI Water Research Center will be indispensable.

Trusting that these overall policies will be developed and applied, our Commission will concern itself especially with providing opportunities for people to get at the water. As you may recall, the Report of our Study Commission attempted to deal with the various categories of water-based recreation from the tiny mountain stream to the Atlantic beach. On the regional maps in our Report are indicated certain general areas for possible development as State or Regional Parks. You will see that almost all of the areas involve water, particularly water near people. The Division of Parks and the Commission of Outdoor Recreation are busy now analyzing these general suggestions in detail. We have already taken steps to acquire a stretch of oceanfront south of Virginia Beach and the National Wildlife Refuge and some attractive land in the Mason Neck area on the Potomac. These are two dramatic instances which will prove of immense value to millions of people for years and years to come.

We will have other equally impressive sites for addition to our State Park System. But do not think for a minute that the people of Virginia will ever gain sufficient and suitable access to Virginia's waters through State Parks. This is not only impossible but undesirable. A major part of the job must be done at the local or regional level. In metropolitan Richmond, for example, there is a strong desire of the people to see and enjoy the river that flows right through the area. The river, however, is quite inaccessible and for the most part unseeable. It is the area's largest and most distinctive feature, but little by little within the past 50-60 years the banks of the river have been cluttered or preempted so that one can gain access only at a few difficult spots and then by trespassing on other people's property.

No one can argue that this destructive crowding of the river banks has been beneficial or economical. Many cities have had the same experience and, realizing that they have denied themselves the benefit of a great asset, have taken steps to reclaim their waterfronts. Chicago did it two generations ago. Jacksonville has done it quite recently; Philadelphia is doing it now. One could cite many other examples.

It will take money and imagination to reclaim the banks of the James in downtown Richmond. But if one looks south from a tall building on Main Street, one can easily recognize the opportunity which offers itself. It is most encouraging that the City Administration and Planning Commission are developing plans and programs for pursuing this opportunity. The plan must be a bold one, based on the determination that Richmond can and must be not just a big city or a rich city, but a livable, dignified, and beautiful city. With the various State and Federal programs available to help the City, with the great generosity of a private citizen who gave the islands of the downtown James to the City; and with the proposed expressway compelling substantial rearrangements, this is certainly the time to move. If the designers of the proposed expressway confine themselves to thinking solely in terms of traffic movement and end up blocking off whatever the railroads have not already blocked off, then we will indeed have achieved a dismal result.

Alas, it appears that the vivid lessons of the past make very little impression on certain suburban areas where the preemption of waterfront continues with leapfrog developments. There is no question in my mind at all but that the failure to require setbacks from river banks produces highly uneconomical results. The earliest cities - the medieval cities notably - are characterized by houses built right to the edge of the street. The results were generally dark, narrow, dirty and

congested passages which made the whole place unpleasant and unworkable. A few hundred years of city building brought us to the convention of zoning requirements to require setbacks from public streets to provide not only for the moving of vehicles, but places for people to walk, room for public utilities, and even trees and grass plots. Perhaps the most splendid example is Paris' Champs-Elysee, but we don't have to go any further than our own Monument Avenue to make the point.

Must we continue crowding river banks and other public waters as medieval city builders crowded their streets?

The concept of providing room along the banks of a river which flows through several constituencies is an excellent example of the usefulness of a Regional Park Authority. The forward looking Board of Supervisors of Henrico County and Richmond City Council are about to create a Regional Park Authority, and I hope this concept will get the priority it deserves. Once it is applied there is no doubt but that its value will be seen and understood by other neighbors.

Just recently I participated in a discussion in Front Royal with citizens, officials, and agencies concerned with the future of the forks of the Shenandoah River. There is no more beautiful river in the country than the Shenandoah; and nowhere is there found finer small mouth bass fishing. At the same time, there is vigorous industrial and population expansion in the area; and an equally vigorous tendency to preempt all the banks of the River for housing developments of one type or another. Mr. John Kauffmann of the National Park Service applied with great force the arguments for required setbacks from the banks of the River - the very arguments I have applied to the James. The great usefulness of the meeting was in showing that no one stands to benefit more by far-sighted steps to protect the River than the inhabitants of the localities along the River.

Certainly, unrestrained license to develop on an every-man-for himself basis will produce some quick profits for the localities and for some citizens. But clearly this is to trade one's birthright for a mess of pottage and to exploit and destroy one's homeland and inheritance.

So, I believe the meeting which was originated out of concern that the Federal Government or the State Government was going to embark on some program of wholesale land acquisition, turned, as it should, to emphasis on the opportunity and responsibility in the hands of local government bodies. Theirs is the first step - to develop sound, long-range land use plans based on their natural assets and anticipating the growth factors; to adopt zoning ordinances based on sound planning; to provide protection of the river banks and access to the river. Virginia has a nearly ideal zoning law available to all localities. It has recently been amended to give local governing bodies clear authority in the matter of protection of flood plains and conservation of open spaces and natural resources.

The story is the same in many places. Smith Mountain Lake is 20,000 acres of clear blue water surrounded by wooded hills. It is close to the urban centers of Lynchburg and Roanoke and heavily traveled interstate roads. It is a sensational and irresistible recreation magnet for the urban populations, and also it offers a great economic opportunity to the counties surrounding the Lake. Undoubtedly there should and will be a State Park on its shores. But unless the local governments act to protect the banks of the Lake from ugly and destructive development and pollution, then the whole asset can be made less attractive and less productive for all concerned. It is absolutely foolish to construe the steps I suggest as involving interference with wholesome economic growth or confiscation by public agencies of vast areas of private land. On the contrary,

they involve the soundest ways to protect an asset and insure its productivity. Whether we speak of Smith Mountain Lake, the Chickahominy, the Appomattox, or the proposed Salem Church Reservoir, the values and principles are the same.

In summary, speaking from the point of view of one concerned with conservation and recreation opportunities, I should say we are concerned first with an adequate supply of water. The number of manmade lakes is increasing rapidly. The work of the Division of Water Resources will, I believe, over the years lead to an adequate flow of water in our rivers. Secondly, we are concerned with clean water. Our own Water Control Board has made good progress; popular concern and the new Federal anti-pollution laws should and will accelerate this progress. So I believe we will actually clean up our streams in the reasonable future. Third, we are concerned with access to the water. Under the Virginia Outdoors Plan some part of this access will be provided by additional State Parks. But the major responsibility - and opportunity - is at the local and particularly the regional level. Here is where the job must be done to require setbacks from the river banks and shorelines, to provide for public access along the waters edge, and occasional local or regional park areas for people to get at and enjoy the water and its shores. We need all three of these - water, clean water, and access to water. With citizen understanding and determination, with sensible and positive local and regional action, with the coordinated assistance of State and Federal Governments, the job of protecting and making available these great common resources for the general common benefit can certainly be done. I assure you that the Commission of Outdoor Recreation is eager to do its part.

ROANOKE RIVER BASIN ASSOCIATION

by

Eric W. Rodgers, Secretary-Treasurer
Scotland Neck, North Carolina

The Roanoke River Basin Association was organized at a meeting held in Danville, Virginia, on October 4, 1946 by three groups which had been previously working on water resources in the Roanoke Valley of Virginia and North Carolina. These were the Upper Roanoke Valley Control Committee, the Central Roanoke Valley Control Committee, both working in Virginia and North Carolina, and the Roanoke River Flood Control Committee of North Carolina. The last-named organization had been formed in 1941 a short time after the disastrous flood of 1940.

It was felt that by creating one major organization in the valley the effectiveness of the work could be considerably increased and the objectives of all three groups oriented so that they could present an united front in their efforts.

At this first meeting a committee composed of nine persons was appointed to draw up a plan of action and to present bylaws for the association. This committee reported at a later meeting in October, 1946, at Danville, Va., the bylaws were adopted, Bolling Lambeth of Bedford, Va. was named as the chairman of the group, Arthur T. Greene of Chase City, Va. was named as vice-chairman for Virginia and Frank C. Williams of Roanoke Rapids, N. C. was named as vice-chairman for North Carolina. Eric W. Rodgers of Scotland Neck, N. C. was elected as secretary-treasurer of the organization.

A statement of the aim of the association was adopted as follows: "The purpose of this association is to promote and support measures for the control and utilization of the waters of the Roanoke River and its tributaries in Virginia and North Carolina." It was decided to make membership a voluntary matter

with citizens of the valley and to stage a campaign for funds, with each person or organization making the decision as to the amount which would be paid in annually. This was done and several hundred members were enrolled and several thousand dollars were raised. The association has continued on a voluntary dues basis since that time and each fall all members are notified and make their voluntary contributions according to their own desires. At the outset about 1,200 members were enrolled, and this continued during the initial years when dams were under construction and interest was great in controlling the Roanoke River. After the major purposes had been accomplished membership fell off but today there are still about 300 active members who are carrying on the various projects which have come about from time to time.

At the outset, the purpose of the organization, and the three organizations which had preceded it, was to get flood control on the Roanoke River. When representatives who were sent to Washington were told that although surveys had been made by the Corps of Engineers, U. S. Army, and small additional grants of money had been allocated for preliminary work, it would be necessary for the project to be self-sustaining and therefore the power factor would enter into it, the association then decided to plug for dual-purpose dams whereever the Corps of Engineers decided they could be constructed profitably. During the years this worked out very satisfactorily. The government decided to erect dual-purpose dams at Buggs Island, Va., and Philpott, Va. These were two of the eleven projects included in the overall planning. The remaining nine either were not of the type where flood control would be a major factor or were strictly power dams.

The first two dams were constructed and then the Virginia Electric and Power Company and the Appalachian Power Company

got into the picture. This caused some discontent among the consumer-owned cooperatives in the area and the association appointed a committee to work with the power companies and the consumer-owned cooperatives so as to bring about a unified program which would be satisfactory to both groups. The association took the stand that where power companies or the cooperatives were ready, able and willing to construct some of the other dams approval would be given to their plans. The Virginia Electric and Power Company made its own investigations and the Appalachian Power Company did likewise. The cooperatives made surveys of certain of the sites selected but no action was taken by them after they studied these surveys. Virginia Electric applied for Federal Power Commission licenses to construct a dam at Roanoke Rapids and a dam at Gaston, both in North Carolina. The Appalachian Power Company made application for licenses to construct dams at Smith Mountain, Va. and at Leesville, Va. These four licenses were granted and these four dams have been completed and are in operation. The consumer-owned cooperatives have been well pleased with the results because they have gotten electric power at a lower rate which enabled them to operate profitably, and in some instances, I am informed, to take them out of "the red". The liaison committee working between the power companies and the consumer-owned cooperatives was one of the best ideas ever put into effect by the association.

It is not likely in the near future that any of the other five dams will be constructed. The Corps of Engineers is reviewing plans at some of these sites and may make definite recommendations for construction at a later date if the cost factor is favorable.

With these dams constructed, there were six great lakes available to provide recreational facilities for the people.

The Corps of Engineers and the power companies have cooperated in making their lakes available for recreation and, I am informed, more than three million people per year are now using these facilities. Developments are growing up around the shores of the lakes, there is fishing, boating, water skiing and other activities.

With completion of the dams and creation of the lakes the association turned its activities in other directions. It aided in plans in Virginia and North Carolina to get state funds and local funds for the development of public playgrounds. The State of North Carolina now controls about 15,000 acres of the John H. Kerr Lake in North Carolina and there are similar developments at several points in Virginia. The association appointed a Wildlife Committee to work with authorities of both states and with the Corps of Engineers in developing game and waterfowl refuges. The association has worked on matters in connection with pollution and cooperated closely with the Steering Committee for Roanoke River Studies which was organized with representation from federal, state and local governments and manufacturing enterprises to solve the difficult pollution problems in the lower Roanoke River from Roanoke Rapids downstream. This work is continuing under the supervision of the United States Government and some effective results are being obtained, although the work is by no means completed.

More recently, that is in the last three years, the association concerned itself with bringing in the tourist trade to make full use of the lakes. A brochure was issued and thus far 40,000 copies have been printed, and additional copies will be printed, detailing the available recreational facilities at each lake. These have been distributed throughout Eastern United States with the aid of the state governments of Virginia and North Carolina and several organizations interested in building

up the tourist trade. Still more recently, during this year since the Congress passed a bill aimed at providing for coordination of the development of river basins in the United States, the association decided to offer its services to the officials at Washington in working out a program for this type of development jointly in North Carolina and Virginia, and dealing of course solely with the Roanoke River which is in both states. Since the law provides that such programs will be developed in cooperation with the governors of both states the association has offered its services and all information which it has gathered during the past twenty years in the hope that this will be helpful to the movement generally. The association has not asked for any grant of funds but it is hoped that when the final plans are drawn at Washington with respect to the Roanoke River basin it will be included among the agencies selected by the two states to carry forward the program in the Roanoke Valley. The association sent its officers to Washington to confer with the various federal officials in charge of programs of this nature and they spent three days in these conferences. A great deal of information was obtained but since most of this work is now in the formative stage there has been no great action thus far, because Washington first had to set up its regional and state facilities.

The association will continue to work with appropriate federal agencies and agencies of the states of Virginia and North Carolina in carrying forward plans for the complete control and utilization of the waters of the Roanoke River and its tributaries in Virginia and North Carolina for the benefit of the people as a whole. Our plan of operation has been successfully copied by similar associations in two other river basins of North Carolina which are now getting underway in much the same manner that this work got started twenty or more years ago.

These are the Neuse River and Cape Fear River Valleys. The association holds an annual meeting once each year in the spring and its full board of directors meets once a year in November. Between these sessions the officers composing the executive committee attempt to carry out the programs which are approved. The association is always ready to answer the call of any group in the Roanoke River Valley for help in solving local problems which arise.

It is with satisfaction that we are able to report officials at Washington have told us that the plan adopted several years ago of having a liaison committee to work with power companies and consumer-owned cooperatives in solving their problems for the good of all and in the best interests of the people of the valley has been adopted as a masterplan for work in other river basins throughout the United States.

JAMES RIVER BASIN ASSOCIATION

by

W. Martin Johnson, President and H. E. Lordley, Vice President
Lynchburg, Virginia

The James River Basin Association is interested in all of the many aspects of the James River Basin. Agriculture, Conservation, Industry, Natural and Human Resources, and Ocean Shipping.

The James River Basin is the heart of Virginia and the Association's motto is to keep the Basin Green.

The purpose of the Association may be covered by four main objectives:

1. To engender interest in, to learn all available facts, and encourage the collection and development of new information concerning water and the other natural resources of the basin.

2. To provide a formula for presentation and discussion of views concerning water and other natural resources of the Basin and if necessary, for the resolution of differences of opinions and aims.

3. To study and take an active part in proposals affecting water and other natural resources of the Basin, so as to insure that they are consistent with wise use and intelligent development, and to exercise this interest and participation in studies, plans or projects affecting the Basin.

4. To encourage and promote those policies, laws, plans and projects affecting water and the other natural resources of the Basin, or the Commonwealth of Virginia, which will be most advantageous to, and in keeping with the desires of the people who live in the James River Basin.

Since all life and development in the Basin is dependent on water, its proper control and conservation is the most

important aspect of the Association's activities other than that of its human resources.

American History began on the James River, the American Revolution got its inspiration on the hills above the James and the tragic Civil War ended on its water shed. This Basin so rich in History is also fast becoming rich in industry so the combination brings travel and tourism to the greatest economic value to the entire Basin.

Since the organization of The James River Basin Association in January 1958, we have concentrated on two main projects - the construction of the Gathright Dam which will be located on the Jackson River approximately ten miles north of Covington, the largest stream in the headwaters of the James River. This project is so located that it can be of maximum benefit the entire length of the main river course. This project has been under consideration for many years, and just prior to World War II the Congress had approved the project for construction, but due to the heavy expense of the war, the construction of the dam was postponed and up to now we have not been able to get the Federal Government to appropriate sufficient funds to complete the project.

During the past few years, due to the efforts of the James River Basin Association with the aid of other interests, Congress has appropriated funds to complete the preliminary plans for the Dam; however, up to now they have not appropriated sufficient funds for the Army Engineer to complete the working drawing, and to let the first contract toward construction of the Dam. The sub-committees of both Congress and the Senate have a request before them now to appropriate $1,500,000.00 which would be sufficient to complete the final drawings and let the first contract toward the $34,000,000 project. Both

committees have met and we are hopeful that our request has been approved - we should know any day now.

The past five dry seasons have forcibly demonstrated to all the need for not only the Gathright Dam, but other dams on the headwaters of the James River and its tributaries. Many large paper mills and other industries located on the river are dependent on this source. The paper mills and forest products industries are the largest single source of income in the Basin, in payrolls and revenue to land owners. The mills are large users but not consumers of water and they are now returning the treated effluent to the stream. In many respects trees are our most important agricultural crop and they consume enormous quantities of water. We cannot forget that many municipalities are also dependent on the James and its tributaries for their water supply. Lynchburg and Richmond have suffered shortages for the past five years. The farmers have suffered great losses due to the drought during these past few years pointing up to the value of supplemental irrigation and which could create very large demands for water.

Without adequate fresh water reaching the estuary of the James River the famous oyster beds below Jamestown may face extinction due to the movement upstream of the higher salinity sea water which brings with it oyster predators.

The second project our Association has been pushing is to deepen the channel of the James from Richmond to the coast from its present depth of 25 ft. to 35 ft.

The Virginia General Assembly authorized $300,000.00 for the Virginia Commission of Fisheries in cooperation with the U. S. Army Corps of Engineers to study possible effects of this dredging on the oyster beds near the mouth of the James River.

The Commission contracted with the Corps of Engineers Waterways Experiment Station at Vicksburg, Mississippi to

construct a hydraulic model of the lower James. This model has been constructed, and these tests are being conducted by the Virginia Institute of Marine Science. These tests will determine the effect of channel deepening on the oyster cultivation near the mouth of the James.

The channel project, of course, has become necessary due to the increase in the size of Merchant ships. As you probably know, Richmond a few years back was quite a sizeable inland harbor, but in the past few years since the ships have increased in size very few are able to pass through the 25 ft. channel. The 35 ft. channel would increase shipping to and from Richmond so our state capital could take its rightful place in commerce. Such shipping facility would increase export business potential and improve the economy of the entire state.

Every square foot of paved surface, roof or other impervious surface created by man in the Basin aggravates the flood flow on the James River and in turn reduces the low water runoff. As developments continue it becomes more and more imperative that adequate conservation measures be taken to assure flood protection and relief for long drought periods.

In summary - the James River Basin Association has pushed the conservation and control of water as the most critical and urgent need in the Basin since everything else depends on it.

The Gathright Dam on the Jackson River is but one of such impoundments that must be developed. Being the uppermost tributary to the James River, makes the Gathright Dam most important since this impoundment will furnish much of the needed relief to both high and low water conditions in the river.

In conclusion, we must not forget the quality control of the James. The time will come in the not too distant future when the highest type of effluent will have to be provided by industry and municipalities so that our Virginia streams of

the future will provide the source for safe, adequate water supplies.

The James River Basin Association has this as a goal among many other things the Basin can and must supply.

INTERSTATE COMMISSION ON THE POTOMAC RIVER BASIN

by

Carl J. Johnson, Executive-Director
Washington, D. C.

The Interstate Commission on the Potomac River Basin is, as many of you know, the Commission organized under authority of an interstate compact, adopted by the states of Virginia, West Virginia, Maryland, and Pennsylvania, and the District of Columbia. The Commission is celebrating its 25th anniversary this year. It was created to enable the member bodies to abate pollution and to provide for the cleanliness of the streams of the Conservancy District, through fact-finding, research, education, and the encouragement of uniform rules and regulations. It also pledges the Signatories to cooperation, one with the other.

When discussions were being held prior to the adoption of the compact law, some of the delegates proposed a broad authority capable of operating in the entire water resource field. However, it was decided that pollution in the Potomac and its tributaries was the critical item and that the Commission should concentrate in this area, looking forward to a broadened responsibility at a later date. In 1959, the Commission proposed such broadening and offered a compact amendment to the Signatories. This amendment was adopted by all of the states except Virginia and was endorsed by the D. C. Commissioners. Since Virginia did not adopt the amendment, the status has not changed.

Last year (1965), the Governors of the four states and the President of the D. C. Commissioners appointed an advisory committee, known as the Potomac Basin Advisory Committee. The purpose of this Committee is to advise the Federal Interdepartmental Task Force on the Potomac on the development of its

Potomac River Plan and to create a draft of a new compact law that can be recommended to the legislatures of the four states and to the Congress. The Committee is working on the draft, and I understand they are looking forward to legislative action in 1967.

This will be a comprehensive proposal covering water and related land resources. It likely will propose that the Federal Government join as a signatory and probably will provide some enforcement and operating authority, which is not provided for in the present law.

I would predict that if and when the new compact law is operative, the present Commission will pass out of existence and its assets and personnel will be transferred to the new agency.

While some might not agree, I would say that the early decision to concentrate on pollution abatement was wise. For example, the Virginia Water Control Board did not exist at that time. The 25th Anniversary Report of the Commission contains a chronological listing of events which took place following the establishment of the Commission. (A copy is available to you.)

In 1941, only about 9 percent of the sewered population was served by secondary treatment plants, 75 percent was served by primary plants, and 15 percent was without any treatment facilities. Industrial wastes for the most part were not treated in 1941. Today the figures are nearly reversed: 88 percent of the sewered population is served by secondary type plants, 11 percent by primary plants, and 1 percent has no treatment facility.

This turnabout is more impressive when one considers that the Basin population has nearly doubled since 1940. The new secondary plant at Arlington will be in operation around the

end of this year (1966). At that time, 97 percent of the sewered population will be served by secondary plants. All major water-using industries are meeting state requirements at this time.

So you see that the early decision to concentrate on pollution abatement has paid dividends, and the big job of introducing a reasonably high order of waste treatment to the municipalities and industries has been successful and is behind us.

However, the job has not been completed. We are now at the point where we can begin to think about water quality management as it relates to desired water use in the various reaches of the River and its tributaries.

As most of you know, President Johnson in February, 1965, called for the Potomac to become a model for the Nation. Since then, an Interdepartmental Task Force has been engaged in this effort and expects to produce a final report in January, 1967. This report will probably set the guidelines for the development of the River.

A demand for a higher order of quality is a foregone conclusion. Recreation and domestic water supply will have high priority. Secondary treatment will not be sufficient. Nutrients will need to be controlled. Pollution from land run-off will need to be controlled and more fully understood. River flows will need to be controlled and managed. We may need to be more concerned about thermal pollution. The tidal estuary is a little understood problem by itself.

The point I am making is that, accepting the wisdom of those early delegates, we have now reached the point where we need to broaden the scope and the authority of the Interstate Compact so that it is equipped to operate efficiently in these modern times and able to undertake a program of water resource management. In this way we can most effectively provide the

local people and the states the opportunity to work out their own destiny within the framework of regional and national needs and goals.

Much of the technology and many of the relationships involved in water quality management from this point on in the Potomac and elsewhere are not well known. Research, both basic and applied, will be needed. We are looking forward to the ability and enthusiasm of the Water Resources Research Institutes in the Basin States and to research groups like the Virginia Institute of Marine Science and the Chesapeake Bay Lab in Maryland to provide many of these answers.

TVA'S MULTIPURPOSE WATER RESOURCES DEVELOPMENT PROGRAM

by

Edward H. Lesesne
Assistant to the Director of Water Control Planning
Knoxville, Tennessee

For a two-day period you folks will be studying the water resources of the Commonwealth of Virginia. I know that this is where your main interests lie, and I also know that when Bill Walker invited someone from TVA to appear on your program that he very probably expected a talk on the Virginia portion of the Tennessee Valley. I do intend to emphasize some of our water resources development activities in Virginia, but the very idea of the TVA Act - regional development - almost dictates that I first outline the multipurpose system of TVA, and disregard for the moment the boundaries of the seven Valley states.

The Tennessee Valley

The Tennessee River drains an area of 41,000 square miles. The upper tributaries originate in the Blue Ridge, Great Smoky, and Unaka Mountains with elevations ranging up to 6700 feet above sea level. The Tennessee River is formed just upstream from Knoxville by the confluence of the French Broad and Holston Rivers at about elevation 800. It flows southwest across Tennessee, dips into Alabama, crosses back across Tennessee almost due north, then flows into Kentucky where it empties into the Ohio River at about elevation 300.

Mean annual rainfall for the Valley is about 52 inches, ranging within the Valley from 37 to 92 inches. Maximum rainfall for a 12-month period at any one point in the Valley, since TVA established an extensive rainfall station network, is 135 inches. This occurred near the North Carolina-Georgia line in the Little Tennessee drainage area.

Generally, rainfall doesn't vary greatly from month to month. Mean monthly amounts range from 2½ to 3½ inches in September, October, and November, and from 4 to 5½ inches in the other months. March is usually the month of highest precipitation.

Annual runoff averages about 22 inches and has varied from about 10½ to about 33 inches.

The Design of the System

Section 9 of the TVA Act states:

> The Board is hereby directed in the operation of any dam or reservoir in its possession and control to regulate the streamflow primarily for the purposes of promoting navigation and controlling floods. So far as may be consistent with such purposes, the Board is authorized to provide and operate facilities for the generation of electric energy at any such dam . . .

The TVA water control system now includes 32 major dams and reservoirs on the Tennessee River and its tributaries and Great Falls Reservoir on Caney Fork, a tributary of the Cumberland River. Of these, 26 were built or acquired by TVA and 6 are owned by the Aluminum Company of America but operated by TVA under a contract originally signed in 1941. The reservoirs have a useful storage capacity of about 15 million acre-feet, equivalent to a depth of 7 inches over the entire Valley. The dams have an installed generating capacity of about 4 million kilowatts, about a fourth of TVA's total installed capacity including steam. In addition, TVA directs the power operation of the 6 hydro projects of the Corps of Engineers on the Cumberland River and its tributaries.

The design of the system was greatly facilitated by the fact that our early flood history studies indicated a definite flood season. Practically all of the Valley-wide floods in the past 100 years have occurred during the months of January, February, and March.

Guide curves were developed for each of the multiple-purpose reservoirs to show limiting elevations during various portions of the year. For example, during the flood season the guide curves for the main-stream reservoirs limit these reservoirs to relatively low elevations in order to reserve as much storage capacity as practical for the regulation of floods. The guides also provide minimum elevations below which these reservoirs must not be drawn in order that 11-foot depths will always be available for barge navigation. Similarly, the guide curves for the multiple-purpose storage reservoirs on the tributaries show relatively low maximum elevations below which these reservoirs must be held during the winter flood season in order to reserve storage capacity for regulating floods. Thus, on January 1 of each year 11,800,000 acre-feet of storage capacity is reserved for the regulation of floods whereas only 2,500,000 is reserved during the summer months. Storage capacity available for flood control is normally considerably greater because the multiple-purpose reservoirs are usually somewhat below the guide curves and because storage capacity is usually available (although not reserved for flood control) in the single-purpose power reservoirs.

During a flood, the reservoirs are filled as necessary in regulating that flood. After the flood the surplus water is discharged as quickly as practical to bring the reservoirs back down to their guide curves. Some of this water is discharged through the turbines to generate power, but a major portion is usually discharged over the spillways of the main-stream dams and over the spillways or through the sluices of the tributary storage dams in order to have storage capacity available should a second flood occur. In this way the integrity of the flood control system is maintained.

The main-stream reservoirs are filled to summer levels near the end of the flood season, increasing head on the turbines, and then drawn back down to the January 1 elevations during the late summer and fall to be ready for the next flood season. Similarly, the tributary storage reservoirs are filled near the end of the flood season as rapidly as streamflow and power demands will permit and are gradually drawn back down to their January 1 flood control elevations in the late summer and fall. Dependable 11-foot navigation is provided throughout the year on the Tennessee River to Knoxville (a distance of 650 miles) and on the Clinch River to Clinton. Water released from the reservoirs also increases navigation depths on the lower Mississippi River.

Flood control, navigation, and power operations of the water control system have enjoyed spectacular success during TVA's history. However, other "benefits" of such a system have come into the picture in recent years and I would now like to direct a few remarks to these benefits.

The Present and the Future

Planning for the full development of the water resources of the Tennessee Valley continues as a major activity of TVA. We find sometimes that people have the impression this job has been completed - since a large regional reservoir system provides a substantial degree of flood control on the Tennessee River main stream, a barge channel has been completed for 650 miles from the river's mouth to Knoxville, and most of the basin's potential for conventional hydroelectric projects has already been realized. But new needs arise as the Valley's economy grows and its people change their residence, their pattern of employment, and their way of life.

Valuable opportunities exist on tributary streams for reservoirs and channel improvements that will reduce flood damages, permit development of sites now subject to frequent flooding, provide water supply for industrial and municipal use, improve water quality, and provide a variety of recreational opportunities from fishing and boating to summer cottages and resorts along the shorelines.

The problem of planning these water resource developments is continually growing more complex. First, the dam sites most desirable for the demands of 30 years ago have already been developed. Second, the demands themselves are becoming more varied as needs grow for cooling and processing water, for water quality control, for more flood-free sites along streams or reservoirs, and as the public in ever-increasing numbers seeks water-based recreation opportunities. No longer can our engineers limit their planning to navigation, flood control, and power. Finally, coordination of project planning with interested groups and agencies is being expanded. Various Federal, state, and local agencies are increasingly concerned with water quality and with opportunities to improve sport and commercial fishing and to provide waterfowl hunting areas. The kinds of projects being considered today for tributary streams involve a greater proportion of localized benefits than earlier projects which emphasized regional and national purposes, and this requires greater local participation in project planning, management, and cost. Close coordination with local leadership is necessary for these projects to make their full contribution to economic growth.

Thus, our engineers engaged in planning water resources developments must identify all needs of the area, find ways to meet the needs in our plans, and then balance costs against benefits. Estimating this broadened range of benefits presents

problems that can defy the abilities of not only the engineers but also the specialists in each of the fields involved. Generally acceptable methods have been developed over the years for estimating navigation, flood control, and power benefits. Reasonably acceptable methods have been developed for estimating a new reservoir's effect on values of surrounding lands for industrial and recreational use by studying the before-and-after value of similar land along existing reservoirs. But what reasonable dollar benefit can be attributed to a day's fishing, boating, or picnicking; or what dollar benefit can be claimed because a stream formerly polluted with industrial waste now has been cleaned to the point that thousands relax along its banks? We know these values exist. Many people are willing to spend sizable sums for fishing and boating equipment, and gladly spend time and money to travel to their favorite recreation areas. Cities are willing to spend scarce tax dollars to develop parks, playgrounds, and recreation areas along attractive streams and lakes.

Finding acceptable ways to evaluate these benefits, both under present-day conditions and over the life of the proposed development, is a fruitful area for research. These kinds of problems require the thoughtful consideration of those versed in social and economic values. Until reasonably acceptable solutions can be found, we must continue to accept rather arbitrary estimates for these relatively intangible benefits.

Community Flood Problems

Although the TVA reservoir system is designed and operated to regulate streamflow, it does not completely remove the flood danger in communities downstream from the reservoirs and, of course, does not benefit communities located on unregulated streams. With our growing population and the general movement

from rural to urban areas, land within and adjacent to our cities is becoming increasingly scarce. The relatively flat and easily developed flood plains, left vacant because of the flood hazard, are enticing to builders and developers who are willing to take a chance or do not recognize the danger.

There is much that states, counties, and communities could and should do for themselves in solving these local flood problems. For the past dozen years TVA has been engaged in a rather unique 2-pronged program under which the states, counties, and communities in the Tennessee Valley are encouraged to keep man away from the water's path through passage of zoning laws and subdivision regulations, while we work with the communities to plan and construct facilities for keeping water away from the existing works of man.

This program begins with preparation of reports that summarize local flood conditions and hazards; these reports have been prepared for more than 100 Valley communities. It includes technical guidance in the use of these data to encourage builders to keep out of flood hazard areas or design their structures to be safe against flooding; technical assistance in preparing subdivision regulations and zoning laws intended to keep developments out of flood hazard areas; and planning and constructing, with local assistance, facilities that will reduce or eliminate flood damages.

A total of 46 communities have now officially adopted flood plain regulations in their zoning ordinances or their subdivision regulations or both, and some 53 communities have cooperated with TVA in comprehensive studies seeking solutions to their flood problems. Channel improvements are now under construction by TVA at Sevierville, Tennessee, and Coeburn, Virginia, that will greatly reduce flood damages.

Activities of TVA in Virginia

About eight percent of the Tennessee Valley lies in the Commonwealth of Virginia. All of this area is mountainous, and is drained by the upper reaches of the Clinch, Powell, and Holston Rivers. The area is upstream from the large multipurpose dams and consequently derives no flood control benefits from these structures. However, the area does lend itself to local flood control projects for the protection of individual communities. It is in attempting to solve these local flood problems that TVA has directed its main water resources development effort in Virginia.

Reports have been issued for 19 communities in Virginia. Some of these communities are small, but their flood problems are great. Reports have been issued for Appalachia, Big Stone Gap, Bristol, Carbo, Carterton, Castlewood, Cedar Bluff, Cleveland, Clinchport, Coeburn, Damascus, Dungannon, Ft. Blackmore, Marion, Norton, Raven, Richlands, Russell County, and St. Paul. Construction of a flood control system has been completed at Bristol, Virginia, at a cost of about $2.2 million of which Bristol paid $120,000. The main features of this system are dams on Clear Creek and Beaver Creek. Channel improvements are now under construction at Coeburn, Virginia, at an estimated cost of about $1.2 million of which $79,000 is to be repaid by the local government. Total local contributions to the plan are estimated to have a present value of $427,000. The Coeburn job does not involve the construction of reservoirs, but is confined to channel improvement. It will be completed this year.

TVA welcomes the opportunity to cooperate with the Commonwealth of Virginia and with the Virginia communities that lie in the Tennessee Valley in solving their local flood problems. And needless to say we also welcome the opportunity of cooperating with Bill Walker and his Water Resources Research Center.

VIRGINIA'S WATER RESOURCES RESEARCH CENTER

by

William R. Walker, Director
Blacksburg, Virginia

The establishment of a Water Center at V.P.I. had been under active consideration since 1962. It did not, however, become a reality until early 1965 after the passage of the Water Resources Research Act of 1964. The Act established an Office of Water Resources Research in the Department of the Interior, and authorized appropriations every year and continuing indefinitely to assist each participating state in establishing and carrying out the responsibilities of a competent, qualified water resources research institute or center at one university in each state. Governor Harrison designated Virginia Polytechnic Institute as the institution to establish Virginia's Center.

A multidisciplinary approach is facilitated through the establishment of research centers at universities. Now all the principle disciplines that may be concerned with water resources research can come together and participate effectively upon a mutually beneficial basis through the funding and coordination functions provided by this Act. I feel very strongly that the emphasis on the multidisciplinary aspect is one of the strengths of the program. This encourages researchers to address themselves to the "real problems" rather than symptoms as viewed from only one discipline.

Organization

An Administrative Committee establishes the policy for the Center and is responsible to the President of the University for its activities. It is composed of the Vice President for Academic Affairs, the Dean of Engineering, and the Dean of Agriculture. The operation and administration is centered in a

Director who is responsible to the Administrative Committee. Since true solutions to water problems can only be obtained through an interdisciplinary approach, a Technical Advisory Committee was established to counsel the director in his activities. This committee is comprised of faculty members from Economics, Sanitary Engineering, Hydrology, Geology, Forestry and Wildlife, Urban and Regional Planning, Statistics, Agricultural Engineering, and Agricultural Economics. The members of this committee provide an important link between the Director and the various disciplines and are extremely helpful in providing support for the Center's programs.

It was evident from the beginning that, if the Center were to truly serve the needs of the state in the area of water resources, there must be some dialogue between the Center and those working in the field outside of the university community. In recognition of this fact, a Statewide Advisory Committee was created. Membership on this committee is from state agencies concerned, either directly or indirectly, with water resources; federal agency representatives working primarily in Virginia; large industrial water users; consulting engineers; and administrative officers of several municipalities. This group meets approximately twice a year to hear reports on the activities of the Center and to suggest research needs and programs.

Research Projects

The research program is quite varied. It reflects many aspects of the water resources picture. The following is a brief description of some of the research projects and the anticipated impact of results on state and regional water problems.

Professor Tom Evrard, Plant Pathology Department, has underway an investigation designed to control certain aquatic plants prevalent in Virginia - principally milfoil and chara. Although

the Tennessee Valley Authority has been successful in controlling milfoil through the use of 2-4-D and the lowering of reservoir water levels for limited periods of time, these alternatives are not always available in Virginia since the lowering of the water in the Chesapeake Bay is not practical and the residual from 2-4-D precluded its use in the oyster growing areas. Over 1,000 farm ponds have been constructed in Virginia in recent years, and their capacity to store water for supplemental irrigation for control of surface runoff and for recreational activities is seriously jeopardized by these aquatic plants.

Most of the sewage treatment facilities in Virginia do not have units which effectively remove the nutrients of nitrogen and phosphorous. The quantity of these elements coming to a treatment plant remain almost unchanged during conventional treatment. There is strong evidence that if one or the other of these nutrients could be removed from the water, algae growth and the accompanying problems could be substantially reduced. You are well aware that this problem has reached critical proportions in some of the northern counties of Virginia. Dr. William A. Parsons has underway a project which shows considerable promise for the removal of phosphorus. If successful, it should be of substantial benefit, not only to citizens of the Commonwealth of Virginia, but to many other areas of the United States.

Over the past thirty-five years, a considerable sum of research money has gone into the investigations of small watershed projects. In our area, and in most of the United States, the effect of bedrock geology on runoff is one aspect which has received very little attention. Dr. Byron Cooper, Head of the Department of Geological Sciences, is directing a project to

evaluate the bedrock factor on runoff for the various formations in the Blue Ridge and Piedmont areas of Virginia. It is hoped that the results of this investigation will provide an empirical relationship which can be utilized by engineers in assessing the water yield of various terrains. This information should be especially helpful to those agencies involved in small reservoir construction where the budget for design cannot justify intensive preliminary investigations.

Also underway is a flood abatement study for the state of Virginia. This project is designed to assess the existing flood problem, to evaluate the preventive measures taken in the past, and to suggest what alternative approaches are available to reduce loss of life and property damages from uncontrolled flooding. Most of the work to date in Virginia has been in the area of flood prevention - construction of dams and levees, but very little has been done in the area of flood-plain zoning, subdivision regulations, and building code requirements. The research will suggest the types of institutional arrangements and alterations in the legal frame-work to reduce the flood losses in the future.

It was recognized from the very beginning that one of the real needs in comprehensive water resource planning for the state would be an evaluation of the water resource laws of the state. Although the availability of water has not been as large a problem in Virginia as in the western states, concern about water quality, increased interest in recreation, and an expanding urban population suggests a study of the legal framework in depth. At the meeting of the General Assembly in 1966, two private bills were introduced, both designed to circumvent the existing water laws of the state. It would appear that unless we can develop a sound legal framework to administer this resource, a jungle of private laws may develop which will prevent

the best use of this resource for the citizens of the Commonwealth. A bill directing the Virginia Advisory Council to make a study of water laws of the state died in a committee. We, therefore, feel that our project will make a substantial contribution to the information needed for sound water resource planning and may illuminate areas for legislative action.

This study has already shown that man-made water laws do not take cognizance of the natural laws. To do otherwise is to make no sense - we are just walking in the dark whistling Dixie. The continuity of hydrologic cycle is a basic principle; because of that continuity the distinction between water and the several phases of the hydrologic cycle (precipitation, soil water, ground water, surface water) are all transient at many places and times. The legal classification of water has failed to recognize this inter-play and inter-relation within the hydrologic cycle. Perhaps this lack of recognition is partly due to the fact that lawsuits traditionally have been neighbor vs. neighbor, riparian vs. riparian, etc. Consequently, the legal classification of water developed in a similar fashion with separate rules for each class.

Today, however, the riparian owner not only must worry about the use made by other riparians on the same stream, but also about the obstruction of tributary waters (including run-off waters) and the drilling of high capacity wells in the area surrounding the stream. These latter users may pose as much of a threat to a riparian supply of water as the use made by a fellow riparian. While the riparian rights to a supply of water in a stream is correlated with the rights of other riparians, the rigid legal classifications of water has prevented such correlation with other appropriations of the water (i.e. run-off or ground water).

Although most of the research is in the applied field, the Center does sponsor some basic research. One such project is entitled "Fundamental Study of Multicomponent Mass Transfer in Aqueous and Membrane Systems." This project is concerned with developing fundamental mathematical laws that can be used to predict and control the diffusional processes. It is of significant importance since one of the promising processes for the removal of contamination from water supply depends on diffusional processes taking place in membranes.

Another project is concerned with establishing the relationship between such basic factors as precipitation, radiant energy, runoff, and evapotranspiration and how these factors affect soil moisture levels under various land use and management systems.

Still another study is concerned with the geochemistry of water and the effect of trace elements in water on biological systems as an aspect of water quality. This has received very little attention from scientists, although several investigations have shown that trace elements may have important implications. In several instances, it has been shown that toxic concentrations of arsenic, lead, zinc, etc. can cause serious systematic disturbances in plants and animals. Usually, such elements are not present in sufficient concentrations to have an effect on, or even be detected by, the usual technique. There is present in the waters of the Piedmont a trace element which alters significantly the bacteria involved in the fermenting processes of the dairy industry. Unanswered is the question regarding its effect upon man. It would appear that the significance, if any, will be more discernable over time.

With the passage of the Water Quality Act of 1965 and the establishment of Water Quality Standards for the various streams

in Virginia, a study has been initiated which has as its principal purpose the formulation of a mathematical model which will enable an engineer to predict with good accuracy the effect of certain waste discharges in a stream. This is becoming increasingly important in Virginia because of increased urbanization and industrial growth. The study will evaluate the conditions of a stream in an effort to determine the interrelationships of waste concentration, algae population, stream flow, and bottom deposits on the oxygen concentration of the stream.

Beginning July 1, 1966, four additional projects were undertaken by the Water Resources Research Center. One will be concerned with the operating effect of pumped storage reservoirs on the biological processes taking place in the waters. This method of power production is becoming more prevalent as the availability of good hydroelectric sites decrease and the need for economical peaking power increases. Very little is known about the impact of this method of water management on the biota. It will be of increasing importance, not only in Virginia, but for other states using this method of power production. Two projects will be concerned with the hydrologic cycle. One will be concerned with the method of stream flow predictions for short time periods based on rainfall measurements. The other is directed to the development of an appropriate design criteria to provide efficient drainage for parking lots, highways, and runways. The last project will attempt to find ways to predict the requirements to be made in urban storm drainage. Past and future designs will be investigated to determine the most economical means to control flooding in urban areas and to compare costs of separating sanitary and storm drainage systems. In Virginia alone, the investment in drainage facilities has been estimated to exceed $20 million annually. Results of this

study will assist municipalities, counties, and utility districts to invest in facilities on a more sound basis.

The Center has now published three bulletins. Bulletin No. 1, Water Resources of Virginia: Inventory of Printed Information and Data, was in response to a need expressed by our Statewide Advisory Committee for compiling the research reports and data from public and private agencies in the field of water resources. Bulletin No. 2, Multidisciplinary Research as an Aid to Public Policy Formation, contains the papers presented at a Seminar by same title held December 8, 1965. The purpose of the Seminar was to stimulate multidisciplinary research in water resources by illustrating the spectra of research opportunities and needs of the field, particularly to those members of the university community who have not heretofore been active in the Water Resources Research. In addition, it suggested potential promising research topics to both staff and students and aided in creating an atmosphere conducive to fruitful, cooperative research in water resources. Several of the speakers were experts in areas not generally associated with water resources who have applied their expertise in resolving problems in this area. For example, Dr. Emil Gumbel of Columbia University, internationally known for his work in extreme values, demonstrated very dramatically the use of his techniques in both flood and low flow conditions. Dr. Jabbar Sherwani of the University of North Carolina, an economist by education, showed the contributions being made by this discipline in the area of water resources. Dr. Robert V. Thomann, Federal Water Pollution Control Administration, discussed "Estuarine Water Pollution Via Systems Analysis." Dr. William J. Hargis, Director of the Virginia Institute of Marine Science, spoke on "Multidisciplinary Research as an Estuarine Engineering Project." We think that the Seminar was quite successful. Among other things, it

has strengthened the existing program between the Statistics and Sanitary Engineering Departments. These two departments have found that an interchange of graduate students has broadened their horizons and intensified their interest in the field of water resources. The third bulletin, A Stochastic Model for Pollution and Dissolved Oxygen in Streams, is a product of the interdisciplinary attack by these two departments on a problem which has both state and national significance.

Future Activities

It is generally recognized that research per se will not provide the answer to all of our water problems, but it may develop the information and data which will permit intelligent decisions to be made. The area where I feel that our Center has its greatest potential for service is in the providing of material for policy decisions in the area of water resources. Policy might be defined as the boundaries, the guidelines, the constraints that determine what we do in the design of programs and procedures for achieving specific objectives.

The knowledge on which intelligent policy decisions are based may be thought of as falling into three broad categories.

1. The Physical and Biological Consequences of Alternative Courses of Action. The policy maker concerned with water policy problems must ask if a given course of action is pursued, what will be the physical and biological consequences?" For example, if the State Water Control Board decides that certain industries must provide secondary treatment of wastes this amounts to a judgment by the Board that the adoption of such a policy will have a specific effect on the water quality.

2. The Values Associated with Alternative Courses of Action. To know the physical and biological consequences of a given course of action is not enough. The policy maker must

have an estimate of the cost and benefits, including an understanding of the incidence of the cost and benefits which will result; that is, he must seek to understand who benefits and who pays, as well as the total benefits and the total cost. The measure of the value cannot be restricted to expressions in financial or monetary terms, but must reflect the utilities which members of our society seek and those are quite difficult to measure. Values are attached to the preservation of biological species, to the enhancement of scenic areas, to the protection of health, etc. In the absence of some measure of value associated with alternative courses of action, measures of physical and biological consequences have no meaning.

3. The Behavioral Response to Alternative Policy. The policy maker cannot rely alone on knowledge of physical and biological consequences and knowledge of the utilities associated with such consequences but he must also gain an understanding of how people will, in fact, respond to a given policy. There is always a presumption that a policy will be followed by those affected but this is not always the case. Irving K. Fox of the University of Wisconsin used this very illustrative example from another field. "Shortly after World War I, policy makers in the United States observed that the consumption of alcohol by human beings resulted in certain physical and biological consequences. They also decided that these physical and biological consequences were, on balance, a negative utility to the American people. In other words, they decided that the physical and biological consequences of alcohol consumption resulted in costs to society that exceeded the benefits. Confronted with this situation, the decision was made to prohibit production and consumption of alcohol except for medicinal purposes. We all know of the sequel to this situation. The policy makers failed to estimate accurately the behavioral response of a large

segment of the population including the response of the law enforcement agents. Although the original estimate of physical and biological consequences and the estimate of the utilities associated with alcohol consumption may or may not have been correct, the fact remains that the policy was a failure and prohibition was repealed." The policy makers' concern with the deleterious effect of alcohol consumption completely miscalculated the response to the policy that was adopted in the Eighteenth Amendment of our Constitution.

Now let us consider the problems confronting the researcher in the field of the physical and biological sciences. First, he must determine the effects of existing practices, both long and short term. Next, he might consider the effect of incremental increases or decreases in current practices. Lastly, consideration should be given to what other alternatives are available for implementing a stated objective. These are very difficult questions and, at best, he may only be able to define our area of ignorance and uncertainty.

Now it is important that the physical and biological consequences be translated into some measure of value. What are the utilities? What are the benefits and costs associated with existing practices and alternatives thereto? Thus we see that value measurement is one of the cornerstones of policy formation.

Value measurement is the special province of the economist and, to some extent, the problem of the political scientist and the lawyer. The discipline of economics is the only scientific discipline which has developed a truly rigorous way of considering and appraising values. To formulate policy in the modern world without the aid of an expert economist, is to deny oneself the contributions a quite rigorous and scientific discipline can make to the advancement of policy.

The political scientist or the lawyer has a function to perform in value measurement. There are values which cannot be readily measured in monetary terms. These include such values as those associated with preservation of biological species, the values associated with certain patterns of income distribution, values associated with scenery or beauty, and values associated with the adherence to certain principles of justice. The economists can contribute a way of thinking about these values but he cannot measure them, and thus we turn to the political scientists and lawyers as specialists to aid us in understanding how these values might be appropriately weighed and considered. They can aid us in devising political and legal procedures which will reflect the value judgments of those affected by a given course of action. They can aid the policy maker in establishing principles and procedures which will implement the concept of government and law on which our society is based in determining what weight should be given to these difficult-to-measure factors.

Since policy is concerned with principles, the question you must ask is, "What principles, when applied, will achieve optimum results?" Implicit in this question is the point which we must be able to estimate how people will, in fact, react if a certain law is passed, if an organization is given certain authority, etc. These are complex questions, and they are even more difficult when we turn to the policy implication of organizational design. This is the area where neither the physical or biological sciences nor the economist can make any claim to expertise. This is the province of the sociologist, certain categories of political scientists, and the social psychologists, as well as members of the legal profession. We have only the vaguest notion of how people will respond to some of these new policies which have been adopted. It, therefore, becomes

important that we have some estimate of the behavioral responses to policy making in that it should be the subject of scientific inquiry.

In the past, many judgments and decisions have been made without having any solid foundation of scientific knowledge. It is not possible to wait for the accumulation of all the knowledge we would like to have. But in looking to the future, there is a major research task to perform to improve and strengthen the policies we do have. We must ask ourselves what kind of research by each discipline is most urgently needed for policy improvement. Many studies are relevant to program implementation, but really have little relevance for policy and, of course, among the relevant studies some are of much higher priority than others. It, therefore, seems that the research undertaken must be of an interdisciplinary nature and not conducted in isolated compartments. There must be communication among the several disciplines which means that each must have an understanding what the others are seeking to achieve and each must understand, and in some cases use, the results of the other's work. It is important for the economist and the behavioral scientist to gain a much deeper understanding than most of them have of the physical and biological aspects of water management. A substantial investment of time and effort is required to gain expertise, but in the absence of it, their ability to contribute to subsequent policy development is limited indeed.

It, therefore, seems reasonably clear that Virginia's Water Resources Research Center should give substantial emphasis to interdisciplinary studies if we wish to contribute to the advancement of the State's water policy in a significant way. It seems equally clear that all significant research is either geared to the improvement of public policy formation or its implementation.

In conclusion, the most promising prospect for solving our serious water problems in the years ahead appears to lie in the three packages of increased research and training, improved planning and development, and more adequate and effective control of pollution. The success of the total program will depend upon consistent strength and excellence in performance in all three, with research playing a basic role.

President Johnson echoed this confidence when he said, "The science that has increased our abundance can find ways to restore the quality of our environment."

The success of Virginia's Water Resources Research Center in performing its function will depend in no small part on its ability to complement the activity of other agencies operating in the state by developing needed information and data through appropriate research. Working together we have the opportunity to assist the Commonwealth in making the most efficient and effective uses of one of its most vital resources - WATER.

CHESAPEAKE BAY - SUSQUEHANNA RIVER BASINS

by

J. Gary Gardner, Deputy Director
Charlottesville, Virginia

This is a proud country in which we live. And, we are justly proud of the rich heritage left to us by our forefathers. Everywhere we turn we find strong foundations upon which we continue to build. However, I am certain each of us is able to point to a few things left by our forefathers that we would prefer returning to yesteryear for modification prior to redelivery.

Not too many years ago our forefathers believed that they were doing themselves and their neighbors a service by dumping waste products into the nearest watercourse to be transported away. Thus, maybe the birth of the old axiom - "out of sight, out of mind." Somewhat later, as rural areas became communities, our forefathers followed another practice of the era and constructed single systems of sewers to transport both sanitary wastes and storm water to those same watercourses. Unfortunately, today we are often confronted with correcting some of grandpapa's sanitary engineering marvels.

As much as we might care to, we cannot place all of the blame on those who walked before us. I am certain each of you will agree that because of a lack of knowledge, as was the case with our forefathers, we are now leaving problems for our descendants to solve. Our task is to be more prudent so our children and grandchildren will not look back too often at our works and shake their heads in disgust.

Abraham Lincoln once made the statement that God must love the ordinary man, because he makes so many of them. Today, as in Lincoln's and grandpapa's day, ordinary men are faced with extraordinary problems. We, as ordinary men, are gathered in Richmond to shed some light on one of today's problems - that of water resource development and management.

As evidenced by the program of this Symposium, we are not faced with a single agency task in the area of water resource development and management. One fact we have learned through our heritage is - "When faced with a Herculean task, a concerted effort is required if we are to be the master."

Often, even with a coordinated effort, our position becomes one of assuming the role of dictatorial experts. True, we may be experts in our respective fields, but somehow we tend to orient ourselves into believing that the public should graciously applaud and accept the medicines we prescribe. We know what a sick watercourse requires to make it satisfactory for specific water uses. However, once we prescribe the medicine and dosage to accomplish the cure, we have, in effect, designated the water use. Unfortunately, this places us in the position of dictating to the public how they will be utilizing a particular stream during the years to come. We tend to forget the public are ordinary people like ourselves, and they, like us, do not want to be told what to do and what not to do without at least the opportunity of being heard. As I implied earlier, we are a proud people.

I realize my opening remarks were a bit harsh, but hopefully they illustrated my feeling of the necessity of having all interested parties in on the planning for water resources development and management. Without a majority in concurrence, any plan or program progresses no further than the bookcase.

Why do we have widespread water problems today? We all know the reason - more people. With the large increases in population expected in the future, particularly in urban centers, and with the accompanying industrial growth, our water problems stand to become more acute. The present drought has highlighted present shortages in both water quantity and quality. As distances diminish between sewer outfall and water intake, we are increasingly

uneasy about viruses and other pollutants in public water supplies. People served by individual supplies cannot always breathe easy, since such supplies are often in close proximity to some of the more than 17 million home septic tanks now in use. Direct water reuse, potential or unintentional, always exist, and in some cases has been demonstrated to be quite real.

Pollution control steps are being actively pursued by all levels of government - City, County, State, and Federal. I shall review briefly some of the program elements as spelled out in the Federal Water Pollution Control Act.

This Act attacks pollution from many sides. As one approach, it calls for the development of comprehensive river basin programs. I will consider this particular aspect later as it applies to the State of Virginia.

This Act encourages interstate cooperation, the enactment of improved state water pollution control laws, and the formulation of interstate compacts.

It authorizes Federal financial assistance to the State and interstate agencies to help them in establishing and carrying out their own water pollution control programs. It authorizes grants to assist municipalities in the construction of waste treatment facilities. It authorizes grants in aid for research, training, demonstrations, and research fellowships; it provides for technical assistance to State and interstate agencies, communities, and industries in pollution problems.

This Act further provides the exercise of Federal enforcement procedures where pollution of interstate or navigable waters endangers the health and welfare of any persons.

Comprehensive programs for water pollution control, as mentioned earlier, have been initiated in several major basins across the Country, including the Chesapeake Bay-Susquehanna River Basins. Others will follow to provide complete coverage of the United States.

The objectives of these comprehensive water pollution control programs are basically to insure that water of proper quality is available in the proper place at the proper time to support our expanding economy, to fulfill the Nation's desire and demand for clean water, to support all types of water-oriented recreation, and to put forward a program that can be achieved with maximum efficiency at least cost. In the words of the Federal Water Pollution Control Act, "In the development of such comprehensive programs due regard shall be given to improvements which are necessary to conserve such waters for public water supplies, propagation of fish and aquatic life and wildlife, recreational purposes, and agricultural, industrial, and other legitimate uses." The comprehensive approach makes it possible to develop a program wherein the upstream user does not solve his problem at the expense of the downstream user.

I fully realize that the term "comprehensive" can be confusing. To some it means complete and detailed in every aspect; to others it may imply a long-range planning activity. Neither is a true definition of the term as applied to water pollution control. But let me hasten to add that there is some truth in each definition. Some degree of completeness is required, and the needs of the future must be anticipated and incorporated into any action program. As with all things, the past is history, the future is a guess, and only the present is real. Therefore, the comprehensive programs must produce orderly and efficient solutions to current problems or else they will not survive to meet those of the future. Thus, one of the primary objectives of a comprehensive program is to promote sustained action by all levels of government.

A comprehensive water pollution control program, if properly organized and functioning, corrects existing water quality deficiencies and preserves water quality to serve future

beneficial uses. The program acts on problems in two categories: present and future. Whether present or future, six basic program activities are normally employed in the solution: (1) obtain the correct information; (2) assemble, analyze, and display the information; (3) forecast water quality and predict the results of possible control measures; (4) test the control measures for cost, time, response, predictability of results, and public acceptance; (5) decide on a course of action and issue the necessary commands; and (6) follow-up to see that actions are taken on time and determine if the desired results are actually produced.

With that as a general introduction to what a comprehensive water pollution control program should be, let us now examine the project which deals with the Chesapeake Bay area of Virginia - The Chesapeake Bay-Susquehanna River Basins Project of the Federal Water Pollution Control Administration.

This Project encompasses the geographic area that drains to the Chesapeake Bay, a land area of approximately 67,000 square miles. This area includes the District of Columbia, almost all of Maryland, about 65 per cent of Virginia, 50 per cent of Pennsylvania, and about 12 per cent each of New York and West Virginia, as well as a portion of Delaware. The major river in the Basin is the Susquehanna, the largest U. S. river on the Atlantic Coast. The Potomac and James River Basins are the second and third largest draining into the Bay. Together these three river systems drain about 80 per cent of the Basin. The dominant feature of the Basin is, of course, the Chesapeake Bay, the largest tidal estuary in the United States.

Because of the magnitude of the area to be covered, the Project, which has its headquarters in Charlottesville, Virginia, opened a field station near Harrisburg, Pennsylvania, in 1963.

The Harrisburg facility serves the Susquehanna River Basin; while a second field station, established in Annapolis, Maryland, in 1964, serves the remainder of the Basin.

Before discussing some of the Project's individual activities and investigations here in Virginia, I would like to mention what might be defined as the most powerful tool we have in our bag of scientific gear - the electronic computer. The computer is used primarily to solve mathematical simulation or prediction models.

Stream actions and reactions can be expressed mathematically with a reasonable degree of confidence. A series of simultaneous linear equations are used to describe the relationships between the many variables affecting stream quality. In an estuary, for example, flow, tides, temperature, sunlight, waste loads, and dispersion (to name a few of the parameters involved) are dependent variables that also change with time. To solve the set of equations depicting an instantaneous set of conditions occurring at a single point in an estuary would require a well-trained individual several days to accomplish with slide rule and calculator. If we were to vary only flow, one can readily visualize the amount of work involved in obtaining a partial answer at a single point. The computer makes it possible to accomplish many repetitions to obtain pictures of the entire estuary under numerous sets of conditions in a matter of minutes.

How can we be sure that the pictures we obtain are correct? This is where our field activities play a vital role. Project field activities are generally designed to develop input for mathematical models and to verify output. In other words, the mathematics of the model are refined to insure that the answers produced are identical to conditions found in the estuary.

Once the model is verified using existing conditions, it is relatively easy to make predictions under other sets of conditions. As examples, we can predict the quality of an estuary if the waste load is increased or decreased, or if the point of waste discharge is relocated.

The Annapolis Field Station has a fully equipped laboratory staffed with highly competent chemists and biologists to support the field sampling program. Other than what might be termed normal sanitary chemistry activities, including analyses for dissolved oxygen, biochemical oxygen demand, solids, nutrients, and coliforms. Project personnel are also engaged in some oceanographic studies. For example, time of water travel and dispersion in river estuaries are being determined through the use of fluorescing dyes.

Studies to determine the uptake of dissolved oxygen by bottom sediments are also a part of our continuing activities. Results obtained in some stream reaches have indicated that sediments draw significantly on the oxygen resources of the overlying waters.

Stream biological studies often indicate the effects of poor water quality more dramatically than do our efforts in chemistry and biochemistry. The number and types of stream flora found in a watercourse tell a rather specific story concerning the quality of their environment.

I have already spent several minutes discussing comprehensive water pollution control programs. I have presented the broad objectives of such a program, but what, actually, are the specific objectives? Basically, the specific objectives must be to meet the water-use desires of the people residing in the program area. The recipe calls for taking all of the desires, as well as responsibilities, and blending them together to provide a workable program.

It should be noted that people's desires are always expressed in terms of water uses, not in engineering terms such as we often use to express quality or quality goals. Since this is the case, what then is quality? We probably should define quality as a measure of the utility of a water when related to a specific desired use. In other words, can a water be used or not? As examples, can it be used for swimming; can it be used as a source of water supply; or is it capable of supporting fish and aquatic life? If it can be used for one or more purposes, it then possesses utility.

It might be said that a comprehensive program must have as its objective means for preserving or increasing the utility of our waters.

In line with the specific interests of this Symposium, I would like to present some of the Project's activities as they pertain to the James River Basin. First, it should be noted that much work has already been done in this Basin by the Virginia State Water Control Board, the Virginia Institute of Marine Science, and others. To supplement the available information requires, however, further intensive field investigations in order to verify the mathematical models under development by the Project.

During this past summer a team of scientists from the Federal Water Pollution Control Administration's Robert A. Taft Sanitary Engineering Center of Cincinnati, Ohio, assisted by personnel from our Annapolis Field Station, conducted some unusual investigations in the Jackson River. The Virginia Military Institute also participated in the work under a contract with the Project. In addition, The West Virginia Pulp and Paper Company at Covington furnished data on plant waste discharges. The combined effort included standard sanitary engineering sampling

and analyses for chemical, biochemical, and biological indicators as well as obtaining stream cross-section and time of water travel information. As a part of the studies, two low-level, radioactive tracers were released into the Jackson River to determine reaeration coefficients.

Two tracers were necessary to differentiate between reaeration and diffusion. A non-gaseous tracer, tritium, was used to evaluate diffusion; krypton^{85} was used to indicate the behavior of gas transfer in the turbulent system. Basically the loss of krypton^{85} to the atmosphere is mathematically equitable to oxygen uptake. By utilizing radiation-counting techniques that differentiate between the two tracers, molecular and turbulent diffusion is nullified, and the atmospheric loss of krypton determined. Although complete results of these investigations are not yet available, the procedures proved to be quite successful. A description of the initial experiments conducted under laboratory conditions can be found in the October 1965 issue of the "Journal, Water Pollution Control Federation."

As a part of the previously mentioned contract with the Virginia Military Institute, two other segments of the James River have been studied. These were performed in the vicinities of Big Island and Lynchburg.

The Virginia Institute of Marine Science, under a contract with the Project, has recently completed a full year of nutrient and chlorophyll studies in the James estuary between Hopewell and Hampton Roads. Samples were collected monthly at ten sampling stations at two meter intervals through the full depth of the river. A similar contract with the Institute for studies in the Nansemond River is presently underway. This schedule calls for 12 weekly samples instead of the annual cycle. Since euthrophication of the river estuaries is a significant problem

in the Chesapeake Area, it is hoped that a knowledge of the James estuary nutrient distributions and associated chlorophyll concentrations will provide a base for developing control measures. It is also hoped that with the collected data, nutrients can be successfully modeled mathematically to produce a prediction tool.

During the past year, Project personnel have, using fluorescing dyes, determined time of water travel under several flow conditions between Covington and Richmond. These same dyes have been utilized to determine diffusion coefficients for the Nansemond River and for the James immediately downstream from both Richmond and Hopewell.

In the very near future, the Project will be using the Vicksburg model of the James estuary to obtain information to aid in verifying our mathematical models.

All of the previously mentioned activities are directed to one end, and that is to provide better knowledge on which to develop a cooperative water pollution control program for the James River Basin.

Unfortunately, some, if not most, of the presently unsolved problems in the field of water pollution control may continue to defy solution for some years to come. Only a continuing, expanded research effort can find the solutions. Comprehensive water quality planning, therefore, must be a dynamic process. Continual cooperative coordination is vital to meet the ever changing conditions; and effective communications must be established and maintained to insure effective management of Virginia's water resources.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

by

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Introduction

As the primary Federal health agency, the Public Health Service is responsible for the general health of the people of the United States. This responsibility is discharged in several ways by many programs. It is carried out by direct operations in research, investigations, training, technical assistance, and consultation; the providing of medical and dental care, and environmental health services to designated beneficiaries; and the enforcement of certain laws and regulations. It is also carried out indirectly by grants to governmental agencies and nongovernmental organizations, for research, construction of facilities, program development and operations, training, and project demonstrations.

Few, if anyone, dispute the fact that water of good quality and in sufficient quantity is a fundamental requirement to maintain and promote the health and well-being of an individual. This paper will discuss only those activities of the Public Health Service related to the control of water and water quality as one method of promoting the health and well-being of the public. Where possible it will make specific reference to the water resources activities in Virginia.

Potable Water Supplies

To prevent the spread of disease from state to state and from foreign countries to the United States, foreign and interstate quarantine regulations were promulgated and are amended from time to time. These regulations include the Drinking Water Standards for water that is used aboard common carriers

engaged in interstate commerce. The Drinking Water Standards were first established in 1914 and have been amended several times, the last in 1962. The standards now contain limits for radio-chemical, chemical, and physical substances, and micro-organisms. Each new amendment of the standards has added more items as the health effects of contaminants found in drinking water become better understood. Some of these limits are recommended and others are mandatory.

Legally these standards apply only to water used by interstate carriers. However, the standards are now utilized by the Armed Forces, and have been adopted by several state and local health departments while other state health departments use them without officially adopting them. The latter is the case in Virginia.

In the enforcement of the Interstate Quarantine Regulations, the Public Health Service relies greatly on the cooperation of the state health departments. They are requested to make an annual inspection of water systems furnishing water to interstate carriers and to recommend a classification based on the drinking water standards. Every three years the Service makes a joint survey with the state health departments to insure uniformity of interpretation of the standards. In Virginia there are 20 water systems furnishing water to interstate carriers and 7 other systems furnishing water to carriers in foreign commerce.

These standards are utilized by all programs of the Service in which water is a consideration, such as the cooperative Public Health Service-State programs of milk and shellfish sanitation, Indian health, and environmental health consultative service furnished to National Park Service.

To improve and maintain the reliability of the bacteriological results used in the evaluation of a potable water

system furnishing water to interstate carriers, and to maintain uniformity in laboratory procedures, the Public Health Service surveys the bacteriological section of state water laboratories once every three years. In addition, a state laboratory employee is certified as a rating officer for local laboratories. The state health departments are requested to survey the local laboratories at least once every three years. This program is in effect in Virginia.

To improve the reliability of the results of chemical analyses, the Public Health Service established an Analytical Reference Service as part of the Training Program located at the Sanitary Engineering Center. Many federal, state, institutional, and industrial laboratories have participated in this activity. Laboratories of the Virginia State Department of Health and the Virginia Water Control Board are among the participants.

This activity was, until the recent administrative changes, centered in the Water Pollution Control Program. However, the Public Health Service is continuing this activity and in fact is expanding it to provide the same type of service to the chemical section of state health department water laboratories as now is being provided the bacteriological sections.

With the increase in the reuse of water which has a tendency to increase the amount and variety of residual substances, and organisms, there is a need to develop new methodologies to identify and measure those elements in water that are significant to the health of the consumer. There is continuing research in this area. The next amendments of the Drinking Water Standards will probably include some items now under study, especially in the field of pesticides.

The Service has a keen interest in any water treatment processes that remove or reduce to an insignificant level,

contaminants which may affect the health of the public. In cooperation with the West Virginia State Department of Health, the Public Health Service is monitoring the new granulated activated carbon process recently installed in the Nitro West Virginia Water Plant, both for carbon, chloroform extracts and specific organics to determine the efficiency of the process. A somewhat similar process is employed during certain months by the Old Dominion Water Company at Hopewell, Virginia. From time to time samples have been analyzed from this supply.

In recent years there has been considerable interest in the effects of pesticides on human health. As a result, the Public Health Service is chairing a committee of governmental agencies which is gathering data to assess the problem. Data are collected from monitoring networks on food, air, water, and from samples of blood and fatty tissue. It is anticipated that the Service will expand its effort to collect additional data from potable water supplies, to assess the problem of pesticides and to take appropriate action.

The Public Health Service also has active programs covering

(1) individual water supplies and sewage treatment facilities,

(2) water supplies for dairies, milk plants and food processing,

(3) plumbing control and

(4) water contact recreation.

These all impinge on and are related to water resource programs.

The Public Health Service had a very large program to support health research. Some of these research projects are in the water supply field. More projects could be supported if more appropriate applications were received. It should be borne in mind that these applications must emphasize the health

aspects of water if they are to be considered. Virginia Polytechnic Institute and Virginia Institute of Marine Sciences are among the organizations, institutes, and universities which have received research grants in this field.

To encourage more people to enter the health field, grants have been made to universities for construction of training facilities, and for the development and improvement of curricula. Virginia Polytechnic Institute is among the universities which have received this type of training grant. Also, traineeship grants are made to individuals for graduate training in the health field. Several people from Virginia have taken advantage of this opportunity.

Health Aspects of Water Pollution

The Federal Water Pollution Act of 1965 established a Federal Water Pollution Control Administration in the Department of Health, Education, and Welfare and transferred previous water pollution activities of the Public Health Service to the new administration. In May of this year, Reorganization Plan No. 2 of 1966, transferred this administration and its activities from the Department of Health, Education, and Welfare to the Department of the Interior with certain exceptions. These pertain to the health aspect of water pollution. The Plan stated that within 90 days the Secretaries of the Department of Health, Education, and Welfare and Department of the Interior would prepare a memorandum of understanding concerning the coordination and cooperation of the two departments in water pollution control activities and submit it to the President for approval. The President approved this memorandum on September 1, 1966.

This memorandum states in part:

> "The Department of Health, Education, and Welfare, under the Public Health Service Act as amended, is responsible for the protection of the public health. Within this responsibility, the Department through the

Public Health Service is, therefore, concerned with the causes, diagnosis, treatment, control and prevention of physical and mental diseases and impairments of man. As related to Reorganization Plan No. 2, these responsibilities include: determination of the health significance of water pollution; investigation of waterborne diseases and means for their control; provision of consultation to the Department of the Interior on the public health aspects of water pollution; and advising on the public health questions involved in the inclusion of storage for water quality control in Federal reservoirs.

"5. Under the terms of this Interdepartmental Agreement the Department of Health, Education, and Welfare will provide advice to the Department of the Interior as follows:

(a) Recommendations on criteria for water quality standard setting based on health aspects of intended water use for drinking water supplies, shellfish and other marine food production, bathing, and other water contact activities. Recommendations will be provided and modified as new supporting data are developed.

(b) Upon request, consultation and technical assistance on specific water-related health problems, as they may arise in connection with water pollution control activities, such as comprehensive pollution control program, enforcement actions, control of pollution from Federal installations, water pollution research projects, construction grants, and the study of water pollution from vessel operations. In cases where epidemiological surveillance activities indicate that a probable public health hazard exists, the Public Health Service will initiate appropriate action to advise the Federal Water Pollution Control Administration.

(c) Review and comment on construction grant applications and on requirements for control of pollution from Federal installations for specific projects whose operation may adversely affect the sanitation of shellfish-growing waters. The Federal Water Pollution Control Administration will refer all such projects to the Public Health Service for review and comment.

"6. Section 1(c) of Reorganization Plan No. 2 of 1966 provides for the Department of Health, Education, and Welfare to advise on public health questions involved in determinations by Federal agencies of the need for and value of the inclusion of storage for water quality control in Federal reservoirs. Advice on the effects of stream-flow regulation on public health will be provided by the Public Health Service based upon the studies prepared by the Federal Water Pollution Control Administration under Section 3(b) of the Federal Water Pollution Control Act. The Federal Water Pollution Control Administration report will be provided to the Public Health Service for review and comment. The Public Health Service comments, together with its own report on the production of disease transmitting insects and other environmental health considerations in the project area, will be submitted to the Federal construction agency concerned.

"7. To assure an adequate basis for such advice and consultation to the Department of the Interior, the Department of Health, Education, and Welfare will, through the Public Health Service, conduct the following kinds of studies on the health aspects of water pollution:

(a) Epidemiological, microbiological, radiological, and toxicological research and investigations into the human health significance of waterborne contaminants, to determine health tolerance for such contaminants as they affect drinking water supplies, shellfish and other marine foods production, and water contact activities.

(b) Epidemiological surveillance of the incidence of waterborne disease based on disease reporting, and on health-related water quality data derived from the Public Health Service drinking water quality network established under the Interstate Quarantine Regulations, the National Shellfish Sanitation Program, and the Radiation Surveillance Center, and on data from the program activities of the Federal Water Pollution Control Administration.

Investigation of waterborne disease will be conducted in cooperation with State and local health departments. Data and participation will be requested from the Federal Water Pollution Control Administration when water pollution is involved in the outbreak. Reports based on these investigations which identify pollution that presents a danger to health will be referred to the Federal Water Pollution Control Administration for appropriate action.

(c) Studies of the relationship of surface water characteristics to the production of disease vectors such as disease-transmitting insects, snails, and protozoa.

(d) Development of techniques for the identification, measurement and study of the behavior of waterborne contaminants which cause or influence disease, such as viruses, bacteria, organic chemicals, and trace elements. The results of these Public Health Service studies will be made available to the Federal Water Pollution Control Administration as a complement to its studies on identification and measurement of water pollutants, the results of which in turn will be made available to the Public Health Service.

Study of methods of removing contaminants of health significance to meet human tolerance levels as related to drinking water, swimming pools, shellfish depuration, and food processing. To avoid duplication of Federal installations for pilot plant, when such facilities are required to study methods of removing contaminants from drinking water, Public Health Service personnel may use Department of the Interior facilities. To assure that such installations will adequately serve such purpose, the Department of the Interior shall consult with the Department of Health, Education, and Welfare in their design.

Study of the human relationship of waterborne contaminants to animals and plants used as sources of foods, such as shellfish and other marine foods, food crops irrigated with polluted water, including their field packaging, and use of sewage sludge as a fertilizer and soil conditioner."

Therefore, the Public Health Service will be interested and involved in studies in Virginia such as the Chesapeake Bay Susquehanna River Basin Study of the Federal Water Pollution Administration, and the James River Basin, the Ohio River Basin, and the North Atlantic Water Resource Studies all of the Corps of Engineers, and other such studies.

The National Shellfish Sanitation Program is a cooperative effort of the State and Federal resources to insure that shellfish of satisfactory quality reaches the market. Shellfish grown, harvested and sold within a state is controlled by State laws and regulations. Those shipped interstate must comply with the Cooperative National Shellfish Sanitation Program. This provides for the Public Health Service to publish monthly a list of shippers who meet the requirements of a satisfactory state regulatory program. The state agencies provide the names of the approved shippers to the Public Health Service for publication. If a shipper is not on the list, buyers in another state legally cannot purchase the shellfish. The state programs are reviewed by the Public Health Service to determine if they meet the standards which have been agreed at national workshops. If the state program does not, then all the shippers in the State will be deleted from the list. This procedure has provided a powerful lever to secure compliance.

A shellfish sanitation program is generally composed of two principal elements: (1) Sanitation of Harvesting and Processing of Shellfish, and (2) Sanitation of Shellfish Growing Areas. The latter is concerned with the water quality control and pollution abatement in or near growing areas. In Virginia

the State Department of Health and the Commission of Fisheries are the two agencies responsible for the Shellfish Program.

It is anticipated that in the future greater attention will be given to the supervision of the water quality of growing areas. The recent Water Pollution Control Law specifically states that action shall be taken if the pollution prevents the shipping of shellfish in interstate commerce.

It has been a pleasure for me to have had this opportunity to discuss with you the keen interest that the Public Health Service and the Department of Health, Education, and Welfare have in water resources programs in Virginia.

U. S. GEOLOGICAL SURVEY

by

J. W. Gambrell, District Chief
Richmond, Virginia

The Water Resources Division of the U. S. Geological Survey investigates the source, quantity, quality, distribution, movement, and availability of both surface and ground waters. This work includes investigations of floods and droughts, their magnitude, frequency, and relation to climatic and physiographic factors; the appraisal and evaluation of available waters in river basins and ground-water provinces, including water requirements for industrial, domestic, and agricultural purposes; the determination of the chemical and physical quality of water resources and the relation of water quality and suspended sediment load to various segments of the hydrologic cycle. Special hydrologic studies of the interrelations between the water supply and climate, topography, vegetation, and soils are made. The Division engages in research to improve the scientific basis of investigations and techniques. It renders scientific and technical assistance in hydrologic fields to other Federal agencies. The work is done in cooperation with State agencies, municipalities, counties, and with other Federal agencies. The results of these investigations are published in the series of Geological Survey publications or, in the case of certain cooperative endeavors, by the cooperator.

In Virginia, the Division presently operates from a district office at Charlottesville. Sub-district offices are maintained at Marion and Fairfax. In the near future, however, district headquarters will be set up in Richmond. This will permit closer liaison with the State agencies concerned with water resources.

The Water Resources Division is no newcomer to Virginia, having begun investigating the water resources of the State in 1895 when gaging stations were established on the James, North, Dan, Roanoke, South, and New Rivers. A few additional stations were established in the early days of the present century.

About 1910, a cooperative investigation was undertaken with the Virginia Geological Survey which culminated two years later in a comprehensive report on the ground-water resources of the Coastal Plain. This report includes, besides a regional discussion, a county-by-county summary of the ground-water resources developed by wells and springs at that time. The report is still widely consulted and has been used extensively by later investigators of the ground-water conditions in that province.

In 1925, a State-wide program was started as a cooperative enterprise between the U. S. Geological Survey and the State. By the end of 1925, 36 gaging stations were in operation. The stream-gaging network expanded continuously until, at its peak in 1955, nearly 200 stations were in operation. At the end of the 1966 water year, about 5,600 station years of streamflow records at 275 sites are available. In addition to being published in the annual series of Water-Supply Papers or Water Resources Data, these data have been presented in compilation and flood reports.

While the cooperative program that began in 1925 was intended to be primarily a surface-water study, in 1928 an intensive investigation of the Hot Springs region in the southern part of the Great Valley was begun. The results were published by both the State Division of Water Resources and Power (now the Virginia Division of Water Resources) and the Virginia Geological Survey (now the Virginia Division of Mineral Resources).

In 1931, the cooperative program with the State was expanded to provide for a systematic investigation of the ground-water resources of the State.

The first study undertaken under this expanded program was an investigation of the ground-water resources of the northern tier of counties. This was followed by a study of the Shenandoah Valley, begun in 1932.

Several other ground-water investigations have been made. Among these are a detailed re-study of the part of the Coastal Plain south of the James River. Other areas that have been studied include that around Roanoke, the York-James peninsula, the Eastern Shore peninsula, Spotsylvania County, the Northern Neck peninsula, and the Middle peninsula.

In 1944, cooperative water-quality investigations were begun.

Under this program, 38 daily chemical-quality stations were operated for periods of 1 to 10 years between 1945 and 1956. Monthly chemical-quality sampling stations were operated, usually on a one-year basis, at 85 sites during this period. Numerous miscellaneous chemical-quality samples were collected at all surface-water gaging stations in the ten major river basins.

As part of the water-quality investigations, systematic collection of suspended sediment samples was started in December 1950. Ten continuous-record sediment stations were operated for all or part of the period 1950 to 1957.

The cooperative program with the Virginia Department of Conservation and Economic Development, under which the State-wide investigation was carried on, was terminated in June 1957. It was, however, reactivated this past July, with a modest start. It is expected that the program will increase in size and scope in the years to come.

In addition to the operation of the basic network of full-time stream-gaging stations, the Survey's Water Resources Division currently has several investigations underway.

One of these is a study of the flood hydrology of streams in Fairfax County and the effects of urbanization on the flood regimen. Areas that will be inundated by floods with recurrence intervals of 25-, 50-, and 100-years are being delineated on large scale topographic maps.

Another current study is one being carried on in cooperation with the Virginia Department of Highways and the U. S. Bureau of Public Roads. Records of flood-flows (crest stage and discharge) are being collected at about 150 sites with small drainage areas. At about 100 of these flood volumes are also measured. A flood-frequency analysis will be made. The information resulting from the study will be used in the design of culverts and small bridges.

At the time the state-wide general cooperative investigations were terminated in 1957, the field work for ground-water studies of the Eastern Shore peninsula, Spotsylvania County, the Northern Neck peninsula, and the Middle peninsula was substantially complete but the reports were unfinished. The work of updating and completing these is now underway. At the present time, water levels are being measured at about 30 wells, most of which are in Fairfax and Arlington Counties.

Gaging-station records in the State through 1962 have been analyzed with an electronic computer to give: (1) the number of days in each year that the daily discharge was between selected limits (duration tables); (2) the lowest mean discharge for selected numbers of consecutive days in each year; and (3) the highest mean discharge for selected numbers of consecutive days in each year. It is planned to update these and present them in a more usable format.

One of the projects to be undertaken under the reactivated cooperative program will be a comprehensive study of the water-quality and streamflow characteristics of the James River basin. This will be a pilot project and similar studies will be made of the other major river basins.

Plans for the future contemplate the strengthening of the basic data collection program with particular attention being given to ground-water and water-quality data.

In addition, a series of analytical and interpretive studies will be undertaken which will eventually provide an evaluation of the total water resources of the Commonwealth and the delineation of the hydrology on an areal basis will be undertaken.

The analytical and interpretive phase of the program will be directed along two lines. One will interpret the basic data so as to give quantitative answers on an areal basis. The other will seek to define hydrologic principles and analyze and explain variations by studying their relation to topography, geology, and other causative factors. This approach will have the advantage of placing the quantitative figures in the hands of those who need them at the earliest possible date and in the end will result in a more complete understanding of the hydrology on an areal basis.

The U. S. Geological Survey is not an "action agency" as the term is commonly used. The business of the Water Resources Division is the collection, analysis, and interpretation of water data and research in the field of water resources. The Division will cooperate in every possible way with any agency or organization with a common interest in that most vital natural resource - WATER.

WATER RESOURCE ACTIVITY - SOIL CONSERVATION SERVICE

by

Tom F. McGourin, State Conservationist
Richmond, Virginia

The Soil Conservation Service is the technical soil and water conservation agency of the U. S. Department of Agriculture. It is responsible for developing and carrying out a National program of conservation for land and water resources.

The Soil Conservation Service (SCS) administers USDA activities involving technical assistance in soil and water conservation. In the small watershed program, it furnishes financial as well as technical assistance in planning and executing plans to protect and improve water and related land resources of the watershed.

Objectives of the National soil and water conservation program are to:

(1) achieve land use adjustments and treatment that will conserve land and water resources,

(2) reduce the hazards of flood and sedimentation,

(3) assure the most efficient long-term use of soil and water,

(4) establish a more permanent and stable agriculture, and (5) otherwise help to insure the orderly development of the natural resources for general welfare of the Nation.

Activities of the SCS are carried on primarily through local Soil and Water Conservation Districts, and in cooperation with other Federal and State agencies.

Within each state, the SCS program is directed by a State Conservationist and his staff.

Virginia is divided into six areas with 81 local offices staffed to serve the 32 Soil and Water Conservation Districts of the State.

The SCS program includes activities authorized by several Acts of Congress. The principal ones that apply in Virginia are:

(1) The Soil Conservation Act of 1935 (Public Law 46)

(2) The Flood Control Acts of 1936 and 1944 (Public Law 534 as amended)

(3) The Watershed Protection and Flood Prevention Act of 1954 (Public Law 566 as amended.)

I shall now give you a brief review of the major activities of the Soil Conservation Service as carried on in Virginia.

Direct and Consultive Assistance to Landowners Through Soil and Water Conservation Districts

Under Public Law 46, SCS carries on a broad program of soil and water conservation activities including direct assistance to landowners in planning and applying needed measures for the conservation of soil, water and related land resources. Similar assistance is also available to local subdivisions of State, State agencies and other Federal agencies and to organized non-governmental groups.

The basis for carrying out this phase of the SCS responsibility is a long range Program developed by the local Soil and Water Conservation District. This Program is the guide to the Service in furnishing technical assistance within the District. It keeps the leadership of the conservation program at the grass roots level under control of local Soil and Water Conservation District supervisors.

The District Supervisors are responsible for receiving requests for assistance and for setting work priority. However, the Service has administrative control of its employees and is responsible for the quantity and quality of work performed.

Assistance to landowners by the SCS involves four principal steps:

First, a Soil Scientist makes a detailed, acre-by-acre soil survey of the land.

Second, the SCS Conservationist and the owner develop alternative possibilities for using the land within its capability and treating it according to its needs. In developing alternative uses, the needs and capabilities of the owner as well as the land are considered. The owner then decides upon a conservation plan for his land. This frequently necessitates land use adjustments plus a combination of practices needed to control erosion, to protect and improve the soil, and to conserve and protect the quality of water.

Third, SCS technicians then give on-site assistance in designing and installing measures which require special skill or knowledge. Such measures include the design and layout of farm ponds, terraces, strip cropping, grass waterways and recreation and wildlife areas.

Fourth, the technicians give guidance when needed in the proper maintenance of the measures applied and in improving and keeping the overall plan current.

Under this program there are approximately 47,000 landowners owning 7 2/3 million acres cooperating with their local Soil and Water Conservation Districts of which basic conservation plans have been prepared for over 35,000 owners covering 5 2/3 million acres.

A few of the major conservation practices applied to date include 31,172 farm ponds having approximately 42,000 surface acres; 27,000 acres of grass waterways; and 265,000 acres of strip cropping.

For the past three years construction of farm ponds has averaged approximately 1300 per year. It is anticipated that this program will continue as in the past.

Agricultural Conservation, Conservation Reserve and the Appalachian Land Stabilization and Conservation Programs

SCS provides technical assistance to participating farmers in these programs of cost-sharing for conservation practices on individual farms. Assistance includes providing technically sound designs and specifications for permanent-type practices such as farm ponds, terraces, strip cropping, spring and seep developments for water supply, drainage systems, etc. For each job, SCS technicians determine the need, provide design and layout, supervise installation and certify compliance.

At the State and county levels, SCS is represented on an interagency committee that formulates these Programs for the State.

Soil Surveys

SCS is responsible for the Federal part of the National Cooperative Soil Survey in cooperation with a State agency. In Virginia, the cooperating agency is the Agricultural Experiment Station of V.P.I. The ultimate goal for soil surveys is to map, interpret, and publish surveys of all counties in the State. Whether surveys are made progressively or on an individual landownership basis, they serve as the basis for planning for proper land use and treatment.

The survey reports provide information interpreted in terms of soil capability and suitability for various purposes - such as agriculture, highway construction, septic tanks, suburban development, forest production and recreation. Knowledge in this field is continually expanding and as it expands, additional information will be added.

A soil survey of 16 counties has been completed. Some of these, however, have not been published.

Surveys are underway in 7 additional counties, and the goal of SCS and V.P.I. is to complete a survey of all counties

in the State as rapidly as funds and man-power permit. To date the two agencies have made "modern" surveys of over 8 million acres.

Watershed Protection and Flood Prevention

Watershed protection and flood prevention work is a major assignment of the Soil Conservation Service. This is a program which combines soil and water conservation on the land with control and use of runoff by upstream structures. In Virginia this work is carried on under two authorities:

(1) The Flood Control Act of 1944 (Public Law 534). This Act authorized flood prevention work on the Potomac above Front Royal which includes both the North and South Forks of the Shenandoah.

(2) The Watershed Protection and Flood Prevention Act of 1954 (Public Law 566 as amended). This Act applies Nationwide but is effective only upon application for assistance by a local subdivision of State.

The basic provisions of the two Acts, including technical and financial assistance available, policies and procedures are the same. This allows a joint presentation of the two Acts. For simplification of discussion we will refer to these activities as the Small Watershed Program.

SCS has administrative leadership for Federal assistance to local organizations for planning and carrying out these small watershed projects.

These Acts provide for technical and financial assistance by the U. S. Department of Agriculture to local sponsoring organizations for land treatment - flood prevention - irrigation - drainage - public recreation or fish and wildlife developments - and municipal or industrial water storage. The total drainage area of a project is limited to 250,000 acres. The storage

capacity of a single structure within a project is limited to 12,500 acre feet of flood storage and a total of 25,000 acre feet for all purposes.

This program is designed to fill the gap that heretofore existed between the soil and water conservation program on individual land holdings and the downstream structural program for water management on the main stems and major tributaries as exemplified by the Corps of Engineers.

Soil and water conservation measures on the land must precede installation of structures. This is a requirement of the law and without adequate land treatment there can be no Federal assistance. This is integrated with a structural program which is technically sound and will meet the objectives of the sponsors.

Structural measures can be for several purposes:

(1) Flood prevention measures - which are eligible for Federal assistance for the full cost of engineering and construction. In Virginia, these are generally floodwater retarding dams and stream channel improvement.

(2) Agricultural water management measures - such as drainage and water storage for irrigation. These are eligible for engineering assistance and cost sharing for construction.

(3) Public recreation and fish and wildlife development - are eligible for technical assistance and cost share in water storage and the development of basic facilities.

(4) Municipal and industrial water supplies - for which local interests pay the full cost.

For a watershed to qualify as a small watershed project, flood prevention (or agricultural water management), there must be a basic and economically justified purpose. When this requirement is met, water storage for any or all other purposes may be added. Loans or advances may be obtained from the USDA

to help local organizations pay their share of the costs.

Loans may also be made for storing municipal and industrial use in which case repayment may be deferred up to 10 years without interest. This should appeal to many Virginia localities.

These are local projects with Federal and State assistance - not government projects. I shall not go into detail but in brief a project is developed as follows:

(1) The local people recognize their problem.

(2) A subdivision(s) of State submits an application to the governor or an agency designated by him. In Virginia, the Virginia Soil and Water Conservation Commission is the approving agency and qualified sponsors are Soil and Water Conservation Districts, counties and municipalities.

(3) If approved the application is turned over to the SCS with a recommended priority for planning assistance.

(4) Administrator of the SCS approves for planning assistance.

(5) The SCS, U. S. Forest Service working through the Virginia Division, the Soil and Water Conservation Commission and other agencies assist the sponsors in development of a plan acceptable to them.

(6) The plan is reviewed by interested State and Federal agencies, then approved by the Governor and SCS. (Large projects require approval by Congressional Committees.)

(7) The plan serves as authorization for expenditure of Federal funds.

(8) When the project is completed the Government steps out of the picture and the sponsors assume responsibility for operation and maintenance.

All land rights are provided from non-federal sources which assure local control and makes them local projects.

Under the Small Watershed Program, 27 watershed work plans have been developed covering 1.6 million acres. These plans include 158 floodwater retarding dams of which 49 have been constructed. These 49 dams create permanent pools totaling 1,050 surface acres, over 45,000 acre feet of flood storage, and in excess of 3,900 acre feet of water for municipal and county use.

It is anticipated that this program will continue at about its present rate with increasing emphasis on storage of water for municipal, industrial, and recreational uses.

River Basin Surveys and Investigations

SCS also participates with other Federal and State agencies in making surveys and investigations of river basins. These studies provide the basis for developing coordinated programs for the orderly development, management, and use of water and related land resources of the basins.

SCS has overall responsibility for USDA participation in these activities and heads advisory committees in Washington and in the states to coordinate the participation of USDA agencies. SCS, Forest Service, and Economic Research Service take part in the surveys and are represented on the committees.

Under the leadership of our Virginia office, we are presently participating with the Corps of Engineers in a study of the James with a target date for completion of fiscal year 1969. At the same time, SCS is participating in a survey of the Kanawha and the Ohio under our West Virginia and Indiana offices respectively.

By special request we are assisting the Department of Interior in revising and updating the plan proposed for the Potomac prepared by the Corps of Engineers and dated February 1963.

We anticipate that this program will continue as additional basins are authorized for study.

Other Responsibilities

Other responsibilities of the Soil Conservation Service include leadership for the Conservation Needs Inventory; technical assistance with Income-Producing Recreation Enterprises; rural radiological monitoring for National Defense; and administrative responsibility for USDA activities in Resource Conservation and Development Projects.

In all of its work the Soil Conservation Service maintains liaison with the several State and Federal agencies concerned with soil and water conservation. Of particular importance in this respect are the Land Grant Universities, their divisions of Research and Extension, the Forestry and Fish and Game agencies and other agencies dealing with water and recreation.

You will note I have taken the liberty of covering the primary responsibilities of the Soil Conservation Service in the field of soil conservation as well as water conservation and management as they apply to Virginia. This was not an oversight. In my opinion - which is shared by many - a sound program of water conservation and management starts with the proper use and conservation treatment of the land. This means that all of the major functions of this agency have a direct or indirect bearing on the quality, management and use of water within the respective watersheds.

THE MARINE WATER RESOURCE PROGRAM[1]

by

William J. Hargis, Jr., Director
Virginia Institute of Marine Science
Gloucester Point, Virginia

THE SEA - boundless source of energy, water, food, joy and wonder; engine of weather; highway for commerce; avenue of attack; bastion of defense; receptacle of society's wastes; repository of earth's soil, scroll of the ages; cradle of life; - It is Important - It Must Be Known. This is the business of Marine Science.

Virginia's marine resources encompass all the physical, biological and aesthetic attributes of her 13,000 square miles of marine waters and bottoms and 4,000 statute miles of shoreline, beaches and marshlands. The Chesapeake Bay and its tidal tributaries and the reaches of the Continental Shelf are among the most productive of all waters. Much of the historical and economic strength of Virginia is based on these resources (Hargis, 1964).

The importance of these resources led a group of far-sighted and public-minded businessmen, educators and statesmen to establish the beginnings of a strong marine research and education program over a quarter century ago (1940) in Virginia. This program, now called the Virginia Institute of Marine Science, has grown rapidly until today it enjoys support of state funds second, almost, to none.

Responsibility for conducting investigations of the marine environment and its biological, chemical, geological and physical phenomena and resources and educating new scientists is derived from Chapter 9, Title 28 of the Code of Virginia which states:

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[1]Contribution No. 233 from the Virginia Institute of Marine Science, Gloucester Point, Virginia.

28.1-195. Virginia Institute of Marine Science; duties. - The Virginia Institute of Marine Science, hereafter referred to as Institute, heretofore operating as the Virginia Fisheries Laboratory, is continued and shall be an independent research and service agency subject to the affiliation hereinafter provided for.

It shall be the duty of the Institute:

a) To conduct studies and investigations of all places of the seafood and commercial fishing and sport fishing industries;

b) To consider means by which fisheries resources may be conserved, developed and replenished and to advise the Commission of Fisheries and other agencies and private groups on these matters;

c) To conduct studies and investigations of problems pertaining to the other segments of the maritime economy;

d) To conduct studies and investigations of marine pollution in cooperation with the State Water Control Board and the Department of Health and make the resulting data and possible corrective recommendations available to appropriate agencies;

e) To conduct hydrographic and biological studies of the Chesapeake Bay and the tributaries thereof and all the tidal waters of the Commonwealth and the contiguous waters of the Atlantic Ocean;

f) To engage in research in the marine sciences and, with proper affiliation with one or more accredited institutions of higher learning, provide education therein;

g) To make such special studies and investigations concerning the foregoing as it may be requested to do by the Governor.

The above studies shall include consideration of the seafood and other marine resources including the waters, bottoms, shorelines, tidal wetlands, beaches and all phenomena and problems related to marine waters and the means by which these marine resources might be conserved, developed and replenished. (Excerpted from the Code of Virginia of 1950 and the 1966 cumulative supplement.)

As can be seen, VIMS is also charged with providing advice and technical and engineering services to the managers, managing agencies and users of the marine resources in addition to conducting oceanographic research and education. This is a very broad charge. What VPI is to freshwater and agriculture, VIMS is, or should be, to salt water and mariculture or aquaculture.

At present the organization consists of about 160 scientists, supporting people and graduate assistants (almost 200 in summer) in several departments. The departments are arranged into four divisions - Research, Education, Applied Science and Engineering, and Administration. The marine specialists involved represent most basic fields of science and all major areas of oceanography. Though biological oceanographers are most numerous, VIMS personnel contains chemical, geological and physical oceanographers. Figures 1, 2, and 3 indicate the present organization by divisions, departments, and functions.

Support for the Institute derives principally from the General Fund of the Commonwealth. Though it amounted to about $350,000 per year in 1960, it is now about $696,500. Federal and private monies, about $257,400, also help support the research and educational activities of the Institute.

The educational program is rather broad, extending from elementary marine science and marine conservation at the primary

VIRGINIA INSTITUTE OF MARINE SCIENCE

ADMINISTRATIVE ORGANIZATION

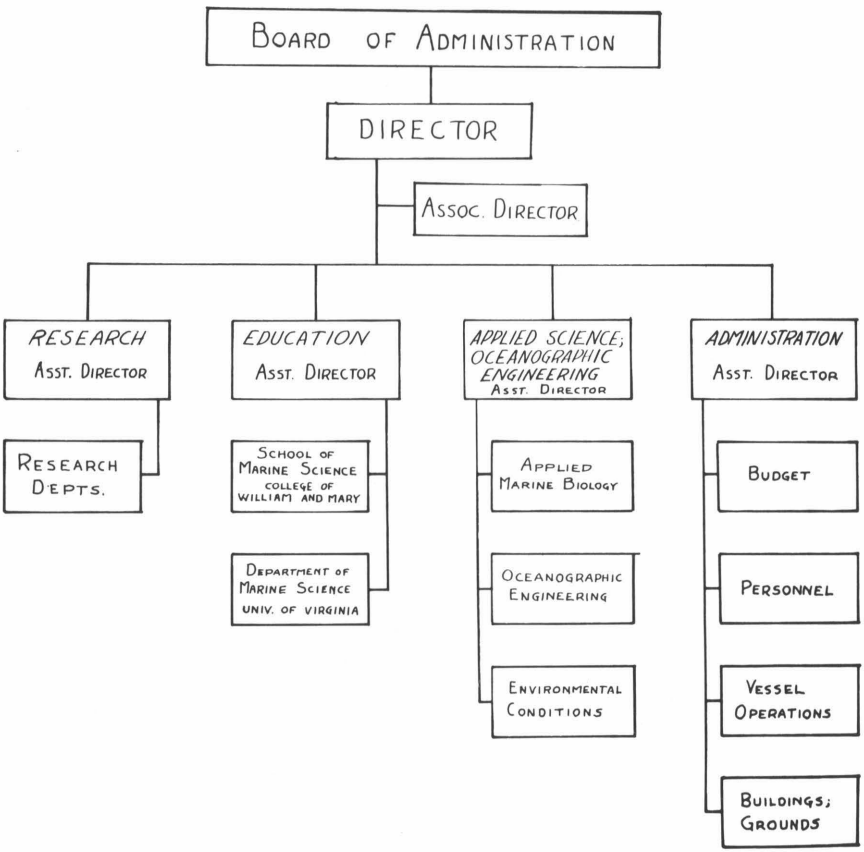

Figure 1.

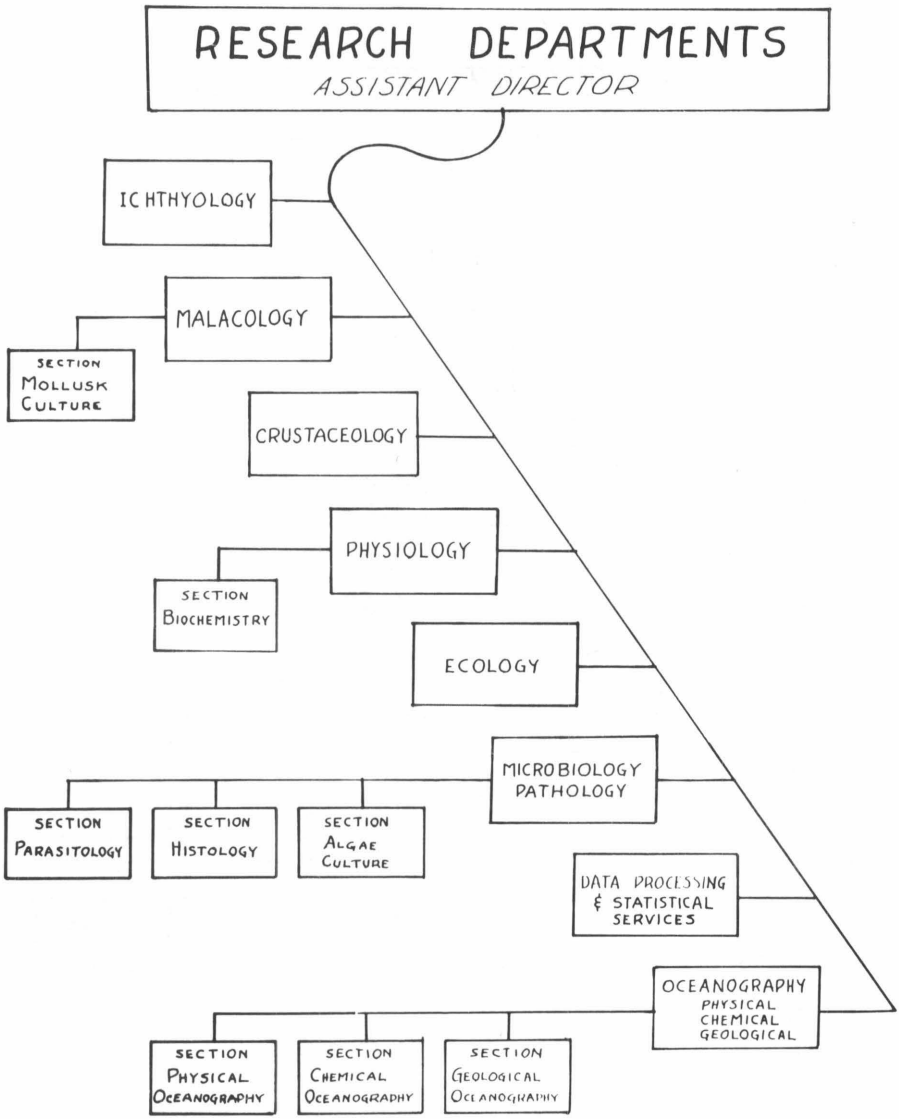

Figure 2. Research Departments of the Virginia Institute of Marine Science

Virginia Institute of Marine Science

FUNCTIONS & PROGRAMS

ADDITIONS TO BODY OF KNOWLEDGE;
RESOURCE-USE ADVISEMENT

ADVISEMENT TO:

1. Intrastate Groups

- GOVENOR & GENERAL ASSEMBLY
- STATE RESOURCE MANAGEMENT AGENCIES (WCB, VFC)
- COMMERCIAL FISHING INDUSTRY
- SPORT FISHING INDUSTRY
- RECREATION & TOURIST INDUSTRIES
- MANUFACTURING INDUSTRIES
- TIDEWATER COMMUNITIES & INDIVIDUALS
- DEFENSE INSTALLATIONS

2. Interstate Groups

- MEMBERSHIP IN INTERSTATE AND NATIONAL GROUPS CONCERNED WITH PROPER USE OF MARINE RESOURCES
- DEFENSE INSTALLATIONS
- U.S. ARMY CORPS OF ENGINEERS
- OTHER FEDERAL AGENCIES

EDUCATION

SCHOOL OF MARINE SCIENCE WM. & MARY

- GRADUATE PROGRAMS
- (M.A. & PH.D. IN OCEANOGRAPHY)
- ADVANCED UNDERGRADUATE PROGRAMS

DEPARTMENT OF MARINE SCIENCE UNIV. OF VA.

- GRADUATE PROGRAMS
- (M.A. & PH.D. IN OCEANOGRAPHY)
- ADVANCED UNDERGRADUATE PROGRAMS

SPECIAL EDUCATION PROGRAMS

- EXTENSION COURSES
- NSF RESEARCH PARTICIPATION FOR COLLEGE TEACHERS
- NSF UNDERGRADUATE RESEARCH PARTICIPATION
- VIMS SUMMER AIDE PROGRAM
- NSF-VIMS CCSS HIGH SCHOOL TRAINING PROGRAM

EXTENSION SERVICES

- SPECIAL INFORMATION BULLETINS
- SPECIAL SCIENTIFIC REPORTS
- VIMS DATA REPORTS
- VIMS APPLIED SCIENCE AND ENGINEERING REPORTS
- NEWS RELEASES
- LECTURES
- WORKSHOPS
- VISUAL PROGRAMS

RESEARCH

BASIC ⟷ **APPLIED**

BASIC

- VERTEBRATE BIOLOGY
- INVERTEBRATE BIOLOGY
- BASIC ECOLOGY
- PRODUCTIVITY
- PLANKTOLOGY
- MICROBIOLOGY
- MICRO. & MACROMORPHOLOGY
- PARASITOLOGY
- PATHOLOGY
- PHYSIOLOGY
- TAXONOMY
- PHYSICAL OCEANOGRAPHY
- CHEMICAL OCEANOGRAPHY
- GEOLOGICAL OCEANOGRAPHY
- METEROLOGICAL OCEANOGRAPHY

APPLIED

- POLLUTION
- FINFISHERIES, COMMERCIAL AND SPORT
- SHELLFISHERIES
- ENGINEERING PROBLEMS
- RESOURCE DEVELOPMENT
- DEMONSTRATION UNIT
- SHORT-TERM AND LIMITED TECHNICAL PROBLEMS

Figure 3

level to strong post-graduate programs in Biological Oceanography, Fisheries Oceanography and General Oceanography (Physical, Chemical and Geological Oceanography). Magisterial and doctoral degrees are available in these courses through the programs operated by the Institute as the School of Marine Science of the College of William and Mary and the Department of Marine Science of the University of Virginia. Almost 50 graduate students are in residence.

Under the provisions of its legislative charter, Institute scientists in laboratory land and sea vehicles operate from the fall lines of all the tidal tributaries of the Chesapeake Bay to the Sargasso Sea. This covers the reaches of the Virginian Sea as the region from Cape Cod to Cape Hatteras was called by Virginia's first English marine explorer, Captain John Smith.

VIMS' shoreside facilities are situated at its campuses at Gloucester Point (Figure 4) and Wachapreague (Figure 5). An hydraulic model of the tidal James is maintained by the Institute at Vicksburg, Mississippi. Several observation stations (Figure 6) situated strategically in the Bay and its rivers provide vantage points for experiments and continuous recording instruments. Special facilities include data processing equipment, computers, electron microscope and a broad array of oceanographic instruments. Sea operations are carried out from the 80' LOA, R/V LANGLEY (Figure 7), the 55' LOA, R/V PATHFINDER (Figure 8) or a number of smaller inboard and outboard vessels operated from Gloucester Point, Wachapreague or the Institute's Norfolk berth.

The basic applied research program encompasses some sixty projects ranging from the massive cooperative biological, chemical, geological and physical study of the James estuary called

Figure 4. Virginia Institute of Marine Science, Gloucester Point campus.

Figure 5. Virginia Institute of Marine Science, Wachapreague, Va. campus

Figure 6. Instrument Platform, mouth of Chesapeake Bay. One of several maintained by Virginia Institute of Marine Science in Chesapeake Bay and its rivers.

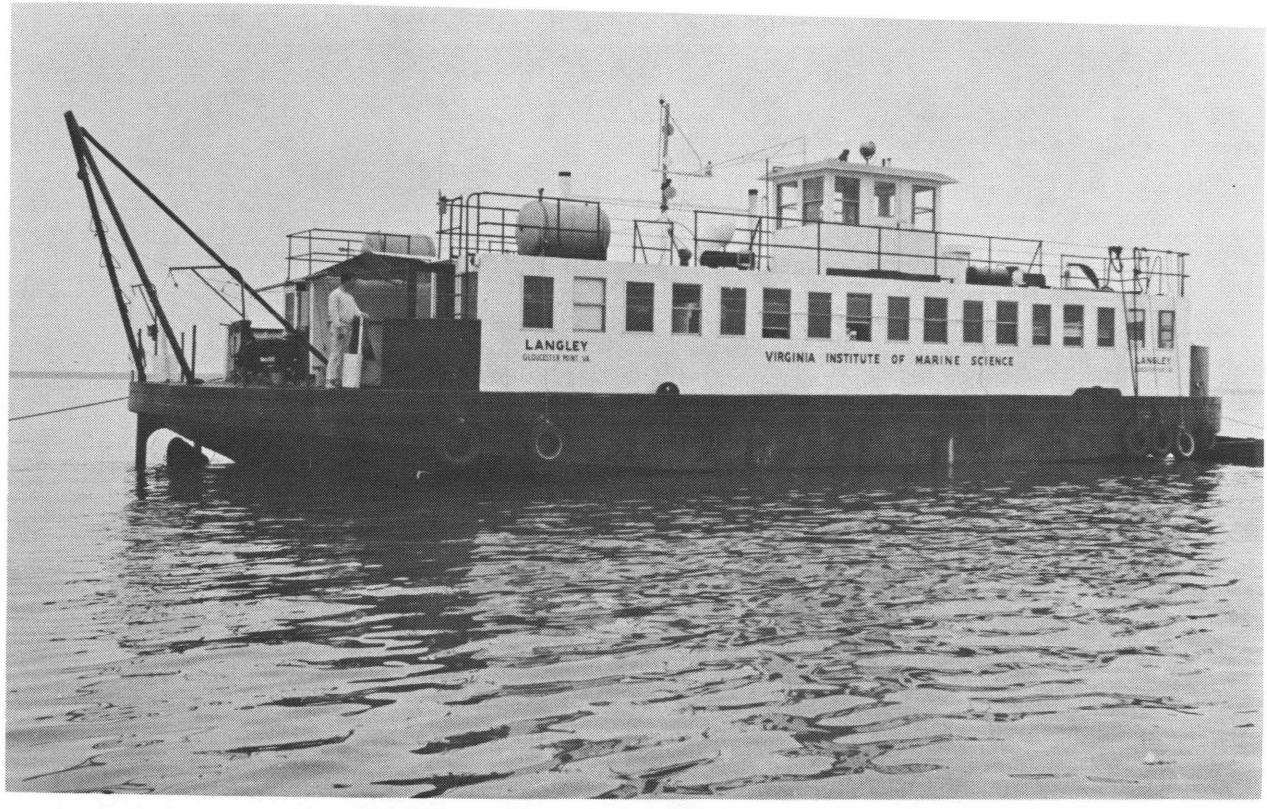

Figure 7. Research Vessel LANGLEY
Virginia Institute of Marine Science

Figure 8. Research Vessel PATHFINDER,
Virginia Institute of Marine Science

Operation James River to studies of the possible uses of pulp mill wastes in oyster culture. Institute scientists are studying basic process of the marine environment in such projects as:

1) The structure and dynamics of the James estuary.
2) The structure and dynamics of the Virginian Sea.
3) Use of fossil foraminifera as clues to historical salinities.
4) Systematics monogeneid ectoparasites of fishes.
5) Mathematical techniques of simulation of estuarine dynamics.
6) Amino acids in sea water and marine organisms.
7) Carbon dioxide cycle in sea.
8) Plankton energetics.
9) Role of marshes in estuarine ecology.

Applied studies are exemplified by:

1) Beach processes at Virginia Beach.
2) Effects of man's activities such as fishing pressure and contamination on sport and commercial fishery organisms.
3) Possible effects of dredging and spoil disposal on the marine environment.
4) Nutrients in estuarine systems.
5) Diseases of molluscs, crabs and finfishes.
6) Aspects of jellyfish biology.
7) Control of marine predators.
8) Development of control measures for water milfoil.
9) Characterization of coastal and estuarine fish survey grounds as natural communities - food and sportfish.
10) Investigation of potential for expansion of the industrial fishery of the Mid-Atlantic bight-industrial fish project.

Marine technology and engineering activities involve such industrial projects as:

1) Spawning, rearing and feeding of economically important shellfish.
2) Development of disease-resistant molluscs.
3) Freshwater regulation to improve estuarine productivity.
4) Use of hydraulic and mathematical modeling techniques to plan marine resource development and management.
5) Location of subaqueous sewage outfalls.
6) Marine corrosion problems.
7) Prediction of currents.
8) Prediction of fishery populations.

Results of these efforts are disseminated in regular oceanographic and scientific journals. In addition, survey and research data and partially analyzed results are published in VIMS Data Report Series and VIMS Special Scientific Report Series, respectively. Other special publications are the VIMS Translation Series, VIMS Educational Series and the Annual Report. In the future, special scientific results also will be released in an occasional Scientific Monograph Series. A new Special Ocean Engineering and Industrial Report is planned.

In summary, the activities of the Institute, Virginia's official oceanographic program, are rather broad. Encompassing a wide range of basic and applied marine projects, the research program is fairly sizable, involving over 60 individual projects.

The educational program in conservation and oceanography covers grammar to post-graduate levels. About 50 graduate students participate regularly in the magisterial and doctoral programs leading to degrees in Marine Science.

Results of the work of the scientific and ocean engineering

staff are disseminated through a number of inhouse and regular publications.

Activities of the Institute are important to the economy of maritime Virginia and the entire Commonwealth and contribute significantly to our knowledge of the marine environment and to the public welfare in the tradition of Virginia's most distinguished marine scientists - Thomas Jefferson, Matthew Fontaine Maury, John Mercer Brooke and Richard Evelyn Byrd.

Literature Cited

Hargis, W. J., Jr. 1964. The Marine Resources of Virginia; Their Development, Use and Preservation. Address presented at the Governor's Conference on Natural Resources, 22 April 1964.

Virginia General Assembly. 1966. The Code of Virginia of 1950 and 1966 Cumulative Supplement (as printed by the Michie Company, Charlottesville).

SUMMATION

by

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This Conference on Water Resources Programs in Virginia has reviewed the water resource related problems in the State. It has been established that the principal problem relates to the existence of an essentially constant supply in the face of progressively increased demands. In addition, the quality of some supplies have undergone deterioration. As mentioned by Dean Harrison, the problem is dynamic inasmuch as the hydrologic equilibrium is progressively altered by industrial and community development. The bright side of the situation was presented when Mr. Eaton expressed the observation that a substantial part of water resource problems may be attributed to growth - and of course this means economic benefits and prosperity for Virginia. The exceptionally pronounced rate of development in Virginia in recent years provides the forecast that we can expect exceptionally challenging problems of water resource management and control in years to come.

An essential element in the management and control of water resources is the monitoring of flows and quality. These data are essential as a base to provide the input for forecasts and planning studies. It is most important that data be obtained to identify trends so that comprehensive planning can be utilized to identify the water resource management programs that will yield the greatest benefit to Virginia.

If we review the agencies involved in water resources management, we could say "Among the agencies involved are . . .," or we could say, "These agencies and others." Among the agencies in the State Government that collect data relative to water

quality and quantity are: State Water Control Board, State Department of Health, State Geological Survey, Division of Water Resources, Institute of Marine Sciences, plus a number of other groups including the Fish and Wildlife Commission and various colleges and universities. Federal agencies include the U. S. Geological Survey, Federal Water Pollution Control Administration, Public Health Service and Corps of Engineers.

The Conference has established through the presentations of Messrs. Robin and Eaton that comprehensive basin-wide planning is necessary for full development of water resources. It has also been developed that local interests are best served by local planning studies within the framework of comprehensive plans. The object of planning studies should be the identification of alternatives for public decision-making. It was stressed by Mr. Eaton that it is most desirable that a strong voice be reserved for the public in decisions relative to local water resource management and development. Agencies involved in studies and planning within the State would include Division of Water Resources, State Water Control Board, State Department of Health, James and Roanoke River Basin Associations, Virginia Institute of Marine Sciences, Virginia Military Institute, and Virginia Water Resources Research Center. Among the Federal agencies involved are Corps of Engineers, which has a broad role; Federal Water Pollution Control Association, in the area of water quality; and Soil Conservation Service.

The role of research in water resources is the invention and development of improved techniques and additional alternatives for use in studies and planning. Simulation and mathematical modeling were cited as promising techniques for upgrading analysis and planning. Among the agencies of the State involved in water resources research are the Water Resources Research Center, State Water Control Board, Virginia Institute of

Marine Sciences, Virginia Military Institute, and Virginia Polytechnic Institute. No doubt all colleges and universities as well as many additional agencies contribute research findings relative to the water resources of Virginia. Among the Federal Agencies contributing to water resources research are the Office of Water Resources Research, Federal Water Pollution Control Administration, Public Health Service, and U. S. Geological Survey.

The development of water resources in Virginia is accomplished by agencies of the Federal Government, State, and by private corporations or groups. Among the government agencies are the Corps of Engineers, Soil Conservation Service, Tennessee Valley Authority, Cooperative Extension Service, and State Soil and Water Conservation Commission. Private groups active in water resources development include electric power companies, other industries, and river basin associations.

The water management practices of Virginia were reviewed by Mr. Paessler. The water resources of the State were cited as being available for public or industrial use to the benefit of the public at large, so long as use by others is not contravened. The expressed attitude appears favorable from the standpoints of industrial development, economic growth, and public use. The recreational aspects of water resources management were reviewed by Senator Bemiss. Water supply was cited as the first concern of the public, clean water as the second concern, and access to State waters as the third concern. There appears to be ample evidence that the public will demand in the future all of the expressed concerns.

The keynote of the conference could be the bold proposal of Senator Bemiss for zoning setbacks from the banks and shores of State waters to provide access for public recreation. Setbacks have been employed with success in applicable situations

in some other states. Virginia could do well to carefully consider the projected public demand for water related recreation and embark upon active programs to provide these resources for her people. Among the ancillary benefits derived from such programs would be the lessening of flood damage by reduction of the degree of development on flood plains, and improved control of unconsolidated discharges containing pollutional materials.

A final observation is that although there exists a substantial shortage of useful information relative to the water resources of the State, there appears to be no shortage of agencies involved. If the information needed for sound management and planning is to be obtained at reasonable cost, it may be necessary for the activities of the multitude of agencies be coordinated to prevent gross overlapping of effort.

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water resources research center

virginia polytechnic institute blacksburg