

NATIONAL RESEARCH COUNCIL
WATER SCIENCE AND TECHNOLOGY BOARD
DRAFT MINUTES
SEVENTEENTH MEETING--DECEMBER 12-13, 1988
NAS CECIL & IDA GREEN BUILDING
WASHINGTON, D.C.

ATTENDANCE

Board Members

Michael C. Kavanaugh, Chairman
Stephen J. Burges
Richard A. Conway
James P. Heaney
R. Keith Higginson
Howard C. Kunreuther (12/12)
G. Richard Marzolf
Robert R. Meglen

James W. Mercer
Betty H. Olson
P. Suresh Chandra Rao
Gordon G. Robeck
Patricia L. Rosenfield (12/12)
A. Dan Tarlock
James R. Wallis

Absent

Luna B. Leopold

WSTB Staff

Stephen D. Parker
Sheila D. David
Chris Elfring

Wendy L. Melgin
Jeanne Aquilino

Liaison Representatives and Guests

Charles Blankstein, Consultant to US Agency for International Development
(12/12)
Steve Cordle, USEPA
Mara Dean, Office of Surface Mining (12/12)
Peter S. Eagleson, MIT, CPSMR, Chairman - Committee on Opportunities in the
Hydrologic Sciences (12/12)
Ron Hoffer, USEPA (12/12)
John Hurley, Board on Science and Technology for International Development
(12/12)
S. Bala Krishnan, USEPA (12/13)
Lyndon Lee, USEPA (12/12)
Edgar Nelson, Soil Conservation Service
Frank Osterhoudt, USDO
Brent Paul, BuRec
Richard Porter, BuRec

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John Randall, US Nuclear Regulatory Commission (12/12)
William Roper, USCOE (12/12)
Larry Schmidt, US Forest Service
Charles Smith, Corps of Engineers
Alfred Whitehouse, Office of Surface Mining (12/12)
William Wood, Purdue University, Chairman, Committee on Coastal Erosion Zone
Management (12/12)

December 12, Monday

CALL TO ORDER AND INTRODUCTIONS

Chairman Michael Kavanaugh convened the seventeenth meeting of the NRC's Water Science and Technology Board at 8:30 a.m. on December 12 in the Green Building, Wisconsin Avenue, Washington, D.C. Following the call to order, members, staff, and guests introduced themselves.

DISCUSSION OF STUDY OF OPPORTUNITIES IN THE HYDROLOGIC SCIENCES WITH CHAIRMAN

P.S. EAGLESON The Board's study of Opportunities in the Hydrologic Sciences is approximately half complete (having begun in January 1988 and expected to be done by December 1989), and the opportunity was taken to discuss progress of the committee with its chairman Peter S. Eagleson (MIT). Prof. Eagleson made a presentation of approximately 30 minutes describing the study's genesis, committee membership, goals, report development, and a variety of "outreach" efforts. The committee's report is more than half drafted, covering research frontiers and hydrologic data. Still to be addressed are issues of education and priorities for research. Various information gathering attempts and assessment/surveys (e.g. federal research funding, profiles of hydrologists) are being carried out by the staff. Eagleson, S. Burges (WSTB ex officio), and S. Parker all indicated that progress was steady and satisfactory. A discussion of about 20 minutes followed Eagleson's presentation. The discussion focused on the impacts and applications of the final report. Also the need for a concise summary or digest that government managers can understand and implement was discussed, as only a portion of the audience can be expected to read a 250 ± page report. It was brought up that S. Burges would be retiring from the WSTB before completion of this study; he would have to be replaced as ex officio member of the committee. Also, Suresh Rao volunteered to serve as peer reviewer for the draft report, expected in the

fall of 1989. The committee and staff have been creating and revising sections of chapters 1 through 4 and will focus on most of the remaining chapters at the March 2-4 meeting in Irvine, California.

HOUSEKEEPING (these had been deferred to accommodate P.S. Eagleson's schedule)

Minutes. Minutes of the Board's sixteenth meeting, August 18-19, 1988 in Irvine were approved, subject to a few minor corrections and addition of material describing potential new activities.

Future Meeting Schedule. Up-coming WSTB meetings are scheduled as follows:

- (1) 18th Meeting; April 20-21, 1989; Washington, D.C. (combined with colloquium)
- (2) 19th Meeting; September 14-15, 1989; Woods Hole, Massachusetts (NAS Study Center)
- (3) 20th Meeting; February 15-16, 1990; Washington, D.C.

Membership. S. Parker explained that the terms of appointment for six members of the Board (Burgess, Conway, Higginson, Leopold, Mercer, and Robeck) were scheduled to end June 30, 1989. The process of identifying nominees was then reviewed and subsequently members turned in approximately 60 suggestions for the six slots. These will be organized and tabulated by staff and assessed by the end of February 1989 by a nominating committee on M. Kavanaugh, R. Conway, P. Rosenfield, and S. Parker.

Agenda. The meeting agenda was then reviewed and, with some adjustments, adopted.

Chairman's Remarks. Chairman Kavanaugh reviewed briefly the Board's program of activities, present and projected. He noted that most all members were engaged in project-level activities in some capacity (development, committee member, ex officio, etc.) and encouraged continuation of this tradition. He encouraged members to continue to play advocacy roles for developing activities and to pursue controversial items aggressively.

REVIEW OF EXISTING STUDIES

Committee on USGS Water Resources Research. Betty Olson (committee chair) summarized the activities of this committee. While the committee would continue to keep abreast of items such as climate change and hydrology, National Water Quality Assessment Program, the "institutes and grants" programs, a major new thrust would be the USGS National Research Program, i.e. both matters of science and program process (reviews, priorities, people, etc.). Parker added that membership changes were scheduled to occur and new members of the committee were announced. The Board thanked B. Olson for her four years of service on the committee, including the last two as chair, as she will be replaced by Walter R. Lynn. R. Marzolf suggested that the committee can serve to advocate more productive linkages among the National Research Program, the National Water Quality Assessment Program, and the "institutes." Parker responded that this idea had been recognized and brought up (but not pursued) previously at committee meetings and promised to explore it further with the new chair and USGS.

Evaluation of USGS National Water Quality Assessment Pilot Program. J. Heaney (ex officio) and S. David reported on the activities of this committee, chaired by Richard S. Engelbrecht (U. of Illinois). They reviewed the first committee meeting (Oct. 24-25) and visits that groups of members had recently made to pilot basins. Heaney commented that the Illinois basin team (he had visited) had done a very good analysis of existing data--data that might turn out more useful than anticipated. He also remarked that how to deal with biology in NAWQA continues to be a major question. He commented on some of the problems of NAWQA receptivity. The program had the potential to embarrass action agencies, it was perceived by some as "more of the same," and there appears to be concern among some that funding of NAWQA would mean less money for some other program(s), i.e. "the zero sum game." EPA reps. Cordle and Hoffer commented that EPA generally favored some kind of a water quality assessment, but the agency felt a more "action oriented" approach would serve them better. The data, they commented, from NAWQA would not represent a sufficiently local scale (i.e. pollution-plume scale) to be of optimum value to EPA. It was decided that committee chairman Dick Engelbrecht should be invited for more discussions with the Board at its April meeting.

Break 10:30 to 10:45 a.m.

Ground Water Modeling Assessment. W. Melgin reported on the progress of this committee, chaired by Frank Schwartz (now at Ohio State U.) and on which J. Mercer and S. Rao serve. The project is nearing completion. The substantive main body of the final report had been completed for several weeks and a small group of committee members had met in November to prepare recommendations. The report was re-organized by the November working group and committee members were asked to revise, expand, reduce, or strengthen their sections as a result. The report will then be edited by the chairman before going to peer reviewers in early-February. It is expected that the report (in pre-publication form) would be released to the agencies before the end of March. The National Academy Press is expecting this to be a high quality and popular report, but the published version is unlikely to be available before May or June.

Committee on Irrigation-Induced Water Quality Problems. C. Elfring reported on the various activities of this committee, including the schedule of meetings, highlights of the government programs, and progress on the committee's to-be-published report. She indicated that the committee was having some difficulty in satisfying itself with this report (not a contractual obligation), but that the most recent version was a considerable improvement over previous ones. The Board indicated that it felt completion of this report was all-but-mandatory and encouraged the committee to complete it for review by March as planned. The committee's many fine letter reports had certainly influenced the governments' irrigation drainage programs, but they had a limited audience. A widely distributed report (National Academy Press projects great demand for published report) is a highly desirable record of the committee's activities, conclusions, and general recommendations about irrigation-induced water quality problems. Following this discussion G. Robeck, R. Meglen, and R. Marzolf all had observations about either the work of the committee or the Department of the Interior Programs related to irrigation

drainage. Meglen, in particular, expressed concern and frustration with quality assurance/quality control activities in the San Joaquin Valley Drainage Program. In spite of the committee's (and Meglen's personal) efforts, QA/QC remained somewhat flawed and may well make SJVDP conclusions vulnerable eventually.

Coastal Erosion Zone Management. William Wood, Purdue U. and chairman of this study committee, made a presentation on the progress of this study. He reviewed study genesis, committee membership, and the scope of work and then discussed progress of the committee, which had met several times. The committee had produced a voluminous manuscript and had reached the point where a logical set of recommendations could begin to be developed. The challenge would be to, in the context of uncertainties of physical processes, make recommendations that would lead to an actuarially based program component of coastal erosion insurance in the National Flood Insurance Program. There remain many questions of both policy and technical nature. The committee has produced two draft reports to date and will meet in March to discuss conclusions and recommendations to FEMA. A final report is due in September 1989.

LUNCH 12:30 TO 1:20 P.M.

Glen Canyon Environmental Studies. R. Marzolf, chairman of the study committee, discussed the history of the project and provided an overview of committee activity, including various reports produced. He and S. David then described activities proposed for the committee in an 18-month timeframe beginning in February 1989. A letter report from the committee was being sent to Secretary of Interior Hodel to reiterate the committee's recommendation that a senior scientist be employed to guide future GCES research activities. A new committee responsibility will be the organization of a symposium concerning the research conducted at Glen Canyon and, in general, the environmental impacts of large dams. A proceedings will be published following the symposium. After some discussion of the frustrations of the committee in seeing its recommendations through to implementation, the WSTB approved continuation of the activity as described by Marzolf and David.

NEW AND DEVELOPING ACTIVITIES

Technologies for Determining Ground Water Recharge Capacity. S. Parker explained that W. Melgin and he, with guidance from M. Kavanaugh and J. Mercer, had been negotiating a new study with the DOI Office of Surface Mining (OSM) concerning the hydrologic functions of surface mined areas. He then introduced Mara Dean and Alfred Whitehouse of OSM, in attendance to discuss the proposed activity before the Board would vote on proceeding with the project. Mr. Whitehouse briefly described the coal industry and the role of the OSM.

The mining of coal and other materials from near the earth's surface is an important industrial and economic activity in many regions of the United States. Mining, however, can have many impacts on the environment, including the hydrologic functions and rainfall-runoff-ground water recharge relationships. To consider and minimize such potential negative impacts, Congress passed the Surface Mining Control and Reclamation Act of 1977, which requires each state to develop and enforce its own Permanent Regulatory Program for surface mining. Strict performance standards were set for all aspects of mining activities, and specifically many requirements exist relative to the hydrologic character of mined areas. Among these is a requirement that, in the restoration of the landscape, mining operators restore "recharge capacity" of mined areas to pre-mining conditions. Interpretation and means for implementation of this requirement are not well understood by the OSM. Mr. Whitehouse had asked the WSTB on OSM's behalf for assistance in evaluating existing hydrologic measurement and analytical technology in respect to its ability to implement procedures that would be responsive to the requirement in the Act. The staff had developed for the Board's consideration a proposal to undertake this study of hydrologic technologies for estimation of ground water recharge capacities in mined areas. The study would be conducted by a specially appointed committee and would require 12-months, March 1, 1989 to February 28, 1990, and \$125,000 in financial support. The study would result in a published report addressing the issue of determining recharge capacity and would also be of general value in quantifying the hydrology and hydrogeology of mined areas.

After considering and discussing this request by OSM, the Board approved (not unanimously) the draft proposal and further study planning, and identified

a nominating committee of J. Mercer, S. Rao, J. Wallis, and W. Melgin (staff support) to make recommendations on the Board's behalf considering study committee membership.

Committee to Advise Agency for International Development on International Soil and Water Activities. Parker explained W. Melgin, J. Hurley (staff director of the NRC's Board on Science and Technology for International Development (BOSTID)), and he, with guidance from M. Kavanaugh, P. Rosenfield, and J. van Schilfgaarde, had been negotiating a major new activity with the Agency for International Development concerning world-wide operations of A.I.D. in the general area of soil and water science and technology. The activity would be in cooperation with BOSTID, whose principal client is A.I.D. Parker introduced Charles Blankstein, consultant to A.I.D., in attendance to discuss the proposal activity before the Board would vote on proceeding with the project. Blankstein, with some help from J. Hurley, described the A.I.D. organization and operating style, and then the proposed activity was discussed.

The WSTB/BOSTID proposal is to establish a technical steering committee to provide advice to the AID's new Soil and Water Agricultural Collaborative Research and Development Network (SWAN) Project. SWAN is a developing AID program which will incorporate all activities in soil and water management under the Science and Technology Bureau's Office of Agriculture. The purpose of the program is to improve the effectiveness of the Agency's network of scientists, administrators, and project managers involved in soil and water management and helping developing countries deal with environmental problems through improved natural resources and agricultural management. The SWAN network will include AID mission administrators, scientists in U.S. universities, users of information in developing countries, and others. SWAN will oversee activities in science and technology research and development related to soil and water issues and work with AID's field programs to produce information on problems, relevant research and technology, options for addressing problems, and specific plans for incorporating these elements into AID projects.

The proposed NRC committee would provide technical advice to the network and policy advice to AID. The committee would bring an expanded perspective to

AID's activities by involving the broad scientific community to which the WSTB has access, as well as the development-related experience of BOSTID in resource and agricultural issues. A high priority for the committee would be to collect and synthesize existing information about natural resource problems related to soil and water management in developing countries. The committee would then identify the most pressing problems and assess whether AID's network has the science and research capability to respond to these problems in the countries where such assistance is needed.

The committee would be composed of approximately 12 to 14 members, representing a range of disciplines in the soil and water sciences; it will also include expertise in relevant social sciences. To carry out its functions, the committee would meet approximately three times each year with AID program personnel to discuss and review SWAN programs. In addition, each year the committee would host a meeting of the network. The committee periodically would provide reports on technical activities, research and development priorities, and policy matters for consideration by AID and the SWAN network. Advice would be transmitted primarily in the form of letter reports; the committee may also issue more in-depth studies.

This might be a long-standing, continuing activity. Thus an initial three-year period of support, March 1, 1989 to February 29, 1992, is being discussed. Expenses for this period are estimated in the range of \$900,000. There also remains to be discussed a competitive granting function that wasn't yet incorporated in the draft proposal. BOSTID's past experiences and AID's current interests need to be considered.

There followed a long discussion on both pitfalls and advantages of such an activity. A.I.D. is a complex bureaucracy that sometimes will involve contractors to carry out politically dictated operational functions of the agency. In addition, the experience of some WSTB members suggest that often such groups have difficulty in interacting with the agency and to implementation of advice. Nevertheless, it was concluded that the activity potentially had much merit, and the project was approved in principle. The staff would consider the meeting discussions, modify the draft proposal accordingly, and circulate it for mail ballot action. It was also agreed that activity particulars would remain negotiable to the point until a supporting agreement is signed.

Wastewater Management for Urban Coastal Areas. At its August meeting in Irvine the Board had reviewed issues associated with wastewater management for urban coastal areas. Jonathan French (Boston Society of Civil Engineers) and Daniel Curll (The Boston Harbor Associates) had been present to describe wastewater management plans for the Boston region, and, with encouragement from Norman Brooks (CalTech, NAS, NAE, CETS) and Donald Harleman (MIT, NAE), the Board had agreed to attempt to develop a general assessment of technical issues and options for urban coastal areas. Subsequent to the meeting, the Board drafted and approved a plan for such a study of this controversial issue. S. Parker updated the members on events relative to this initiative. While the study, perceived to be focused on the Boston situation, was regarded as objectionable by the U.S.EPA a number of expressions of interest and offers of sponsorship had been extended to the Board via Parker, including: the Boston Society's Freeman Committee, National Science Foundation, and the National Academy of Engineering.

The Board had felt that the considerable future national investment in the coastal area wastewater management infrastructure could be governed by a more flexible, scientifically-based set of policies than are now in place. Such policies could: be reflective of costs and benefits, integrate consideration for other media (i.e., land, air, inland water bodies), be flexible enough to account for regional conditions and new information, and still be environmentally protective.

As a practical matter, evaluation of "Section 301(h)" of the Clean Water Act and options for its decision framework were identified as one possible focus of WSTB study. A two-year \$250,000 study by a WSTB committee would:

- (1) Assess in general marine water quality objectives that face urban coastal areas,
- (2) Assess technologies and systems (including control of combined sewer overflows) that can address these objectives, including benefits in relation to costs,
- (3) Consider several case studies in the context of technology and policy options,

(4) Provide generic recommendations on procedures for selecting among available technological and institutional actions to protect coastal water quality and maximize efficiency of financial expenditures, and

(5) Provide recommendations for subsequent research monitoring of coastal systems so that evaluation of the effectiveness of management becomes part of a sustained program of environmental protection.

The committee would produce a report in this general framework. The report should be useful to planners, legislators, and regulators at the federal and state levels, the courts, the municipalities, and the public. Whether because they have failed to modernize their sewage systems, identified new pollution problems or outgrown the capacity of their current systems, coastal urban centers around the country--and in fact the World--face the same need to match wastewater management technologies with available funds and set priorities.

The members felt it important to press forward with this initiative, with the understanding that the study be kept generic (both geographically and technically), that any BSCE funds be accepted only as part of a larger pool, and that the issues be better developed. To this end a steering group of B. Olson (chair), R. Conway, J. Heaney, and G. Robeck was identified and asked to conduct a planning session of scientists, engineers, and policymakers. (Note: Cong. Schneider suggested as interested and able participant.) Parker was authorized to seek NRC program initiation funds for such a meeting, to be held in the February-April 1989 timeframe.

Options for Western Water Management Change--Third Party Effects. Staff reported that funding to support this long-planned activity was starting to be received. Funds are in hand from the Metropolitan Water District of Southern California. Additionally, the BuRec, U.S.EPA, California Urban Water Agencies Group, and The Ford Foundation were all reportedly processing proposals. D. Tarlock is the WSTB nominee to chair the committee of 12 to 14 members, which would likely be appointed early in 1989. A discussion of committee prospects followed, and these were considered on December 13 by the membership nominating committee of Tarlock, J. Heaney, K. Higginson, and W. Melgin.

Restoration of Aquatic Systems: Science, Technology, and Public Policy. S. David reported on this initiative, the objective of which would be to assess aquatic restoration attempts and scrutinize how and why certain approaches to restoration have succeeded or failed. The study had been designed in June 1988 at a WSTB planning session. A two-year, \$250,000 study was proposed. In September proposals for support had been sent to Chevron, Living Lakes, U.S.EPA, the Corps of Engineers, the BuRec, W. Alton Jones Foundation, and Pew Charitable Trust. The first funding was expected to be received from Chevron in January 1989. A discussion of committee prospects followed, and these were considered on December 13 by the membership nominating committee of J. Heaney, R. Marzolf, and S. David.

Following this discussion, Lyndon Lee (USEPA and University of Georgia) was introduced and made a short presentation. Lee is responsible for conducting a short course on wetlands, including restoration and protection. After describing the course, including a wetland tour of sites in Florida, Lee asked the Board to consider how it might assist in reviewing and critiquing the course. While Lee lacks financial resources to cover an in-depth study, the possibility was raised of providing available funds (\$25,000) as incremental support for the Restoration . . . Committee, when established, and including such a review of this relevant course as an activity for the committee. No decision was reached and the possibility was left open.

After a brief recess at 5:30 p.m. the Board and guests adjourned for a reception and dinner at Germaine's Asian Cuisine, 2400 Wisconsin Ave.

December 13, Tuesday

REPORT ON CHINA TRIP

The meeting reconvened at 8:15 a.m. on Tuesday, December 13. The first item of business was an informative report by M. Kavanaugh and R. Conway on an NRC/Office of International Affairs activity in which they were participants. A team of U.S. Engineers, led by Kavanaugh, had recently made a trip to China

on behalf of the China Committee. Their mandate was to observe and assess wastewater and water recycling technologies being applied in a large steel mill (50,000 employees) in Taiyuan, RRC. Their goal was technological exchange; a similar group of Chinese engineers had come to the U.S. previously. The system observed was somewhat of a disappointment. It was built but not fully operational. 80 percent of the mill's wastewater enters the Fen River untreated. The group is preparing a report on its trip. According to Kavanaugh, Chinese employ recycling extensively, and some interesting technological/policy challenges are being faced by its environmental management community. There may be further opportunities for WSTB involvement, but none were identified.

COLLOQUIUM PROGRAM AND DISTINGUISHED LECTURE SERIES

S. David reported on the status of the report on the March 1988 colloquium Great Lakes Levels: Shoreline Dilemmas. The report had been peer reviewed and was being readied for publication and distribution by February 1989. R. Conway and David reported on the colloquium Ground Water Remediation: Are Science and Policy Compatible? They distributed and discussed the colloquium agenda, indicating topics, speakers, etc. A November 30 planning meeting with principal participants had provided assurance that the Board could anticipate a successful event.

The Board then discussed the concept of a lecture series, as introduced at the August meeting in Irvine. The colloquium program placed great demands on the staff and financial resources. It was agreed that well planned and delivered lecturers (one hour, plus) could realize some of the same goals (i.e., educate WSTB, address controversy, introduce emerging topics). Lecture topics and speakers would be identified by the Board and scheduled several months to a year in advance. Accompanying papers would be published, distributed, and promoted. Two types of lectures were discussed. First it was felt that Board members or representatives of other NRC activities could be scheduled to discuss interesting aspects of their work. This would be relatively informal and was suggested to start at the September meeting in Woods Hole. No topics were suggested, though. A more formal "Distinguished Lecture" idea will require more planning and would be widely advertised and

held in Washington, perhaps beginning at the February 1990 meeting. Several suggestions for speakers for this series were made, as summarized below:

- Bob Dickinson--global climate modeling
- Peter Eagleson--frontiers in hydrologic sciences
- Charles Howe--water markets
- Helen Ingram--institutional arrangements
- Howard Kunreuther--relevant topic of his choice in risk/decision making
- John Labadie--optimal operation of water systems
- Luna Leopold--major investigations on the Colorado River restoration
- Perry McCarty--topic of choice re: ground water contamination
- Suresh Rao--techniques for assessing ground water vulnerability
- Gordon Robeck--topic of choice in area of water and public health
- Jan van Schilfgaarde--irrigation-induced water quality problems
- Bob White--climate change
- Gilbert White--topic of his choice

As an example of the less formal variety of lecture, J. Wallis came prepared to address the Board on the subject of the utility of Geographic Information Systems in Water Resources Management. Wallis delivered a seminar-style presentation he had made at the October 1988 GIS Symposium convened by the NRC and USGS in Denver. In his half-hour talk, Wallis discussed enthusiastically the technology and several applications. He stressed that this field is advancing very rapidly and, though quality control is a problem, it is a tool that will have revolutionary impacts on the field of water resources. Break throughs in the early 1980's in computer power, and decreasing costs thereof, were making it possible for planners at all levels to employ GIS.

This excellent presentation by Wallis confirmed the Board's view on the value of lecturers or seminars of the informal variety, led by Board members. Finally, while it was agreed that this type of activity should be incorporated into meetings right away, colloquia should not be discontinued. The regularity will be reduced; colloquia will be scheduled on an "as proposed" or "as needed" basis. There are many issues that will arise where this is the appropriate format for consideration by the NRC.

ANNUAL REPORT

S. Parker explained that the staff soon would begin drafting the Board's Annual Report for 1988. He reviewed the format, general content of past versions, and report purposes. He invited suggestions for change of any type for the 1988 issue. In response, several members commented that the 1987 version should serve as a model and that it was a very useful document. The staff was asked to consider the use of "desk-top publishing" to upgrade print and presentation appearance.

NEW INITIATIVES

At the August 1988 Board meeting, a special session was held to review the scope and completeness of the program of studies and recommend new initiatives for the future. About 12 such activities were identified and are recorded, with descriptions, in the minutes of that meeting. They are, therefore incorporated herein by reference. After reviewing the August meeting, M. Kavanaugh challenged the Board to identify several priority items in which further development efforts should be invested.

Kavanaugh and Parker explained that they had already chosen one such topic, Emerging Technologies in Water Treatment, and had obtained internal NRC program initiation funds for a small conference to develop the item further. It is expected that the meeting will produce a well defined study proposal and identify financial sponsors. Water treatment, in its broadest interpretation, includes potable water treatment, municipal and industrial wastewater treatment, removal of hazardous constituents from contaminated ground water, industrial water treatment, and treatment of wastewater streams with low concentrations of suspended solids. In the context of increasingly stringent environmental standards or criteria, and a societal goal of reducing intermedia transfers, new demands are being imposed on water treatment and technologies.

The contemplated study might evaluate the current status of water treatment technologies (efficiency, reliability, cost-effectiveness, ability to minimize residuals), evaluate the adequacy of technological development in this sector (historically and currently), and assess the need and recommend strategies for achieving these perceived future requirements. There was considerable enthusiasm for this activity. In the context of international

competitiveness this was regarded as very timely. (The U.S. is reportedly lagging behind France, Taiwan, and Japan.) It was suggested that reuse and conservation should be incorporated into the topic. S. B. Krishnan added that EPA was interested in the topic. EPA was concerned with impact of treatment byproducts. He expressed worry that, as grants for wastewater treatment wind down, research on technologies will be eliminated. NSF and the Army Construction Engineering Research Lab had also expressed interest in the activity prior to the meeting. Other prospective sponsors include EPRI, API, and the AWWA. This discussion concluded with the agreement that Kavanaugh and Parker would consider several suggested participants (including non-technologists) for a planning session and organize the meeting for sometime prior to the April 1989 WSTB meeting.

With time running short, it was not possible to discuss other initiatives in ample depth. However, several were discussed briefly and comments were as follows:

- Water Quality for Special Populations (B. Olson): this important problem should continue to be pursued, if not by the WSTB, possibly by another NRC unit with health orientation (e.g. CLS) ATSDR, CDC, EPA, AIDs Foundations, the VA, and insurance institutes might be sponsors.
- Supplemental Irrigation (D. Tarlock): change in the humid East's water budget as a result of supplemental irrigation is upsetting the water balance. Perhaps a new look at Eastern water law principles is called for. Support for such an institutional study might come from Dept. of Agriculture or Corps of Engineers Institute for Water Resources.
- Greenhouse Effect (three items this category). Criteria for Impact Determination (B. Paul): a study of how to determine vulnerability of catchments to climate change, based on parameterized approach, would be useful and is doable. Paul to check on BuRec interest in such an effort. Hydrologic Forecasting (K. Higginson): review of science of forecasting, in context of changing climate, as basis for planning and operation. How to use past records to predict future, a tricky proposition; Estimating Impact of Anthropocentric Climate Change upon Water Resources (Wallis and Burges): how to determine impacts on water resources. With limited time, it was concluded that the Board should

continue to try to refine ideas for activity in important area of climate change and water resources, i.e. what are certainties and uncertainties?, what might be an early warning system? D. Tarlock suggested a small WSTB colloquium to extend the discussions.

- Water Resources Education (J. Mercer): important topical area. Not sure what to do, but revisit again. The general question of how to increase science literacy ought to be pursued by NRC if not being done already.
- Techniques for Assessing Ground Water Vulnerability (S. Rao): note--this was identified as an excellent lecture topic.

ADJOURNMENT

Following discussion of these initiatives and a working lunch the meeting formally adjourned at approximately 1:30 p.m., though several of the nominating or planning groups convened for afternoon meetings.