Appendix B
Summary of Model Use by Individual Federal Agencies

Introduction

This appendix summarizes water resource modeling activities of Federal agencies, using information supplied by the agencies and reviewed by OTA contractors and staff. The information was obtained from three sources: participants attending an OTA workshop, selected interviews with agency personnel, and a survey requesting agencies to indicate their model use under specific water resource laws. Agency representatives to the OTA workshop on Federal agency model use provided OTA with a written description of their agency's model use and model documentation, when available. Further information about model use and model documentation was obtained through selected interviews with agency personnel. The survey yielded information on legislation-related model use in Federal agencies as of June 1980, for agencies and ofllces in existence at that time (see survey form, attachment II).

This appendix describes, by agency, the water resource programs in which models are used and the types of models generally employed. The summary table of agency model use (table B-1) provides an overview of the water resource modeling activities of most of the agencies discussed in the text. The 33 water resource issues used to construct the table are listed in their unabbreviated form in table 1 of chapter 2. References for the text are listed by agency in attachment 1.

U.S. Department of Agriculture (USDA)

Economics and Statistics Service (ESS)

ESS provides economic projections of short-term and long-range agricultural demands for land and water resources. Its analyses focus on how alternative development of such resources could affect the agricultural and related sectors of the economy. ESS responsibilities include basinwide and interregional economic aspects of comprehensive river basin planning.

ESS is involved in programs under the Federal Water Pollution Control Act of 1972 (Public Law 92-500), as amended by the Clean Water Act of 1977 (Public Law 95-217, hereinafter referred to as the Clean Water Act); the Soil and Water Resources Conservation Act (Public Law 95-192, hereinafter referred to as the Resource Conservation Act); and the Water Resources Planning Act (Public Law 89-80). It uses models in each program area.

Under section 201 of the Clean Water Act, which deals with construction grants for treatment plants, ESS has used models to assist local groups in Pennsylvania in choosing among alternatives for treatment facilities. ESS also uses these models as part of its own general research and development effort. For its programs in areawide waste treatment management planning, under section 208 of the act, ESS has developed a large policy model to evaluate alternatives for improving water quality in the San Joaquin Valley in California. Among the factors the model considers are land-use options, zoning, and application of irrigation water. ESS uses models under section 209 of the act as well, which addresses nationwide river basin planning. Models are also used to determine the minimum cost of comporting sewage sludge in evaluating different projects under section 405 (disposal of sewage sludge) of the Clean Water Act.

ESS is also involved with regional or river basin planning under section 102 of the Water Resources Planning Act. The service uses models to estimate economic impacts of section 102 programs (regional or river basin plans). The models help project future economic conditions in rural areas under various scenarios. As is the case with all USDA river basin studies, these studies are carried with the cooperation of local sponsors.

In planning conservation programs under section 6 of the Resource Conservation Act, ESS uses models to project the likely effects of different economic conditions and conservation programs on land and water use, on erosion, and on the national economy.

ESS develops and applies computer programs for such other agencies as the Soil Conservation Service, the Water Resources Council, and the Environmental Protection Agency (EPA). These models generally incorporate economic criteria and are often of the optimizing or prescriptive type. An increasingly important service of ESS is to maintain the Land and Water Resources and Economic Modeling System (LAWREMS) described in chapter 4 of this report. This directory aids communication and technology transfer among agencies in order to reduce duplication in model development. LAWREMS contains models and data sets developed and maintained by ESS and other agencies and nongovernmental bodies.

Table B-1 - Federal Agency Model Use - January 1981

		Water resource issues	ESS	Forest Service	SEA	SCS	National Weather Service	Corps of Engineers	DOE	FWS	Bureau of Reclamation	USGS	CEQ	EPA	WRC
Surface flow/supply	Hydrology	flood forecast and control		X	X	X	X	X			X	X			
		drought/low flow forecast			X	X	X	X	X		X	X			
		streamflow regulation					X	X	X		X	X			
		instream flow needs		X			X	X		X	X				X
	Use	domestic supply		X			X	X			X				X
		irrigated agriculture	X	X	X	X	X				X	X			X
		offstream use		X			X	X	X	X	X				X
		efficiency and conservation				X	X	X	X	X	X				
Surface water quality	Nonpoint Pollution	urban runoff						X		X		X		X	
		erosion & sedimentation	X	X	X	X		X		X	X	X		X	
		salinity	X			X		X		X	X	X		X	
		agricultural runoff	X		X	X		X			X	X		X	
		airborne pollutants													
	Quality	waste load allocation				X		X	X		X	X	X	X	
		m													
		ma													
		nki g													
		impacts on aquatic life		X			X	X	X	X	X	X	X	X	
Ground water	Quality/Qnty	available supply			X	X	X		X		X	X			X
		conjunctive use													X
		drinking water quality										X		X	X
		gr po													
		me po													
		ru													
Economic/Social	Economic	cost of pollution control							X					X	
		benefit/cost analysis	X	X		X	X	X	X		X			X	
		al													
		forecasting use	X					X	X		X		X		
	Social	social impacts						X	X		X		X		
		risk/benefit analysis				X							X	X	
		competitive use demands	X	X	X			X	X	X	X		X		X
		river basin management	X	X		X	X	X	X	X			X		X

Forest Service

The Forest Service is responsible for developing, managing, and protecting lands in the national forest system. Its objectives include fostering multiple use and sustained yield of forest and rangeland resources. Beyond its research and data-gathering functions, the Forest Service coordinates planning for the forest~ component of river basin surveys and investigations, as well as for the small watersheds program under the Watershed Protection and Flood Prevention Act (Public Law 83-566). It is also responsible for managing flood plains and protecting wetlands on national forest system lands.

The Forest Service carries out a large number of programs authorized under water-related legislation, and uses models in connection with many of these programs. These include:

Under the Clean Water Act:
- section 107—mine-water pollution control;
- section 208—areawide waste treatment;
- section 209—river basin planning;
- section 303—water quality standards and implementation plans; and
- section 3 14—clean lakeso

Under the Endangered Species Act (Public Law 93-205):
- section 7—minimizing impacts of Federal activities modifying critical habitats.

Under the Surface Mining Control and Reclamation Act (Public Law 95-87):
- section 506—surface coal mine reclamation permits; and
- section 51 5—environmental protection performance standards for surface coal mine reclamation.

Under the Resource Conservation Act:
- section 5—collection of data about soil, water, and related resources; and
- section 6—soil and water conservation programs.

Under Executive Order No. 11988:
- sections 5 and 6—flood plain management.

Under the Water Resources Development Act of 1974 (Public Law 93-251):
- section 73—planning nonstructural measures.

Under the Flood Control Act of 1936 and amendments (33 U.S. C. 701, et. seq.):
- sections 1 -3—choosing and designing flood control structures.

The Forest Service provided detailed information on models used under the Forest and Rangeland Renewable Resources Planning Act of 1974, as amended (Public Law 93-378). Under this act the Forest Service creates and implements long-range land and research management plans at local, regional, and national levels. Models are used to estimate changes in water quality and supply under alternative management practices, and to project the economic effects of such management practices on localities. Models also aid in determining National Forest Management Act regulations—the models are used to analyze potential standards and guidelines and compare results of their applications.

Under planning activities mandated by the Forest and Rangeland Renewable Resources Act of 1978, the Forest Service uses models to compute soil moisture and streamflow in forests and rangelands. Information on soil moisture is used to determine whether and when to plant trees, and to determine viable levels of livestock per acre of rangelands. The effects of timber harvesting on streamflow are evaluated using water yield models, which determine the maximum levels of harvest consistent with preventing excessive peak flows in rivers. Models are also used to determine harvest designs which increase the water yield in watershed areas.

Science and Education Administration (SEA)

SEA is actively involved in water resources modeling as part of its mission in natural resources research. The agency's water resource modeling activities embrace a wide range of topics: climate and weather, the hydraulics of overland and channel flows, rill and interrill erosion, sediment yields from agricultural watersheds, infiltration, evapotranspiration, irrigation scheduling, subsurface drainage, and the transport of agricultural chemicals, among other topics.

In its program under section 208 of the Clean Water Act, SEA uses models to estimate the effects of land-use practices on agricultural nonpoint source pollution. This information is made available to USDA ofilces and to the public through USDA technical assistance programs. The agency also uses water resource models in the agricultural research it conducts under section 1402 of the Food and Agriculture Act of 1977 (Public Law 95-1 13). Models are used to predict the effects of different land-use practices on agricultural and nonpoint source pollution.

SEA extramural funds are used for scientific research at universities to assist in developing water resource models for resolving local, State, and regional water and water-related problems. The research may produce components and mathematical techniques for use in developing models or in checking the scientific validity of models. SEA scientists coordinate these research efforts among the respective States and the intramural research programs of SEA. In a number of cases, State and Federal scientists are cooperating on the same regional project, working on mutually developed objectives, and sharing ongoing research progress at least annually.

For the most part, SEA's modeling program aims to improve understanding of the fundamental physical, chemical, and biological processes that control or constrain crop production; assist resource conservation; and reduce present or future impacts of agricultural activities on the environment. In selected areas such as erosion and nonpoint source pollution, model development has reached the point that applying the models to resource management, planning, and policymaking is considered both feasible and justified. Examples of these models are the Universal Soil Loss Equation (USLE) model, and the Chemicals, Runoff, and Erosion from Agricultural Management System (CREAMS) model.

Soil Conservation Service (SCS)

SCS is authorized to develop and carry out a national soil and water conservation program in cooperation with landowners and operators and local, State, and Federal agencies. Its programs assist farmers, ranchers, and State and local organizations to prepare plans for resource management, including structural and nonstructural improvement for flood protection, water conservation, use and disposal of water, agricultural pollution control, environmental improvement, and rural community development.

SCS has a background of mathematical modeling dating back to the 1950's. It has applied models to flood and irrigation water control and to erosion and sedimentation problems. The principal physical models deal largely with hydrologic phenomena: generation of hydrography; flood routing; calculation of areas, elevations, and frequencies of floods; and the mechanics of irrigation. One model is devoted entirely to applications of the universal soil loss equation, although this functional relationship also appears in many other models.

Recently, several models for economic evaluation have been developed. In fact, approximately one-half of the 30 models SCS currently uses are physical/economic integrative models that serve as planning tools to help evaluate and select conservation strategies. They are used, for example, to project floodwater damage to urban and agricultural areas, and the costs and benefits of various cropping, conservation, and land-treatment methods.

SCS reported model use under a number of legislative mandates. Under the Rural Development Act of 1972 (Public Law 92-419), the agency uses models to assist qualified local sponsors in initiating and sponsoring resource conservation and development areas.

Through the Watershed Protection and Flood Prevention Act (Public Law 83-566), SCS has primary responsibility for USDA's cooperation with local organizations in small watersheds throughout the Nation, and has specific responsibility for flood prevention measures. To carry out these responsibilities, two types of models are used—a management information model and models to determine the effects of water quality projects. The first type is a System of Watershed Automated Management Information (SWAMI), used to evaluate present programs and assess needed changes.

SCS river basin and area planning activities use models for planning and evaluating the physical, environmental, and economic aspects of water resources. Most activities include an inventory of existing resources, projections of future resource uses, and the evaluation of alternatives. Some studies develop specific models to represent unique physical processes where no existing model can be used.

Other programs involving model use that are authorized under water-related legislation include:

- The Rural Clean Water Program (Public Law 96-108), which uses models to evaluate the quality and quantity of runoff from agricultural watersheds and to evaluate alternative systems of best management practices.
- The Resource Conservation Act (Public Law 95-192), under which models are used to predict the effects of conservation programs on erosion rates and land and water use.
- The Clean Water Act (Public Law 95-217; sec. 208j), under which models are used to determine the effects of conservation practices on nonpoint source pollution from agricultural land.
- The Colorado River Basin Salinity Act (Public Law 93-320), under which models are used to determine the effects of irrigation practices in specific areas on salinity levels in the Colorado River Basin.
- The Flood Control Act of 1950 (Public Law 81-516), under which models are used to select and design floodwater-retarding structures built under this authority.
- Floodplain Management (Executive Order No. 11988), under which models are used to delineate flood plains and to predict the river stage effects of different levels of flood plain encroachment.

Department of Commerce

National Oceanographic and Atmospheric Administration (NOAA)

NOAA uses models extensively to support its numerous activities under current water resource legislation. Under the Clean Water Act, for example, NOAA's activities in basin planning, secondary treatment requirements, water qualty standards, standards for pretreatment of toxic effluents, and clean lakes (sees. 219, 301, 313, 307, and 314, respectively) all involve some model use. NOAA also uses models in its soil and water programs under the Resource Conservation Act and in its programs under the Water Resources Planning Act.

Information from NOAA models is also supplied to Federal agencies concerned with fish and wildlife habitat protection under the Fish and Wildlife Coordination Act (16 U.S.C. 661). These models help project effects on fish and wildlife habitats when planning or evaluating projects. NOAA also uses models under sections 101 and 102 of the National Environmental Policy Act (Public Law 91-190). Models are used to estimate effects on instream flow, evaluate effects on habitats and on an ecosystem's trophic relationships, and predict the probable dispersion of an oil spill.

NOAA's hydrologic service programs are managed by the National Weather Service (NWS) under authority of its Organic Act (1890) and the Flood Control Act of 1936($ 1,2,3j, 15 U.S. C. 313, 33 U.S. C. 706). NWS is responsible for issuing weather and river forecasts and warnings. Federal, State, and local agencies rely heavily on NWS for river and flood information for management planning, and for probable maximum precipitation estimates used in designing river and flood control structures. NWS hydrologic forecasts are important for reservoir operations, water supply management, navigation, irrigation, power production, recreation, and water quality management. Most of the information supplied is output from models.

The agency's concentrated ongoing effort to implement a system of interrelated mathematical models and predictive techniques is known as the National Weather Service River Forecast System (NWSRFS). The system incorporates models already in use and new hydrologic forecast techniques. Included are models of snow accumulation and ablation, soil moisture, streamflow routing, and unsteady open channel flow. The system also includes programs for handling and processing data and for model calibration and verification. Planned additions to NWSRFS are an enhanced reservoir operation model, and an extended streamflow prediction technique for water supply forecasting based on a conceptual watershed model. The extended streamflow prediction technique will eventually complement the current water supply forecasting procedures, which are based on statistical methods.

The first version of NWSRFS was implemented in 1971 and used for river forecasting in the lower Mississippi River basin. When fully implemented, NWSRFS will be used by all 13 NWS River Forecast Centers (RFCS) in preparing daily streamflow forecasts for more than 2,500 river forecast points and drainage areas covering approximately 97 percent of the United States.

Department of Defense

U.S. Army Corps of Engineers

The Corps of Engineers is authorized to investigate, develop, conserve, and improve the Nation's water and water-related land resources. Its programs include planning and development activities for protecting navigable waters, flood control, hydroelectric power production, flood damage reduction, flood hazard information, urban land drainage, wastewater management, shore and beach restoration and protection, fish and wildlife conservation, outdoor recreation, aquatic weed control, and environmental protection. These responsibilities include consideration of the economic, social, and environmental impacts of public works alternatives.

The Corps' mandates are based on a wide variety of water-related legislation and many are carried out with the use of models. Under the Clean Water Act, the Corps uses models to help evaluate costs and designs for water treatment facilities proposed for Federal funding pursuant to section 201 of that act. The Corps also uses models under section 1444 of the act (Federal facility pollution control).

The Corps employs models in its water resource planning activities. It uses models in its regional or river basin activities under section 102 of the Water Resources Planning Act (Public Law 89-80) and in planning and evaluating nonstructural measures under section 73 of the Water Resources Development Act (Public Law 93-251).

The Corps makes major use of models in connection with its flood control and management function. Models are used in designing and selecting flood control structures to be built pursuant to the Flood Control Act and in planning or evaluating flood-control projects. The models help assess flood peaks, compute water surface profiles, and supply data for flood damage assessment. The Corps also uses models to assist the Federal Insurance Administration in conducting flood insurance studies under the Flood Control Act.

The Corps' flood plain management programs under Executive Order No. 11988 also make use of models. Models are used to delineate the 100-year flood plain so that Federal and non-Federal interests may comply with current regulations. For example, one regulation requires that flood plain encroachment should not result in an increase in water surface elevation of more than 1 ft. The models help predict the relationship between extents of encroachment and the rise in surface water surface elevation.

The Corps' research and development in water resource modeling focuses on solving field problems. In hydrologic analysis, the Corps' Hydrologic Engineering Center (HEC) has developed a number of computer models for evaluating the expected magnitude and frequency of runoff from urban and nonurban watersheds. The principal urban runoff models are HEC-1 and STORM. HEC models have also been used to improve the operation of reservoirs during floods. Both HEC and the Corps' Waterways Experiment Station (WES) have developed several models relating to river mechanics. These models simulate hydrodynamic and sediment transport processes in rivers, lakes, and estuaries. The Corps' WES and the Coastal Engineering Research Center (CERC) have also developed and applied various models to compute hurricane surges and wave heights for design and planning purposes.

HEC has developed two reservoir-system analysis models: HEC-3 and HEC-5. These are multipurpose reservoir operation models used in planning and operating reservoir systems for flood control, hydropower, and water supply. The models have been used at the planning level to evaluate the water-supply performance and hydropower potential of existing and proposed reservoirs, and to study flood control. The HEC-5 model is currently being used in operational studies of hydropower sites selected from the Phase I screening of the National Hydropower Survey. The Corps also uses models to assess the potential impact of a partial or complete dam failure.

Both HEC and WES are developing water quality models. These models are applied to proposed Corps projects to predict overall water quality conditions and to develop appropriate design and operational criteria for attaining desired water quality levels. Models are also used to evaluate design of operational modifications for projects in which water quality problems exist.

The Corps' water resource planning models focus on flood control. Flood-damage computation procedures are part of several of HEC flood forecast and control models. These procedures evaluate the expected damage from a series of flood events, with and without various proposed management measures. An optimization routine in the HEC-1 model analyzes various sizes and combinations of flood-control measures and allows for the evaluation of tradeoffs among facilities, performance, and cost. The HEC interactive nonstructural analysis model focuses on analyzing and formulating flood-damage reduction measures other than traditional construction projects.

Department of Energy (DOE)

Office of Environmental Assessments

Within the water resources area, DOE's OffIce of Environmental Assessments is concerned with the impacts of energy technologies on water resources, including the effects of energy-related pollutants on biological systems. The office is also involved in defining water and land resource requirements for energy technologies including coal gasification, coal liquefaction, uranium enrichment, geothermal development, small-scale hydroelectric development, enhanced oil recovery, and shale oil production.

The majority of the water resource models DOE uses are deterministic simulations of physical systems, and they deal primarily with three subjects: assessing surface water supply related to the potential for energy facilities development; analyzing energy-related environmental impacts including thermal effects and transport of various pollutants; and determining the economic and social effects of water use for energy development,

The Ofllce of Environmental Assessments uses several water resource models. The Water Assessment System (WAS), located at Oak Ridge National Laboratory, is used principally for large-scale regional impact assessments. This model projects variations in streamflow, water use, and water availability over time to assess water availability for various energy scenarios. The basic geographic unit is the Water Resources Council (WRC) aggregated subregion (ASR) level. In support of WAS, the Automated Downstream Accounting Model (ADAM) calculates cumulative water availability and consumption data for surface streams in hydrologic sequence.

The Water Use Information System (WUIS) of Hanford Energy Development Laboratory is used for a number of DOE assessments. This is a computerized information system containing comprehensive data on water resources, on water availability and quality, and on electrical generating plant characteristics and operational characteristics relating to water use. Its basic geographic resolution is the WRC cataloging unit. The Los Alamos Coal Use Modeling System (LACUMS) incorporates water supply and demand sectors into a linear programing model of energy supply to facilitate water- and energy-related policy analysis. Water SUPPl,is ac-counted for by coal demand regions.

For large-scale water quality impact assessments, Argonne National Laboratory has de~eloped the Argonne Water Quality Accounting System (AQLJAS), a new regional screening model. The model utilizes streamflow data, measured water quality data, and residual discharge data at the accounting unit level to estimate changes in concentrations of selected pollutants. These several models are used by other agencies and organizations within and outside of DOE.

The Strategic Environmental Assessment System (SEAS) is not a water resource model per se, but it calculates wastewater residuals and regional water use for energy scenarios during the course of general environmental assessments. DOE has supported Fish and Wildlife Service development of an instream flow calculation system to quantify the effects of water consumed by the energy industry and to determine the effect on aquatic species, habitat, and the like. Its purpose is to estimate instream flow requirements that might constrain energy development.

Aquifer modeling, though not a major program, is being developed to investigate the migration of pollutants, particularly radioactive materials, from waste-disposal sites. Energy storage in aquifers has also been modeled to determine geothermal reservoir dynamics in support of this energy source. Other models investigate the effects of thermal energy releases on localized meteorology—including effects on rainfall and cloud formation—which could influence water supply.

Federal Energy Regulatory Commission (FERC)

FERC in DOE uses models under two major programs of the Federal Power Act (16 U.S.C. 803(f)): Dam Safety and Headwater Benefits.

A number of models are used to plan or evaluate projects under the Dam Safety Program. Some determine water surface profiles and downstream water velocities resulting from a dam break. Other models are used for preparing flood hydrography, reservoir routing, and design analysis.

Payments under the Headwater Benefits Program are determined with information provided by models. These models are used to determine the energy gains at downstream hydropower plants resulting from the operation of headwater reservoirs.

FERC also indicated model use for its cooperative activities program under the Water Resources Planning Act, and for its participation in planning Federal water resources projects under the Flood Control Act of 1936 and amendments. Models are used to plan, evaluate, and review projects, and for data acquisition, statistical analysis, and water resources/hydropower system analysis.

Department *of the* Interior

Bureau of Land Management (BLM)

BLM is responsible for managing, conserving, and developing 174 million acres of publicly owned land in the 11 Western States and an additional 162 million acres in Alaska, BLM also administers the subsurface minerals underlying approximately 370 million additional acres throughout the Nation managed by other agencies or owned by private citizens, and on the 1.1 billion acres of Outer Continental Shelf owned by the Federal Government.

BLM's use of computer-based resource models is occasional, and is confined to selected models for site-specific analyses. Stochastic hydrologic models are used to evaluate alternate grazing systems in preparing grazing environmental impact statements. Hydraulic models are used to evaluate instream flow needs for adjudicating water rights, designing fishery habitat improvements and water facilities such as dams and water distribution systems, and in analyzing overburden materials associated with surface mining. In addition to these models, BLM uses technological guidelines developed through the use of hydrologic models to analyze various resource problems, including timber harvesting and planting techniques and their impacts on water quantity and quality; fishing improvements associated with spawning areas; flood plain identification; soil erosion; analysis of potential mineral leasing tracts; and the siting of campgrounds associated with water-based recreation.

BLM currently contributes financially to research within USDA and the Department of the Interior, as well as to various university investigators. These research projects are expected to produce a series of water resource models that will be used on a continuous basis, and to develop an additional technological guideline to address routine multiple-resource problems. In addition, BLM expects to continue to use models developed by others for solving problems related to public lands.

Bureau of Mines

The Bureau of Mines' principal responsibilities are to develop mineral resources, promote mine safety, and maintain healthful working conditions and environmental quality in the mineral industries. The bureau is concerned with the quality of water discharges in all phases of mineral production, and it engages in research to develop and improve mining technology, including methods of protecting water resources used or affected by mining.

The bureau uses models in two of the programs it carries out related to the Clean Water Act, section 107, which authorizes mine-water pollution control demonstration projects. Models are used to predict the effects of iron ore mining in the Mesabi Range of Minnesota on the area's hydrologic system. Another program involving model use is designed to develop management practices to minimize water quality problems during and after open pit mining of copper ore in Arizona. The information these models generate is furnished to mining companies to help them comply with mine-water pollution regulations.

The bureau also uses models in several other programs concerned with the effect of mining on water quality. These programs stem from various acts dealing with water resources:

- Under the Safe Drinking Water Act (Public Law 93-523), section 1421—the bureau has used models to help predict the effects of surface coal mining on the ground water regime of western Tennessee. This information is made available to mine operators to aid them in complying with existing regulations.
- Under the Surface Mining Control and Reclamation Act, section 515—the bureau is using models to predict the effect of coal mining on hydrologic regimes in Coshocton, Ohio.
- Under the Resource Conservation Act, section 6—the bureau uses models to predict the effects of coal mining on the hydrologic system, particularly ground water, in the Power River Basin in Wyoming. This information is also made available to mine operators to assist them in preparing EISS, and in complying with regulatory standards set by different agencies. This work is also related to the Surface Mining Control and Reclamation Act.

One Bureau of Mines model, UNSAT2, is used to predict seepage patterns and quantities from mine-waste impoundments. Applications of this model include analyses of the stability of spent oil shale deposits and the flow of leachates into ground water systems.

Office of Surface Mining

The Office of Surface Mining administers portions of the Surface Mining Control and Reclamation Act, using models in connection with several of its programs under title V of the act—Control of the Environmental Impacts of Surface Coal Mining.

Section 515 authorizes environmental protection performance standards for surface coal mine reclamation. The office and its contractors use models in assessing the cumulative effect of surface coal mining on an area's hydrologic regime to determine regulations and standards for protecting water quality and quantity. This information is provided to State and local agencies and to private sector interests. Under section 510 of the act, the office uses models to evaluate permit applicants' assessments of the hydrological consequences of their proposed mining activities, and as a basis for approving or denying permits. The office aiso uses models to evaluate protection of the hydrologic balance under the environmental protection standards set pursuant to section 515 of the Surface Mining Control Act.

Office of Water Research and Technology (OWRT)

The principal functions of OWRT are to improve technologies and methods for addressing water resource problems, train water scientists and engineers, coordinate water research, and disseminate water resource information. These tasks, carried out under the State Institute Program by university water resources research institutes in each State, are aimed at resolving local, State, and regional water and water-related problems. The State water resources research institutes and the State Institute Program are described in detail in chapter 4 of this report.

Because OWRT is not a mission-oriented agency, it does not itself use water resource models. It is active in funding model development, however. Water resource models developed by OWRT grantees and contractors span almost the entire range of issue areas and model uses. At present, OWRT is assessing the need to develop simpler, less data-intensive models than those that now exist. A concomitant concern is to adapt existing models to specific applications.

Fish and Wildlife Service

The primary responsibilities of the Fish and Wildlife Service consist of conserving and protecting fish and wildlife resources and ensuring their equal consideration with other aspects of water development planning as required by the Fish and Wildlife Coordination Act (16 U.S.C. 661). The service has a vital interest in water and related land-use programs, including diversions, impoundments, facilities development, and streamflow regulation. The service participates actively in studies leading to the formation of national, regional, or river basin plans for using water and related land resources.

The service uses models in several of its programs concerned with managing *water resources* for the benefit of fish and wildlife. When asked to analyze construction projects and alternatives proposed by other agencies in EISS, the service uses models to project the relative impacts of the proposed construction and its alternatives over a number of years. Models also help determine the potential effects of a project on endangered and threatened species, as well as on water flow requirements for these species. The service also uses models in surveys and investigations of the fish and wildlife impacts of water resource projects under the Federal Reclamation Act (43 U. S.C. 421 and 422), dealing with irrigation distribution systems and construction of small water resource projects, respectively.

The Fish and Wildlife Service uses models for several purposes in its programs in accordance with the Fish and Wildlife Coordination Act. Under this legislation the service recommends modifications in project design and operation consistent with sound wildlife management principles.

Some of these uses are:

- For water resources planning: the service uses models to help assess water availability and instream flows, to predict the effects on habitats surrounding such projects, and to assess the impacts of water development projects.
- For operation and management activities: the service uses models to help determine waterflow regimes and how to mitigate impacts from construction projects.

The service also acts in an advisory capacity to State and local agencies that use models to assess instream flow needs and the effects of construction and energy-related activities on aquatic populations.

For evaluating the effects of powerplant design and siting, the Fish and Wildlife Service principally uses two types of models. One type includes fairly large simulation models for investigating and predicting physical impacts of powerplant operation (specifically, cooling) on the aquatic environment. Such impacts include fish entrainment-impingement, as well as habitat modification. The service also uses a Multiple-Objective Programing (MOP) model to study regional alternatives for powerplant location. The regional energy location model (RELM) was recently modified to incorporate biological/ecological considerations into an economic optimization model. This modified model is intended to include ecological criteria in siting decisions at the earliest possible planning stage, thus reducing the likelihood of expensive litigation over the development of future energy resources.

Bureau of Reclamation

The Bureau of Reclamation is involved in developing water and related land resources in the 17 Western States. Planning such development is a multiobjective and multipurpose activity directed at irrigation, municipal and industrial water supply, hydroelectric power, flood control, navigation preservation, propagation of fish and wildlife, outdoor recreation, drainage, pollution abatement, water quality control, streamflow augmentation, watershed protection, and erosion control. All the bureau's water and land resource development activities are authorized under the Federal Reclamation Act (43 U.S.C. 421).

During the last 15 years, considerable attention has been directed toward developing and managing Western resources. As a result of this attention, a large body of water-related legislation has been passed that relates to, and has some impact on, the basic water and land resources development mission of the bureau. Sections 208, 209, and 303 of the Clean Water Act require the bureau to consider areawide wastewater treatment facilities and management, river basin planning and management, and quality standards and implementation in plans, respectively. The National Environmental Policy Act of 1969 in section 102 requires evaluation of impacts from water resource development projects both during construction and for the long term.

The Colorado River Salinity Control Act was established to define and implement effective salinity control measures to meet established water quality standards. Other legislative acts affecting the bureau's water resource development activities include: the Endangered Species Conservation Act; Executive Order No. 11988, sections 2 and 3 (flood plain management); the Water Resources Development Act, section 73, (nonstructural measures); and the Flood Control Act (building flood control structures).

To assist in accomplishing its basic water and land resource planning, development, and management mission, the Bureau of Reclamation has developed several water resource-related models. These models are used in the planning, design, and operational phases of the agency's mission, and are employed extensively to evaluate the effects of planned actions as they relate to and affect the legislation described previously. These models were not developed for any specific legislation or as a result of it, but are used as tools to assess the impacts of planned actions or change in operating strategies to see how they relate to and comply with the various statutes.

The bureau uses physical/ecological ground and surface water models, as well as various economic/social models. All of the bureau regional offices and many of its project offices use surface water models. These models are usually developed or adapted by the office using them. Most of these models are project-specific, and simulate project operations over various time periods and with various hydrological inputs. The models are used for single projects, multiple projects, or entire river basins. Model applications include developing reservoir operation strategies; hydropower simulation; and water quality, water rights, water availability, and flood control studies.

The bureau uses models to help determine how temperature changes or peaking power releases resulting from various reservoir operation, release, and withdrawal schemes would affect downstream fisheries and recreation and power users. This information is communicated to States, localities, and other Federal agencies so that reservoir operations can comply with State and Federal fish habitat temperature guidelines, optimize power generation, and meet water user contract agreements. Models are also used to evaluate the impact of reservoir and stream operations on fish habitat and populations.

The bureau makes extensive use of simulation models to evaluate the impacts and effectiveness of irrigation systems. The models provide information for determining whether projects should be modified to exclude lands that irrigation would affect adversely. They are also used to help predict the quality and quantity of irrigation return flows and the effects of project development on aquifer quality, receiving stream quality, and chemical, physical, and biologic properties of project soils. The Return Flow Quality Simulation model has been used to calculate salinity and other ground and surface water quality changes from major irrigation projects in California, Colorado, and the Dakotas. This model can also be used to schedule the timing and amounts of water required for a variety of crops and climates.

Models are used in developing salinity level standards and in evaluating the effects of specific actions on salinity levels in the Colorado River Basin. Specifically, the models estimate the effect of future water uses on salinity and the cost effectiveness of salinity control measures for meeting established standards. The models also help determine the technical feasibility of proposed salinity control measures at point, nonpoint, and agricultural sources. In addition, the models are used to develop operating strategies for reservoirs, determine the optimum size of desalting plants and reservoirs, and maximize the water supply for all competing uses, including power, municipal and industrial, irrigation, instream flows for fisheries and recreation, and water quality.

Other types of surface water models used by the bureau include unsteady flow routing models to predict outflows and downstream routings of floods from hypothetically breached dams. These models assist in developing maps of expected inundation areas for emergency preparedness planning. The bureau also employs and continues to develop synthetic models to describe extreme storm precipitation and meteorologic conditions. These are used to determine maximum probable flood values for sizing spillways and to describe atmospheric modification potential for precipitation augmentation.

The bureau also uses a wide variety of ground water models in water resource planning, system design, and project operation. With few exceptions, these are theoretically based models that simulate the movement of both water and solutes.

A major recent effort by the Bureau has been to develop and implement the Bureau of Reclamation Economic Assessment Model (BREAM), a simulation-type model. BREAM's basic function is to provide a systematic, theoretically sound approach to projecting population, employment, and income. The bureau envisions using BREAM principally for alternative futures analyses, public involvement, projection of municipal and industrial water requirements, and economic/demographic impact assessments related to water resource construction activities and long-run uses and outputs of water resource development. The economic and demographic outputs of BREAM are also major inputs and driving variables necessary for evaluating the social impacts of water resource development activities. The bureau uses other economic models to analyze and optimize farm enterprises in determining irrigation benefits and payment capacity, and to analyze hydropower additions to existing power system networks.

The bureau has also developed data management and scheduling systems based on models of management functions. These provide for scheduling program activities, and funding and manpower requirements.

U.S. Geological Survey (USGS)

USGS conducts research on the physical features of the Nation, including its mineral and water resources. This research is based on the fields of hydroloW, geology, geochemistry, and geophysics, and aims at developing new technologies and methods for appraising and conserving minerals and water. The Water Resources Division of USGS is responsible for investigating and appraising the source, quantity, quality, distribution, movement, and availability of both ground and surface water. The legal authority for this work stems from the act of October 2, 1881 (25 Stat. 505, 526), augmenting the organic act establishing USGS in 1879, and has been reinforced by the general language of annual appropriation acts for the Department of the Interior since 1894. AIso, USGS has been the indirect recipient of program responsibilities under many different water resource laws that are primarily directed toward resource management agencies.

USGS uses models in connection with many of its programs. Models are used to study flow, ion transport, and geochemistry in aquifer systems; information thus generated is made available to Federal and State agencies, and to the general public. Modeling activities of the USGS Water Resources Division—in particular, the

Federal-State Cooperative Program—are described in detail in chapter 4 of this report. Models are used in connection with USGS activities relating to sections of the Clean Water Act, namely:

- section 201 —grants for construction of treatment plants;
- section 3 I l—oil and hazardous substances liability;
- section 3 14—clean lakes;
- section 3 16—thermal discharges and exemptions; and
- section 404—guidelines and permits for use of dredge or fill materials.

USGS also develops models for use by itself and others in programs under the Resource Conservation and Recovery Act (Public Law 94-580).

USGS develops models to study many aspects of quality in selected rivers of the United States. These models analyze flow and transport, dissolved oxygen, and thermal discharges. Use of these models is generally related to provisions of the Water Resources Planning Act, which requires a continuing study of the adequacy of the Nation's water supply. USGS is also developing models that will be used to assess the impact of surface coal mining on the hydrology of mined river basins, an activity relating to section 515 environmental protection standards under the Surface Mining Control and Reclamation Act.

USGS is also concerned with flood control and uses models in connection with its activities under the Flood Control Act and sections 2 and 3 of Executive Order No. 11988, dealing with flood plain management. USGS models determine flood discharges for specified recurrence intervals, flood profiles, and flood routings. The information the models produce is available to appropriate Federal, State, and local authorities and to the public.

In addition to these uses of models, USGS indicated that it uses or is developing models in connection with its activities under the following acts:

- The Safe Drinking Water Act (Public Law 93-523):
  - — section 1421—protection of underground sources of drinking water; and
  - — section 1444—special study and demonstration project grants for wastewater reuse, reclamation, and recycling processes.
- The Surface Mining Control and Reclamation Act:
  - — section 506—surface mining permits; and
  - — section 5 15—environmental protection standards for reclamation.
- The Resource Conservation Act:
  - — section 5—data collection about soil, water, and related resources;
  - — section 6—soil and water conservation programs.
- The Water Resources Development Act of 1974:
  - — section 73—nonstructural measures.
- The Federal Reclamation Act:
  - — 43 U.S.C. 421—irrigation distribution systems.

USGS has made significant contributions to the development of models for analyzing ground water problems. Specific areas include: physical characteristics of ground water flow, effects of ground water depletion on surface lands, flow in coupled ground water/stream systems, integration of rainfall-runoff basin models with soil moisture accounting and aquifer-flow models, interaction of economic and hydrologic considerations, prediction of pollutant transport in aquifers, and estimation of the effects of development schemes for geothermal systems. USGS is actively involved in updating and improving most of these models.

USGS surface-water modeling efforts include: flow routing in streams, estuaries, lakes, and reservoirs; sedimentation; transport of physical, chemical, and biological constituents; coupled stream-aquifer flow systems; physical hydrology for rainfall-runoff relations, stream simulations, channel geometry, and water quality; statistical hydrology for synthetic streamflows, floods, reservoir storage, and water quality; management and operations problems; and water quality problems that result from environmental pollution, such as thermal loading, pesticide pollution, and freshwater eutrophication.

Independent Agencies

Council on Environmental Quality (CEQ)

CEQ has responsibilities for national overviews of environmental quality conditions and trends. To satisfy these responsibilities, CEQ with the cosponsorship of other agencies and organizations, has developed the UPGRADE computerized environmental analysis system. This system of models and data bases is used to analyze water quality, air quality, environmental health, and socioeconomic data. The system permits cross-analysis (e. g., water pollution vs. health) at the county level. It is an interactive system and is completely English-language prompted. Data bases on wide-ranging subject areas are being added to the system in order to broaden and deepen the system's analytical capabilities.

Environmental Protection Agency (EPA)

The responsibilities of EPA include establishing and enforcing environmental standards, conducting research on the impacts of pollution and ways to control it, and assisting CEQ in developing and recommending to the President new policies for protecting the environment.

With respect to water resources, EPA is concerned with providing water supplies that are adequate in quality for all beneficial purposes. The following EPA offices indicated use of water resource models in connection with program responsibilities.

1. Office of Research and Development (ORD)—ORD is actively involved in developing and using water resource mathematical models and predictive techniques. The major thrust of its modeling activity is to develop capabilities to translate water quality standards into maximum allowable pollution loadings, select the most cost-effective combination of controls, and assess environmental risks associated with production, transport, use, and disposal of toxic chemicals. ORD has conducted special studies of the Great Lakes, Chesapeake Bay, James *River,* and other areas where other EPA offices have requested technical assistance.

Two principal types of models have been developed as part of the ORD Great Lakes program. The first, a series of physical/ecological models, focus on the relationship of phytoplankton biomass to nutrient loadings. These models were developed to understand and control accelerated eutrophication in portions of the Great Lakes; they are being used to recommend guidelines for nutrient discharges. The second type of model describes the transport and fate of toxic pollutants introduced into the Great Lakes, in order to determine the levels of control required to keep environmental risks within acceptable levels.

ORD has also developed nonpoint source, toxic pollutant, eutrophication, and circulation models for the Chesapeake Bay. These address the problems of accelerated eutrophication in portions of the bay, the decline of submerged aquatic vegetation, and associated impacts on aquatic life and commerce.

ORD assists EPA's operational programs in selecting and using models to deal with specific problems. These models include urban and rural runoff models and receiving-water quality models. The models are used in determining control requirements to be placed on discharges and in planning studies required under section 208 of the Clean Water Act. ORD also provides technical assistance with the Exposure Analysis Modeling System (EXAMS), a major mathematical model for assessing the primary pathways, persistence, and fate of toxic organic chemicals in freshwater systems.

Future water resource modeling needs ORD is addressing concentrate on providing the capability to assess environmental risks associated with toxic chemicals in ground and surface water, and identifying cost-effective pollution control measures to attain and maintain water quality goals.

2. Office of Water Regulations and Standards (OWRS)—EPA'S OWRS uses some models in developing guidelines for toxic and pretreatment effluent standards pursuant to section 307 of the Clean Water Act. The models OWRS currently uses address three main problem areas: the fate of pollutants discharged into receiving waters, and their effect on water quality; the quantity and quality of runoff from urban and agricultural areas, and its impact on receiving waters; and the economic effects of water pollution regulations on industries.

A principal model in the first category is EXAMS. The Water Quality Analysis Branch of OWRS currently uses EXAMS to evaluate different control strategies for selected pollutants in order to determine whether these pollutants should be subject to best available technology (BAT) requirements or to more stringent controls. The EXAMS model is being used in conjunction with agricultural runoff models, such as ARM-II, and receiving-water quality models, such as QUAL-H, for screening analyses of new pesticides.

Another major use of models of this type is in establishing and enforcing wasteload allocations for National Pollutant Discharge Elimination System (NPDES) permits. These models are used to assess the assimilative capacity of a water body and to relate stream water quality levels to pollutant discharges. The models are also used to determine whether dischargers are complying with permit allocations.

OWRS'S Office of Analysis and Evaluation assesses the economic impact of water pollution regulation on industrial sectors by one of two techniques, depending on industry size. For small industries, the office performs industry-specific financial analyses to determine if compliance with point-source BAT regulations will force firms to close. The office uses econometric models to study larger industries. These models deal with capital requirements, pricing, future demand for products, and the effects of regulation on industry growth.

3. Office of Water Program Operations (OWPO)—Urban and agricultural runoff models are used to a limited degree by the national office of the Water Planning Division of OWPO in planning studies. These models are used at the State level to estimate potential runoff and to evaluate different pollution control strategies, as required under section 208 of the Clean Water Act.

4. OffIce of Water and Waste Management—EPA's Drinking Water Program in the Office of Water and Waste Management has the responsibility to implement provisions of the Safe Drinking Water Act, and it uses some models to improve the decisionmaking process. Under section 1412, for example, it uses health effects models as part of the background *information base for* setting standards and promulgating regulations. These models provide data on the health risk from exposure to contaminants in drinking water. Information from

such models has been used in the standard-setting process for radioactive and organic contaminants. The program also uses economic and benefit/cost models to determine the economic effects of alternative policy and regulatory options on the water supply industry.

Protection of underground sources of drinking water, prescribed in section 1421 of the Safe Drinking Water Act, is also a responsibility of the Drinking Water Program. Hazardous and toxic wastes have frequently been disposed of through injection into underground formations. The program uses models to provide information on the impact of injection practices on the natural system, the costs of constructing new wells, and the economic costs of shutting down existing wells. By comparing regulatory and remedial alternatives available, programs can be developed to balance the risks and costs of contamination prevention measures.

The Drinking Water Program has also conducted a major surface impoundment assessment authorized by section 1442 of the act. The assessment includes a nationwide survey of surface impoundments in order to determine their potential for contaminating ground water. Uniform criteria were developed and used to assess current and potential leakage of contaminants into ground water. These criteria include, among others, type of geology underlying the site, type of waste involved, proximity of aquifers, and capability of soil to attenuate pollutants. Based on data collected, ground water models can be developed to account for these factors in predicting an impoundment's potential for contaminating ground water.

The Drinking Water Program also uses models to evaluate State needs and capabilities in order to determine the appropriate grant amounts States receive under section 1443 of the Safe Drinking Water Act. These are financial models, but they take into consideration such factors as the number and type of injection wells in the State, the number of wells used as part of a water supply system, the geographic area, and the manpower available in the State.

Models have also been used to develop a more complete understanding of sole-source aquifers. These ground water resources may, in some parts of the country, provide the only available source of water. Models provide information on the impact of discharges and other economic activities on these sources of drinking water. Facilities that may adversely affect these aquifers include: leaking underground gasoline storage tanks, waste disposal sites, improper land use, construction of roads and buildings in the recharge zone, and pollution of adjacent streams. Once the relative impacts of sources of contamination are determined and evaluated, EPA works with State agencies and communities to establish and enforce procedures to prevent future aquifer contamination.

5. Office of Toxic Substances (OTS)—EPA'S OTS uses models in several of the programs it carries out under current water resource legislation. The principal focus of its model use is the transport and fate of toxic chemicals released into the aquatic environment. Currently, models are being used in OTS for risk assessment studies, to estimate the movement of pollutants through the environment and their expected environmental concentrations. The office uses models in connection with activities under the Toxic Substances Control Act. Its models help measure the effectiveness of regulatory options in order to set standards according to sections 4, 5, and 6 of the act, which deal with testing, issuing manufacturing and processing notices, and regulating hazardous chemical substances and mixtures.

OTS uses a three-step analysis to determine whether a substance should be regulated, and, if so, how stringent the regulation should be—such regulation could range from labeling a substance as hazardous to banning its use entirely. The office first determines the exposure of human and nonhuman populations to the toxic substance. It then combines this exposure information with estimates of health and ecological effects for various exposures. Finally, the office weighs these costs against the benefits of using the substance. Models are used in accomplishing the first step of the analysis.

In addition to this use of models, OTS uses models to help design chemical testing programs and to develop monitoring studies carried out under provisions of the Toxic Substances Control Act.

OTS is also involved in programs under the Federal Insecticide, Fungicide, and Rodenticide Act of 1972 (Public Law 92-516), and uses models in conducting these programs. In its review of pesticide product registrations, OTS must consider the potential effect of the substance on ground and surface waters. In this connection, OTS uses models to assess pesticide runoff potential and the likelihood of ground water contamination by pesticides, and to predict pesticide concentration in streams. OTS also uses models for advising State and local agencies of the likelihood of ground water contamination by pesticides.

OTS mainly uses the EXAMS model, although its Evaluation Division makes limited use of ARM-II in pesticide screening studies. OTS is developing multimedia (water, air, land) models for preliminary assessments of a chemical's behavior in the environment. These models provide concentration estimates used in the exposure calculations that support risk analysis. The multimedia formulations are capable of accommodating various types of chemicals and modes of release into the environment. In addition, two ground water contamination models are being developed for OTS.

6. Office of Water Enforcement—EPA's Office of Water Enforcement uses models in connection with its

activities under the NPDES permit program and sections 301 and 316 of the Clean Water Act. The NPDES program under section 402 of the Clean Water Act requires issuance of permits to regulate discharge of pollutants into the Nation's waters. Permit limits are either technology or water quality based. When technology-based limits are unavailable or inadequate to meet water quality standards, permits are based on "best professional judgment, ' which may include the use of wasteload allocation or other water quality models. In addition, water quality models, dispersion models, and hydrological models are used to measure compliance with water quality standards.

Under section 316 of the Clean Water Act, which authorizes variances from thermal discharge standards, the office uses predictive studies of entrainment and impingement losses to populations of fish and shellfish in enforcing regulations governing powerplant siting. It also uses fish population models and hydrological models for the cooling intake structures program.

Section 301, which includes environmental and economic variances, demands the use of models when predictive demonstrations are needed to establish ambient concentrations of nonconventional pollutants.

National Science Foundation (NSF)

NSF does not use water resource models, nor does it directly fund the development of specific models. It does, however, fund basic research at universities that may contribute to the formulation of water resource models. Such research may also produce components and mathematical techniques that can be used in developing such models or in checking their scientific validity.

The research NSF funds in the area of water resources is for the purpose of building a firm scientific foundation, wherever possible, for empirical procedures and practices that are used in developing water resource models. Well-known examples are rainfall-runoff relationships and rainfall-soil erosion relationships.

NSF responds only to unsolicited basic research proposals in water resource engineering. During fiscal year 1979, NSF supported hydrologic and water resource studies on hydrologic data, irrigation, planning, flood forecasting, reservoir control, and surface runoff, among others. Any or all of these topics may have models associated with the project.

Water Resources Council (WRC)

WRC encourages Federal, State, and local governments and private enterprise to conserve, develop, and use water and related land resources on a comprehensive and coordinated basis. WRC also conducts periodic national water assessments to identify the Nation's critical water problems.

For its Second National Assessment in 1978, WRC developed a water supply adequacy model. This model is based on the concept of a balance between water use and water supply for both ground and surface water. The model is comprised of 21 water resource regions and 106 subregions. The subregions have data on water inflow or supply from upstream subregions, interbasin imports, precipitation runoff, and ground water. Water uses include interbasin exports, consumption, and evaporation. Ground water recharge is accounted for in the model and is not considered a loss. The hydrologic and water-use data fed into this model were derived through models incorporating precipitation records, runoff estimates, economic growth projections, and other measured or calculated variables at the water-accounting-unit level (352 nationwide). These models were produced or operated for WRC by various Federal, State, and regional agencies.

The water supply adequacy model helped identify several water supply problems. These included shortages resulting from poor distribution of supplies, instream - offstream conflicts, competition among various off-stream users, ground water overdraft, quality degradation of ground and surface water, and institutional conflicts that prevent a unified approach to water management.

WRC'S Water and Energy Program was authorized by the Federal Nonnuclear Energy Research and Development Act of 1974 (sec. 13 of Public Law 93-577), which directs WRC to conduct regional and site-specific water resource assessments of potential energy developments. For this purpose, a number of computerized models have been used by various WRC contractors and other Federal and State agencies, e.g. , the Colorado River System Simulation (CRSS) of the Bureau of Reclamation and the respective models of the White River developed separately by Utah and Colorado. These, and similar models, evaluate flow regime, hydropower impacts, salinity and suspended solids concentrations, and other water quantity and quality changes anticipated from energy developments.

WRC presently evaluates river basin plans pursuant to section 209 of the Clean Water Act. It is testing a model that assesses water quality impacts of existing or proposed river basin management schemes—specifically, in its Yadkin-Pee Dee Level-B study.

Some river basin commissions under the purview of WRC use models to help plan or evaluate projects developed under section 102 of the Water Resources Planning Act. This section deals with regional or river basin plans and programs and their relationship to other considerations. The commissions use models to analyze the impacts of potential projects on water supply, to estimate depleted flows at key gaging stations, and to com-

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pare the cost effectiveness of alternative wasteload reduction strategies.

Federal Emergency Management Agency

The Federal Emergency Management Agency, through the Federal Insurance Administration (FIA), administers the National Flood Insurance Program as established by the National Flood Insurance Act of 1968 (Public Law 90-488). The program provides flood insurance availability to property owners within communities that adopt and enforce minimum flood plain management measures to mitigate future flood losses. The act also requires the identification of flood-prone areas and risk zones within such areas.

Flood insurance studies are conducted for individual communities to establish flood plains, floodways, regulatory flood elevations, and insurance risk zones. These data are often developed using models and are subsequently provided to participating communities as the basis for their flood plain management program. They are also used to establish actuarial flood insurance rates.

Several different hydrologic models have been used by FIA to establish flood flow frequencies and for flood hydrography routing. The most commonly used hydrologic models are the HEC-1 Flood Hydrography Package, developed by the Corps of Engineers, and the TR-20 Computer Program for Project Formulation, developed by SCS. These models simulate the rainfall-runoff process on watersheds and flood hydrography progression in downstream channels.

Several hydraulic models have been used to establish flood elevations and floodways in streams. The most commonly used hydraulic models are the HEC-2 Water Surface Profile Package, developed by the Corps of Engineers, WSP-2 (TR61) and FLDWY (TR-64), developed by SCS, and E431, developed by USGS. These models simulate open channel steady uniform flow using the standard step backwater method.

FIA has also developed two coastal storm surge models, including one for northeasters and one for hurricanes. These models utilize joint probability techniques and coastal hydrodynamic principles to establish regulatory flood elevations on the Atlantic and Gulf coasts of the United States. A finite element model has also been established to simulate storm surges in the Chesapeake Bay.

Nuclear Regulatory Commission (NRC)

NRC water resource activities are related to determining hydrologic factors in nuclear facility site evaluations, ecological effects of water use, and radionuclide transport in ground and surface waters. NRC has used models in connection with all of these programs. For example, to comply with regulations under section 102 of the National Environmental Protection Act, NRC used models to evaluate powerplant intake effects on Hudson River striped bass.

NRC has specific responsibilities under the Uranium Mill Tailings Radiation Control Act and the Atomic Energy Act. Under the first act, NRC uses models to determine the movement and concentration of ground water pollutants from uranium mill tailings. Information provided by these models was used to prepare a generic environmental impact statement on uranium milling and associated rule changes. NRC also uses models to support various licensing actions. Models help support licensing decisions for uranium mills, tailings disposal systems, and uranium extraction operations. Models also help measure compliance with regulations and license conditions.

Under the Atomic Energy Act, NRC uses models to help it evaluate proposed sites for nuclear powerplants, fuel cycle facilities, and waste disposal sites. Models are used to help determine whether a plant's water supply is adequate for safety-related functions, as specified in regulations. NRC also uses models to evaluate whether proposed nuclear facilities are in compliance with regulations governing flood protection.

Models have been used by NRC in carrying out its responsibilities under the Atomic Energy Act to limit radioactive liquid effluents to ground and surface waters. NRC is using models to help prepare an EIS and to formulate proposed regulations governing the disposal of low-level radioactive waste and low-activity bulk solid waste. The models are presently being used to evaluate siting criteria and alternative disposal techniques in terms of radionuclide transport and concentrations at site boundaries. When disposal site regulations are adopted, site-specific models will be used to determine whether adequate protection exists to prevent radionuclide migration from exceeding acceptable limits. Models are also used to help determine whether other types of nuclear facilities are in compliance. These models help evaluate potential concentrations of radionuclides in ground and surface waters as a result of both accidental and normal releases.

NRC provides assistance to States in the use of models to evaluate radionuclide migration from disposal sites. This is done as part of the agreement State program, through which certain States, pursuant to section 274 of the Atomic Energy Act, have entered into an agreement with NRC for assuming regulatory control of byproduct, source, and small quantities of special nuclear materials.

ATTACHMENT I.—REFERENCES BY AGENCY

Department of Agriculture

Economics and Statistics Service

1. Dyke, P., and Hagen, L., Resource Systems Program, Natural Resource Economics Division, *Economics*, Statistics, and Cooperative Service, USDA, *Land and Water Resource and Economic Modeling System*, *LA WREMS Directoxy*, version 1, January 1979.
2. Land and Water Conservation Task Force, "LAWREMS, Land and Water Resources and Economic Modeling System, Current Capabilities, Conceptual System, Future Options, Final Draft, " USDA, December 1978.
3. Weisz, R. N., National Systems Section, Natural Resource Economics Division, Economic, Statistics and Cooperative Service, USDA, October 1979.

Forest Service

4. Forest Service, USDA (unknown title), sec. 2, Hydrologic and Soils Simulation Programs, pp. 32-65.
5. Group Leader, Watershed Systems Development Group, Forest Service, USDA, Userguide Abstracts.

Science and Education Administration

6. Data Systems Application Division of Agricultural Research Service, USDA, *File of A.gricultural Research Models (FARM)*, November 1977.
7. Knisel, W. G., "A Field Scale Model for Estimating Chemicals, Runoff, and Erosion From Agricultural Management Systems, Science and Education Administration, USDA.
8. Wischmeier, W. H., and Smith, D. D., "Predicting Rainfall Erosion Losses—A Guide to Conservation Planning, Science and Education Administration, USDA, agriculture handbook No. 537, 1978.

Soil Conservation Service

9. Ecology Simulations, Inc. , Athens, Ga. , "SECWATS: A Simulation Concept and Model for Assessment, Evaluation and Optimization of Southeastern Coastal Plain Stream Modification Projects, With Application to Horse Range Swamp, South Carolina. " contract No. AG SCS-001 11, submitted to: SCS, USDA, June 1, 1978.
10. King, Arnold D., "Universal Soil Loss Equation, Soil Conservation Service, 1979.
11. Pasley, R. M., Dempster, T., Stierna, J., Caldwell, B., King, A., and Evans, G., interviews with Soil Conservation Service and USDA personnel, Aug. 30, 1979.
12. Soil Conservation Service, "Executive Summary of Responses to Objectives, USDA, Oct. 19, 1979.
13. Soil Conservation Service, Farmer Decision and Conservation Simulation Model, draft RLC: PEB, USDA, Aug. 23,1979.
14. Soil Conservation Service and Stanford Research Institute, draft, "Documentation of the SRI Methodology for RCA Evaluation, September 1979.
15. Soil Conservation Service, West Technical Service Center, *User's Guide to the Irrigation Method Analysis Program, IRMA,* Colorado River Basin Salinity Control Studies and Irrigation Planning, USDA, February 1978.
16. Metcalf and Eddy, Inc. (sponsored in part by USDA), *Process Design Manual for Land Treatment of Municipal Wastewater,* October 1977.
17. Soil Conservation Service, USDA, "Land Damage Analysis, " attachment, 1976.
18. Soil Conservation Service, Engineering Division, WSP-2 *Computer Program*, technical release No. 61, USDA, May 1976.
19. Soil Conservation Service, Special Projects Division, *User Guide to the SCS Automated Irrigation Water Use Requirements Model Utilized in the 1975 National Water Assessment Program*, USDA, May 1975.
20. Soil Conservation Service, Engineering Division, *Urban HydroZogy for Small Watersheds*, technical release No. 55, USDA, January 1975.
21. Soil Conservation Service, ' 'Urban Floodwater Damage, Economic Evaluation, attachment 28, USDA, 1976.
22. Soil Conservation Service, Engineering Division, *Computer Program for Project Formulation, Structure Site AnaZysis*, technical release No. 48, USDA, February 1971.
23 Soil Conservation Service, Economics Division, ECON2, Economics—Floodwater Damages, program description, Apr. 1, 1969.
24, Soil Conservation Service, Engineering Division, *Computer Program for Project Formulation, Hydrology*, technical release No. 20, 1965.

25. Soil Conservation Service, Applied Conservation Effects System, briefing paper, USDA.

Department of Commerce

NOAA: National Weather Service

26. Curtis, D. C., and Schaake, Jr., J. C., "The NWS Extended Streamflow Prediction Technique, " presented at the Engineering Foundation Conference: Water Conservation-Needs and Implementation Strategies, held at Franklin Pierce College, Rindge, N. H., July 9-13, 1978.
27. Fread, D. L., ' 'National Weather Service Operational Dynamic Wave Model, presented at Numerical Modeling for Engineers Symposium, Vicksburg, Miss., U.S. Army Corps of Engineers, Waterways Experiment Station, Apr. 17-21, 1978.
28. Fread, D. L., ' 'The NWS Dam-Break Flood Forecasting Model, presented at Dam-Break Modeling Seminars at Kansas City, Mo., Sept. 18-22, 1978.
29. Hydrologic Research Laboratory, National Weather Service River Forecast System Forecast Procedures, NOAA technical memorandum NWS-HYDRO-14, Silver Sring, Md., Department of Commerce, 1972.
30. Krsysztofowicz, R., Davis, D. R., Ferrell, W. R., Hosne-Sanaye, S., Perry, S. E., and Robotham, H. R., "Evaluation of Flood Forecasting Response Systems II, report to Hydrology Laboratory, Office of Hydrology, National Weather Service, NOAA, Department of Commerce, contract No. 6-35229, Reports on Natural Resource Systems No. 33, University of Arizona, Tucson, Ariz., 1979.
31. Office of Hydrology, National Weather Service, "Response to OTA Questionnaire: Task Force on Water Resource Modeling in Federal Agencies, personal correspondence, October 1979.
32. Ostrowski, J. T., National Weather Service, "Products Useful for Reservoir Regulation, " Hydrologic Research Laboratory, National Weather Service, NOAA, Silver Spring, Md., mimeograph, 1979.
33. Peck, E., and Hudlow, M., staff, Ofilce of Hydrology, National Weather Service, NOAA, Department of Commerce, personal interview, Aug. 29, 1979.
34. Schaake, Jr., J. C., "Use of Mathematical Models for Hydrologic Forecasting in the National Weather Service, " in *Proceedings of the EPA Conference on Environmental Modeling and Simulation,* W. R. Ott (cd.), report No. EPA-600 /9-76-106 (Cincinnati, Ohio: Environmental Protection Agency, 1976).
35 Twedt, T. M., Schaake, Jr., J. C., and Peck, E. L., "National Weather Service Extended Streamflow Prediction, " in *Proceedings of the Western Show Conference,* Albuquerque, N. M., Apr. 19-31, 1977.

Department of Defense

U.S. Army Corps of Engineers

36. Boyd, M. B., "Response to OTA Questionnaire: Task Force on Water Resource Modeling in Federal Agencies, personal correspondence, October 1979.
37. Eichert, B. S., and Bonner, V. R., HEC Contribution to Reservoir System Operation, technical paper No. 63 (Davis, Calif.: Hydrologic Engineering Center, U.S. Army Corps of Engineers, August 1979).
38 Gundlach, D. L. and Thomas, W. A., "Guidelines for Calculating and Routing a Dam-Break Flood, " research note No. 5 (Davis, Calif.: Hydrologic Engineering Center, U.S. Army Corps of Engineers, May 1977).
39, Hydrologic Engineering Center, Urban Stormwater Runoff 'STORM, Generalized Computer Program 723-58-62520 (Davis, Calif., Hydrologic Engineering Center, U.S. Army Corps of Engineers, May 1976).
40, Hydrologic Engineering Center, Computer Program Abstracts (Davis, Calif.: Hydrologic Engineering Center, U.S. Army Corps of Engineers, December, 1978).
41, Hydrologic Engineering Center, "Response to OTA Questionnaire: Task Force on Water Resource Modeling in Federal Agencies, personal correspondence, October 1979.
42, Robey, D. L., "Response to OTA Questionnaire: Task Force on Water Resource Modeling in Federal Agencies, personal correspondence, October 1979.
43, Roesner, L. A., Nichandros, H. M., and Shubinski, R. P., "A Model for Evaluating Runoff-Quality in Metropolitan Master Planning, technical paper No. 58 (Davis, Calif.: Hydrologic Engineering Center, U.S. Army Corps of Engineers, April 1974).
44, Walski, Thomas M., "MAPS-A Planning Tool for Corps of Engineers Regional Water Supply Studies, " Water Resources Bulletin, vol. 16, No. 2, April 1980.

Department of Energy

Office of the Environment

45, Osterhoudt, Frank H., "Response to OTA Questionnaire: Task Force on Water Resource Modeling in the Federal Agencies, personal correspondence, November 1979.

46, Owen, P. T., Dailey, N. S., Johnson, C. A., and Martin, F. M., ' 'An Inventory of Environmental Impacts Models Related to Energy Technologies, ORNL/EIS-147, February 1979.

47, Shepard, A. D., "A Spatial Analysis Method of Assessing Water Supply and Demand Applied to Energy Development in the Ohio River Basin, " ORNL/TM-6375, August 1979.

48, Shriner, C. R. and Peck, L. J. (eds.), "Inventory of Data Bases, Graphics Packages, and Models in Department of Energy Laboratories, " ORNL/EIS-144, November 1978.

49, Shriner, C. R. and Peck, L. J. (eds.), "Water Resource Management, Planning and Policy Models in Department of Energy Laboratories, November 1978.

Department of the Interior

Bureau of Land Management

50. Bureau of Land Management, ' 'Water Resource Modeling in the Bureau of Land Management, personal correspondence, 1979.

Bureau of Mines

51. Bloomsburg, G. L. and Wells, R. D., "Seepage Through Partially Saturated Shale Wastes: Final Report, contract No. H0252965, September 1978.

52. Bureau of Mines, ' 'Response to OTA Questionnaire: Task Force on Water Resource Modeling, personal correspondence, November 1979.

53. Hittman Associates, Inc., "Monitoring and Modeling of Shallow Groundwater Systems in the Powder River Basin: Second Annual Technical Report, " No. H-D0166-78-757F, February 1979.

Office of Water Research and Technology

54. Reefs, Theodore G., ' 'Response to OTA Questionnaire: Task Force on Water Resource Modeling, " personal communication, October 1979.

U.S. Fish and Wildlife Service

55. Hyra, Ronald, ' 'Methods of Assessing Instream Flows for Recreation, " FWS/ORS-78/34, Fish and Wildlife Service, Fort Collins, Colo. , June 1978.

56. U.S. Fish and Wildlife Service, annotated list of water resource models developed for or by the U.S. Fish and Wildlife Service, 1979.

57. U.S. Fish and Wildlife Service, "Response to OTA Questionaire: Task Force on Water Resource Modeling, personal correspondence, October 1979.

U.S. Geological Survey

58. Appel, Charles A., and Bredehoeft, John D., "Status of Ground-Water Modeling in the U.S. Geological Survey, " Geological Survey circular No. 737, 1976.

59. Baltzer, Bob, personal interview, August 1979.

60. Carrigan, Hadley, personal interview, August 1979.

61. Faust, Charles R. and Mercer, James W., "Finite-Difference Model of Two-Dimensional Single- and Two-Phase Heat Transport in a Porous Medium —version 1, U.S. Geological Survey report 77-234, 1977.

62. Federal Interagency Work Group on Water Quality Data Needs for Small Watersheds, "Water Quality Data Needs for Small Watersheds: Surface Water Data, Draft, ' August 1978.

63, Grove, David B., ' 'Ion Exchange Reactions Important in Groundwater Quality Models, " symposium proceedings, Advances in Groundwater Hydrology, 1976.

64. Jackman, Alan P. and Yotshkura, Nobuhiro, "Thermal Loading of Natural Streams, " U.S. Geological Survey professional paper 991, 1977.

65. Jennings, Marshall E. and Yotshkura, Nobuhiro, "Status of Surface-Water Modeling in the U.S. Geological Survey, ' Geological Survey circular No. 809, 1979.

66. Konikow, Leonard F., "Modeling Chloride Movement in the Alluvial Aquifer at the Rocky Mountain Arsenal, Colorado, " U.S. Geological Survey water supply paper 2044, 1977.

67. Konikow, L. F. and Bredehoeft, J. D., "Computer Model of Two-Dimensional Solute Transport and Dispersion in Ground Water, USGS book 7, ch. 2, 1978.

68. Konikow, Leonard F., and Bredehoeft, John D., "Modeling Flow and Chemical Quality Changes in an Irrigated Stream-Aquifer System, Water Resources Research, vol. 10, No. 3, June 1974.
69. Laird, L. B., "Response to OTA Questionnaire: Task Force on Water Resource Modeling in the Federal Agencies, " personal correspondence, October 1979.
70. Larson, Steve, personal interview, August 1979.
71. McKenzie, Stuart W., et al., "Steady-State Dissolved Oxygen Model of the Willamette River, Oregon, " U.S. Geological Survey circular 715-J, 1979.
72. Plummer, L. Niel, et al., " WATEQF-A FORTRAN IV Version of WATER, A Computer Program for Calculating Chemical Equilibrium of Natural Waters, " USGS, Water Resources Investigations 76-13, September 1976.
73, Trescott, Peter C., "Documentation of Finite-Difference Model for Simulation of Three-Dimensional Ground-Water Flow, " U.S. Geological Survey report 75-438, September 1975.
74. Rickert, David A., and Hines, Walter G., "River Quality Assessment: Implications of a Prototype Project, ' *Science,* vol. **200,** pp. 1113-1118, June 1978.
75. Trescott, Peter C., "Documentation of Finite-Difference Model for Simulation of Three-Dimensional Ground-Water Flow, U.S. Geological Survey report 75-438, September 1975.
76 Trescott, P. C., Pinder, G. F., and Larson, S. P., "Finite-Difference Model for Aquifer Simulation in Two Dimensions with Results of Numerical Expediments, " ch. 1, book 7 of *Techniques of Water-Resources Investigations of the U.S. Geological Survey.*
77. U.S. Geological Survey, "Computer Programs for Modeling Flow and Water Quality of Surface Water Systems, " September 1978.

Bureau of Reclamation

78. Bureau of Reclamation, "Response to OTA Questionnaire: Task Force on Water Resource Modeling, " personal communication, November 1979.
79. Bureau of Reclamation, "Response to OTA Questionnaire: Task Force on Water Resource Modeling in Federal Agencies, personal correspondence, October 1979; Bureau of Reclamation, Bureau of Reclamation Economic Assessment Model (BREAM) Technical Description, January 1978; Ribbens, Richard W., Technical Description of Return Flow Quality Simulation Model, Water and Power Resources Service, January 1980.

Independent Agencies

Council on Environmental Quality

80 Buffington, J. D., Milask, L. J., "An Overview of the UPGRADE Data Analysis System.
81 CEQ Executive Summary, response for OTA Water Resources Workshop.
82 C E ~ " 'Strawman' Responses to Objectives of the OTA Task Force on Water Resourses Modeling, " Oct. 24-25, 1979.

EPA: Office of Research and Development

83. Office of Research and Development, "Response to OTA Questionnaire: Task Force on Water Resource Modeling in Federal Agencies, personal correspondence, October 1979.
84. Richardson, W. L., and Thomas. N. A.. "A Review of EPA's Great Lakes Modeling 'Program, " in *Proceedings of the EPA Conference on Environmental Modeling and Simulation,* W. R. Ott (cd.), report No., EPA-600/9-76-106 (Cincinnati, Ohio: Environmental Protection Agency, 1976).

EPA: Office of Toxic Substances

85. Wood, B., "Response to OTA Questionnaire: Task Force on Water Resource Modeling in Federal Agencies, personal correspondence, October 1979.
86. Survey and Analysis Division, Office of Toxic Substances, "Response to OTA Questionnaire: Task Force on Water Resource Modeling in Federal Agencies, personal correspondence, October 1979.
87. Zweig, G., "Response to OTA Questionnaire: Task Force on Water Resource Modeling in Federal Agencies, personal correspondence, October 1979.

EPA: Office of Water Planning and Standards

88. Athway, D., and Somers, P., staff, Urban Runoff Program, Implementation Branch, Water Planning Division, Office of Water Planning and Standards, EPA, personal interview, Aug. 17, 1979.
89. Cogger, B., "Response to OTA Questionnaire: Task Force on Water Resource Modeling in Federal Agencies, personal correspondence, October 1979.
90. Dupuis, L., staff, Office of Analysis and Evaluation, Water Planning and Standards, EPA, personal interview, Aug. 17, 1979.

91. Ehreth, D., Callahan, M., Frederick, R., and Slimak, M., staff, Water Quality Analysis Branch, Monitoring and Data Support Division, Office of Water Planning and Standards, EPA, personal interview, Aug. 17, 1979.
92. Myers, C., staff, Implementation Branch, Water Planning Division, Office of Water Planning and Standards, EPA, personal interview, Aug. 17, 1979.
93 Office of Analysis and Evaluation, "Response to OTA Questionnaire: Task Force on Water Resource Modeling in Federal Agencies, personal correspondence, October 1979.
94. Stuart, T., Chief, Monitoring Branch, Office of Water Planning and Standards, EPA, personal interview, Aug. 17, 1979.
95. Swader, F., staff, Agricultural Runoff Program, Implementation Branch, Water Planning Division, Office of Water Planning and Standards, EPA, personal interview, Aug. 22, 1979.
96 Water Quality Analysis Branch, "Response to OTA Qestionnaire:" Task Force on Water Resource Modeling in Federal Agencies, personal correspondence, October 1979.

EPA: General References

97. Beckers, C. V., Parker, P. E., Marshall, R. N., and Chamberlain, S. G., " RECEIV-11, A Generalized Dynamic Planning Model for Water Quality Management, in *Proceedings of the EPA Conference on Environmental Modeling and Simulation,* W. R. Ott (cd.), report No. EPA-600/9-76-100 (Cincinnati, Ohio: Environmental Protection Agency, 1976).
98< Environmental Protection Agency, "A Statistical Method for the Assessment of Urban Stormwater, report No. EPA 440/3-79-023, prepared for Environmental Protection Agency, Washington, D. C., May 1979.
99. Falco, J. W., and Mulkey, L. A., "Modeling the Effect of Pesticide Loading on Riverine Ecosystems, " in *Proceeding-s of the EPA Conference on Environmental Modeling and Simulation,* W. R. Ott (cd.), report No. EPA-600/9-76- 106 (Cincinnati, Ohio: Environmental Protection Agency, 1976).
100. Leytharn, K. M., and Johnson, R. C., "Watershed Erosion and Sediment Transport Model, Report No. EPA-600/3-79-028, prepared for Environmental Protection Agency, Athens, Ga. , March 1979.
101. Pechan, E. H., and Luken, R. A., "Watershed Erosion and Sediment Transport Model, ' report No. EPA-600/3-79-028, prepared for Environmental Protection Agency, Athens, Ga., March 1976.
102. Taylor, P. L., "STORET: A Data Base for Models, " in Workshop on Verification of Water Quality Models, report No. EPA-600/9-80-016, prepared for Environmental Protection Agency, Athens, Ga., April 1980.
103 True, H. A., ' 'Planning Models for Non-Point Runoff Assessment, in *Proceedings of the EPA Conference on Environmental Modeling and Simulation,* W. R. Ott, (cd.), report No. EPA-600/ 9-76-106 (Cincinnati, Ohio: Environmental Protection Agency, 1976).
104 Versar, Inc., " Environmental Assessment of Priority Pollutants: A Review of Evaluative Models in Assessing the Fate of Pollutants, Final Report, contract No. 68-01-3852, prepared for Environmental Protection Agency, Washington, D.C. February 1979.

National Science Foundation

105. Ezra, A. A., "Executive Summary and 'Strawman' Responses to Objectives of the OTA Task Force on Water Resource Modeling, ' Oct. 24-25, 1979.

Water Resources Council

106. Walker, Lewis D., Water Supply Adequacy Analysis Model, for the OTA Task Force on Water Resource Modeling in the Federal Agencies, Oct. 24-25, 1979.

General References

107. Brandstetter, A. G., ' 'Assessment of Mathematical Models for Storm and Combined Sewer Management, report No. EPA-600/2-76- 175a, prepared for Environmental Protection Agency, Cincinnati, Ohio, August 1976.
108. Bugliarello, G., and Gunther, F. C., *Developments in Water Science I: Computer Systems and Water Resources (New* York: Elsevier Publishing Co., 1974).
109 Chung, Sang Chu, et al., *Computer programs in Water Resources,* Minnesota University Water Resources Research Center, November 1977.
110, Grimsrud, G, Paul, et al., *Evaluation of Water Quality Models: A Management Guide for Planners* (Palo Alto, Ca]if.: Systems Control Inc., 1976).
111, Hinson, M. O., and Basta, D. J., "Analyzing Receiving Water Systems, " in Analysis for Residuals

—Environmental Quality Management: Analyzing Natural Systems, Resources for the Future, D. J. Basta and B. T. Bower (eds.), Washington, D. C,, prepared for the Office of Research and Development, Environmental Protection Agency, December 1979.

112 Horton, M. L., et al., *Analysis and Dissemination of Water Resources Information*, South Dakota State University Water Resources Institute, 1979.

113 Huber, W. C., and Heaney, J. P., "Analyzing Residuals Generation and Discharges From Urban and Nonurban Land Surfaces, in Analysis for Residuals-Environmental Quality Management: Analyzing Natural Systems, Resources for the Future. D. 1. Basta and B. T. Bower (eds.\. Washington, D. C., prepared for the Office of Research and Development, U.S. Environmental Protection Agency, December 1979.

114. Marks, David H., "Models in Water Resources, in A Guide to Models in Governmental Planning and Operations, EPA, August 1974.

115. U.S. Environmental Protection Agency, *Environmental Modeling and Simulation,* Washington, D. C., Office of Research and Development and Office of Planning and Management, EPA-600/ 9-76-016, 1976.

116, Viessman, W., Jr., Knapp, J. W., Lewis, G. L., and Harbaugh, T. E., *Introduction to Hydrology,* 2d ed. (New York: Harper & Row, 1977).

ATTACHMENT II.—SURVEY OF FEDERAL AGENCY MODEL USE RELATED TO MAJOR LEGISLATION

July 14, 1980

CONGRESS OF THE UNITED STATES
Office of Technology Assessment
Washington, D C 20510

OTA Survey of Model Use
in Major Federal Water
Resources Programs

Survey Instructions

The survey consists of two major parts: Part I, a Water Program Checklist; and Part II, Individual Program Questionnaires.

The Water Program Checklist provides information on model use in programs with which your office is actively involved. By involvement we mean any water resources programs your office has direct responsibility for or routinely deals with. Involvement includes program activities such as enforcement of regulations, compliance with regulations, operations and management, etc. A more complete list of activities appears on the Individual Program Questionnaire.

The Individual Program Questionnaire provides information on the purposes for which models are used in the program. Completing the Checklist will indicate which Questionnaires should be filled out.

Specific Instructions

Part I: Water Program Checklist

1. Column One - Program Involvement

   Check the boxes corresponding to programs with which your office is activity involved.

2. Column Two - Model Use

   Check the boxes corresponding to programs with which your office is actively involved and in which models are used. The term "model" refers to formal models, primarily mathematical models.

3. Last Row - Additional Programs

   Space is provided at the bottom of the Water Program Checklist to add any unlisted water resources programs with which your office is actively involved.

Part II: Individual Program Questionnaires

1. Individual Questionnaire (Limit Five)

   Complete one Questionnaire for each program that has both columns checked in Part I, the Water Program Checklist. If more than five programs qualify, choose the five water resources programs with which your office is most involved, and complete questionnaires for only those five programs.

2. Program Title and Legislative Authorization

Fill in the program title at the top of each questionnaire. Provide the authorization if it is not on the Water Program Checklist or other than authorization listed.

3. Complete the Questionnaire(s)

A partial example questionnaire is given below:

PROGRAM: Thermal discharges

Legislative Authorization - Public Law 95-217

Activity	Specific Purpose Models are Used	Relevant Section of Law, Rule, Regulation or Agency Guideline	Name of Model(s) or Generic Type
Enforce Regulations, Standards, Guidelines	Power Plant Siting	Section 316	temp. models USP and WRECEV

4. Additional Comments - Any additional comments may be written on the back of the Individual Program Questionnaires.

If you have any questions about the survey, please do not hesitate to call Robert Friedman, Project Director, at (202) 224-7031.

Please mail the completed Water Program Checklist and Individual Program Questionnaire(s) to:

Dr. Robert M. Friedman
Project Director
Office of Technology Assessment
U.S. Congress
Washington, D.C. ?(-151~

PART I: WATER PROGRAM CHECKLIST

Column One Program Involvement	Column Two Model Use		Section
		FEDERAL WATER POLLUTION CONTROL ACT AMENDMENTS OF 1972 (AS AMENDED BY THE CLEAN WATER ACT OF 1977)	
[ ]	[ ]	Grants for pollution control programs	S. 106
[ ]	[ ]	Mine water pollution control programs	s. 107
[ ]	[ ]	Grants for construction of treatment works	s. 201
[ ]	[ ]	Areawide waste treatment management	S. 208
[ ]	[ ]	Basin planning	S. 209
[ ]	[ ]	Water quality related effluent limitations	S. 302
[ ]	[ ]	Water quality standards and implementation plans	s. 303
[ ]	[ ]	Toxic and pretreatment effluent standards	s. 307
[ ]	[ ]	Oil and hazardous substances liability	s. 311
[ ]	[ ]	Clean lakes	s. 314
[ ]	[ ]	Thermal discharges and exemptions	S. 316
[ ]	[ ]	Guidelines. . . permits for dredged or fill material	s. 404
[ ]	[ ]	Disposal of sewage sludge	s. 405
		SAFE DRINKING WATER ACT	
[ ]	[ ]	Protection of underground sources of drinking water	S. 1421
[ ]	[ ]	Special study and demonstration project grants for waste water reuse, reclamation and recycling processes	s. 1444
		TOXIC SUBSTANCES CONTROL ACT	
[ ]	[ ]	Testing of chemical substances and mixtures	s. 4
[ ]	[ ]	Regulation of hazardous chemicals and mixtures	S. 6

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Column One Program Involvement	Column Two Model Use		Section
		RESOURCE CONSERVATION AND RECOVERY ACT	
[1	[1	**Solid waste management guidelines**	S. 1008
[1	[1	**Identification and listing of hazardous wastes**	s. 3001
[1	[1	**Standards for owners and operators of hazardous** waste **treatment, storage and disposal facilities**	s. 3004
[1	[1	Consolidated permits for hazardous waste management facilities	s. 3005
[1	[1	Grants for state resource recovery and conservation plans	S. 4008
[1	[1	Full scale demonstration facilities grants	S. 8004
[1	[1	Resource recovery systems and improved solid waste disposal facilities	s. 8006
		ENDANGERED SPECIES ACT	
[ ]	[1	Minimizations of impacts of Federal activities modifying critical habitats	s. 7
		SURFACE **MINING CONTROL** AND RECLAMATION ACT	
[1	[1	Surface coal mine reclamation permitting	*S. 506*
[1	[1	Environmental protection performance standards for surface coal mine reclamation	s. 515
		SOIL AND WATER RESOURCE CONSERVATION ACT OF 1977	
[1	[1	Data collection about soil, water and related resources	s. 5
[1	[1	Soil and water conservation programs	S. 6
		WATER RESOURCES PLANNING ACT	
[1	[1	Regional or river basin plans and programs and their relation to larger region requirements	s. 102
[1	[1	Coordinating Federal water and related land resources programs and policies	s. 102

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Column One Program Involve- ment	Column Two Model Use		Section
		COASTAL ZONE MANAGEMENT ACT	
[1	[1	State coastal zone land and water resources management program development and management grants	s. 305
		EXECUTIVE ORDER 11988	
[1	[1	Floodplain management	S. 2&3
		FLOOD CONTROL ACT OF 1936 AND AMENDMENTS	
[1	[1	Flood control structures	S. 1,2,3
		WATER RESOURCES DEVELOPMENT ACT OF 1974	
[1	[1	Nonstructural measures	s. 73
		FEDERAL RECLAMATION ACT OF 1902 AND AMENDMENTS	
[1	[1	Irrigation distribution systems	(43 U.S.C. 421)
[1	[1	Construction of small projects	(43 U.S.C. 422)
		OTHER ACT ____________	
[1	[1	Other Programs ____________	S.
[1	[1	____________	S.
[1	[1	____________	S.
		OTHER ACT ____________	
[1	[1	Other Programs ____________	S.
[1	[1	____________	S.
[1	[1	____________	S.

PART I I : INDIVIDUAL PROGRAM QUESTIONNAIRE

PROGRAH ____________________
(fill inonly one program on each Questionnaire)

Legislative authorization ____________________
(If not on OTA program list or other than authfi~zation listed on Water Program Checklist)

Respondent _ _ _ _ _

OffIce ________ ________

Agency _ _ _ _ ________ _

Phone Number ____________________

Actlvlties	Specific Purposes for which Models are Used	Relevant Section of Law, Rule, Regulation or Agency Guideline	Name of Model($) or Generic Type
Program Planning and Scope			
Promulgate Regulations, Set Standards, Oevelop Guidelines			
Enforce Regulations, Standards, Guidelines			
Comply with Regulations, Standards, Guidelines			
Plan or Evaluate Projects, Activities			
Allocate Plannlng or ConstructIon Funds			
State or Local Advisory Assistance			
Operation and Management			
Other Program Activities			