Appendix A

Useful Sources of Information on the World Wide Web for Dam Removal Decision Makers

EXISTING DAMS

National Inventory of Dams (U.S. Army Corps of Engineers and Federal Emergency Management Agency)

http://crunch.tec.army.mil/nid/webpages/nid.cfm. This web site (as of Oct. 15, 2001) is offline as a security precaution in light of the Sept. 11, 2001, terrorist attacks on the United States. The site may be restored after further evaluation.

- The online interactive map and downloadable database contains information about approximately 76,000 dams. Includes those structures whose collapse might be a threat to life and property downstream, those greater than 6 ft (2 m) high with more than 50 acre-ft (61,000 cu m) of storage, and those that are 25 ft (8 m) high with more than 15 ac ft (18,500 cu m) of storage.

National Atlas (U.S. Geological Survey)

http://www.nationalatlas.gov/damsm.html

- This online interactive map and downloadable database contains information about approximately 7,700 major dams. A subset of the National Inventory of Dams, the dataset includes dams that are 50 feet or more in height, have a normal storage capacity of 5,000 acre-feet or more, or have a maximum storage capacity of 25,000 acre-feet or more.

DAM REMOVALS

Dam Removal Success Stories (American Rivers, Friends of the Earth, and Trout Unlimited)

http://www.americanrivers.org/damremovaltoolkit/successstoriesreport.htm

- In December 1999, these three organizations issued a cooperative report outlining the experiences of specific dam removal projects. American Rivers

also has a resource center of material regarding dam removals at http://damremoval.americanrivers.org.

Wisconsin Rivers (Wisconsin River Alliance)
http://www.wisconsinrivers.org/
- This organization provides examples of changes brought about by dam removal and useful information on dam removal decision-making processes.

MAPS

National Atlas (U.S. Geological Survey)
http://nationalatlas.gov
- The atlas contains a variety of high-quality, small-scale maps for the entire United States, including authoritative national geospatial and geostatistical data sets. Examples of digital geospatial data include soils, county boundaries, volcanoes, rivers, streams, and watersheds.

Topographic maps

U.S. Geological Survey
http://www.usgs.gov
- Paper maps can be ordered online.

MapTech
http://www.maptech.com/mapserver.

Microsoft's Terraserver
http://terraserver.microsoft.com
- This web site includes aerial photography for many parts of the nation.

TopoZone
http://www.topozone.com
- This web site provides digital topographic maps at a variety of scales.

Maps showing census data related to social and economic data

Bureau of the Census
http://tiger.census.gov and http://factfinder.census.gov/servlet/BasicFactsServlet

Maps showing environmental data

Environmental Protection Agency
http://maps.epa.gov/enviromapper
http://www.epa.gov/surf/

Department of Housing and Urban Development, Healthy Communities
http://www.hud.gov/emaps

U.S. Geological Survey and U.S. Environmental Protection Agency, National Hydrography Dataset
http://nhd.usgs.gov/

Maps showing earth science data
U.S. Geological Survey
http://geode.usgs.gov

Base maps for use with geographical information systems
Environmental Systems Research Institute, ArcView
http://www.esri.com/software/arcview/index.html

Map Info Professional
http://dynamo.mapinfo.com/products/web/Overview.cfm?productid=44

Hydrological Information and Maps
Federal Emergency Management Agency
http://www.fema.gov/maps
- This web site contains surveys and highly detailed topographic maps (including cross sections) of many streams and rivers used to determine the extent of the active channel and the 100-year floodplain.

National Hydrography Dataset (U.S. Geological Survey and U.S. Environmental Protection Agency)
http://nhd.usgs.gov/
- The dataset is a basic source for stream and river geography.

U.S. Geological Survey
http://www.usgs.gov/water
- A variety of water data based on the 6,600 stream gages USGS operates. Data are available for each day of record, as well as in an abbreviated form showing only annual peak flows; information on each gaging station includes its dates of operation and a map showing its precise location. Users can retrieve the data either in tabular form for numerical analysis, or in easily read graphs.

OTHER DATA SOURCES

Sediment

U.S. Geological Survey

http://water.usgs.gov/owq.html

- The USGS keeps data on the quantity of sediment discharged passing through approximately 1,600 gaging stations.

Water Quality

National Water Quality Assessment Program (U.S. Geological Survey)

http://water.usgs.gov/owq/data.html

- Near real-time and historical data for many of the nation's rivers are available from the web site. The data can be downloaded in the form of tables for analysis from much, but not all, of the country.

Appendix B
Glossary

Acre-foot the amount of water required to cover one acre to a depth of one foot. An acre-foot equals 326,851 gallons or 43,560 cubic feet.

Adaptive management a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Its most effective form — "active" adaptive management — uses management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed.

Aggradation the raising of a riverbed due to sediment deposit

Allochthonous characteristic of or referring to events originating from outside the organism or the self.

Anadromous fish that hatch in freshwater, migrate to the ocean to mature, and return to freshwater to spawn.

Anchoring The practice, by some survey respondents, of basing stated willingness to pay for a non-market good on the known value of a market good that is considered similar or related in some way.

Arch dam a dam construction type used at sites that are narrowly constricted (e.g., valley or canyon containing the stream) and that spans the valley opening as one single structure, anchored in the sidewalls by thrust blocks.

Autotrophic needing only carbon dioxide or carbonates as a source of carbon and a simple inorganic nitrogen compound for metabolic synthesis

Bequest value a willingness to pay to preserve the environment for the benefit of one's descendants.

Breach a break or opening in a dam

Buttress dam a dam construction type made of flat decking sloping from crest to the base, typically comprised of reinforced masonry or stonework built against concrete.

Channelization the modification of a natural river channel, including deepening, widening, or straightening

Crib dam a dam construction type that is constructed of a timber outer box typically filled with rocks for stability, sometimes further stabilized with wire or brush blankets

Dam any barrier that impounds or diverts water

Decommissioning is a term used mostly for dams that are or have been generating hydropower and are shutting down power operations after losing relicensing from the Federal Energy Regulatory Commission (FERC). This may or may not include removing diversions for power generation, shutting down operations entirely, safe maintenance of dams after turbines are shut down and restoring sites to their normal, pre-project conditions.

Dam removal removal of the entire structure on a river or stream. This can also include restoration of the site to pre-project conditions.

Diversion the taking of water from a body of water into a pipe or other conduit

Earth fill dam a dam construction type that is constructed from local earth materials that are shaped and rolled into a sill across the watercourse to be dammed.

Existence value In the case of a unique and essentially irreplaceable resource, the value experienced by some due to the simple knowledge that the resource exists, irrespective of any current or expected future use.

Erosion wearing away of the land surface by detachment and movement of soil and rock fragments during a flood or storm or over a period of years through the action of wind, water, or other geologic process.

Fish ladder a series of ascending pools of running water constructed to enable fish to swim upstream around or over a dam.

Fish passage any feature of a dam that allows fish to move around, through, or over a dam without harm.

Free-flowing Undammed and unchannelized watercourses, as defined by the federal Wild and Scenic Rivers Act.

Gravity dam a dam construction type usually made of concrete, the weight of which is capable of providing the major resistance to the water forces exerted on it.

Hydroelectric power electric power generated by a flow of water.

Hypothetical bias Random error in survey results which is attributable to the hypothetical nature of the valuation task. Hypothetical bias is not actually a bias, since it is defined to have a zero mean.

Implied value cues Information communicated, explicitly or implicitly, in the course of an interview or in the body of a survey instrument that serves to suggest a value or range of values that may be appropriate for the non-market good in question.

Impoundment a body of water (such as a pond or reservoir) confined by a dam, dike, floodgate or other barrier used to collect and store water for future use.

Levee a raised embankment of a river, showing a gentle slope away from the channel, usually built to protect land from flooding.

Nonresponse bias A systematic error in valuation which results from incorrect assumptions about respondents who do not answer some or all questions; for example, assuming that these respondents hold values similar to those who do answer the questions.

Option value often categorized as a nonuse or passive use value and refers to the fact that an individual places a certain current value on the option to use a resource in the future.

Reservoir a large natural or artificial lake used as a source of water supply.

Restoration return of an ecosystem to a close approximation of its condition before a disturbance. The goal is to emulate a natural, functioning, self-regulating system that is integrated with the ecological landscape in which it occurs.

Riparian pertaining to a river.

Riparian habitat the habitat found on the bank of a natural watercourse (as a river) or sometimes a lake or tidewater.

River a natural stream of water of considerable volume.

Rock fill dam a dam construction type that uses rocks for weight and stability with a cover or membrane to provide watertightness.

Run-of-the-river dam A structure built by humans across a river or stream for impounding water, such that the impoundment at normal flow levels is completely within the banks and all flow passes directly over the entire dam structure within banks, excluding abutments, to a natural channel downstream. Some dams with storage reservoirs create a run-of-river condition through operating rules, whereby the dam releases water at approximately the same rate as the reservoir receives it.

Sample bias A systematic error in valuation which results from the way in which the sample of respondents was selected from the population.

Spillway a channel on a dam over which excess or flood flows are discharged designed to prevent impounded water from escaping over the top of the dam.

Strategic bias A systematic error in valuation which results from attempts by respondents to answer questions in a way that will benefit them in the future; for example, by understating values so as to cause lower user fees.

Stream Order The numbering of streams in a network. There are many different methods; the most widely used is a classification which labels all unbranched streams as first-order streams. When two first order streams meet, the resulting channel is a second-order stream. Where two second-order streams meet, a third-order stream results, and so on. Any tributary of an order lower than the main channel is ignored.

Watershed a region or area bounded peripherally by a divide and draining ultimately to a particular watercourse or body of water.

Appendix C

about the contributors and the project staff

The Heinz Center panel met with federal and state officials during a field visit to the site of Rindge Dam on Malibu Creek in California. Back row, left to right: Syd Brown (California Department of Parks and Recreation), David Wegner (panel member), David Freyberg (Stanford University), Reinard Knur, Sheila David (Heinz Center Fellow and project manager), Will Graf (panel chair), Tom Downs, Mary Lou Soscia (panel member), William J. Bennett (California Department of Water Resources), Jack Kraeuter (panel member), Phil Williams (panel member), Doug Dixon (panel member). Front row: Jason Shea (U.S. Army Corps of Engineers), Chris Peregrin (California Department of Parks and Recreation), Suzanne Goode (California Department of Parks and Recreation), and Robert Hamilton (U.S. Bureau of Reclamation). Photograph courtesy of Sarah Baish.

THE CONTRIBUTORS

William L. Graf, *Chair*, is Educational Foundation Endowed University Professor and professor of geography at the University of South Carolina. His specialties include fluvial geomorphology and policy for public land and water. His research and teaching have focused on river-channel change, human impacts on river processes, morphology, and ecology, as well as contaminant transport and storage in river sediments. In the arena of public policy, he has emphasized the interaction of science and decision making, and the resolution of conflicts among economic development, historical preservation, and environmental restoration for rivers. He has published several books and more than 100 scientific papers and is past president of the Association of American Geographers. Previously, he was Regents Professor of Geography at Arizona State University. He has served on the National Research Council (NRC) as a member of the Water Science and Technology Board and is a member of the Board on Earth Sciences and Resources. His NRC committee experience includes a 10-year membership on the Committee to Review the Glen Canyon Environmental Studies and chairing the Committee on Innovative Watershed Management and the Committee on Research Priorities in Geography at the U.S. Geographical Survey. He was appointed by President Clinton to the Presidential Commission on American Heritage Rivers. He is also a National Associate of the National Academy of Science.

John J. Boland is a professor of geography and environmental engineering at Johns Hopkins University. He is a registered professional engineer. His background includes management positions in water and wastewater utilities, teaching, research, and consulting activities at all levels of government and private industry. Dr. Boland has published widely on economic aspects of water and resource policy. He is an associate editor of *The Annals of Regional Science* and a member of the Risk Management Technical Advisory Workgroup of the American Water Works Association. He has served on a number of committees and panels of the National Research Council and served as chair of the Water Science and Technology Board (1985–1988). He holds a B.E.E. in electrical engineering from Gannon College, an M.S. in governmental administration from George Washington University, and a Ph.D. in environmental economics from Johns Hopkins University.

Douglas A. Dixon manages the aquatic protection, water quality and fishery research initiatives at the Electric Power Research Institute (EPRI). Dr. Dixon has more than 25 years of wide-ranging experience in environmental science and engineering research, including 10 years assessing the impacts of hydroelectric projects on aquatic resources. He is experienced in the regulatory and procedural requirements of the Clean Water Act, National Environmental Policy Act, Fed-

eral Power Act, Endangered Species Act (ESA), and numerous other environmental acts as they apply to the Federal Energy Regulatory Commission's licensing and re-licensing authority and state permitting of steam-electric facilities. Areas of expertise include ecological risk assessment, environmental impact analysis, ecological modeling, fish passage, impingement/entrainment monitoring, ESA assessments, instream flow assessment, fisheries management plan review, and current and historical aquatic resource assessment. He holds a B.A. in biology from the State University of New York at Geneseo and a Ph.D. in marine fisheries science from the College of William & Mary.

Thomas C. Downs is a member of Patton Boggs's administrative and regulatory practice and concentrates on environmental law and general public policy. Mr. Downs has extensive experience in federal environmental law and policy, including the Comprehensive Environmental Response, Cleanup, and Liability Act (CERCLA, or Superfund); brownfields; Clean Water Act; and solid waste issues. Mr. Downs assists clients in briefing congressional offices, drafting legislation and congressional briefing papers, and developing legislative strategy. He also works closely with federal agency staff on executive branch initiatives. Mr. Downs handled environmental and natural resources legislation and other matters on Capitol Hill for more than 10 years before joining Patton Boggs. He served as legislative director and chief of staff to Representative George J. Hochbrueckner (NY-01) from 1987 to 1995 and as legislative assistant to Representative Martin O. Sabo (MN-05) from 1985 to 1987. He received a B.A. from Brown University in 1983 and J.D. from The American University, Washington College of Law in 1994.

John J. Kraeuter is an aquatic biologist with the Pennsylvania Department of Environmental Protection, Bureau of Waterways Engineering. His responsibilities include evaluating the environmental impacts of the proposed construction, modification, and removal of dams across the Commonwealth. Previously, he worked for a consulting firm specializing in the collection of biological data, including fishery, benthic macroinvertebrate, plankton, and freshwater mussel surveys, in streams, rivers, and lakes. He holds a bachelor's degree in biology from the University of Delaware.

Mary Lou Soscia serves as the Columbia River coordinator for the U.S. Environmental Protection Agency (EPA), Region 10-Seattle. In this role, she represents the EPA in discussions of the role of the Clean Water Act in future federal decisions on the Columbia River power system. Ms. Soscia has more than 20 years of experience with state, federal, and tribal government, specializing in watershed and river management issues. While on an assignment from the EPA in 1993–1997, Ms. Soscia served as coordinator of the Tribal Watershed Program

for the Columbia River Inter-Tribal Fish Commission and as program manager for the Oregon Watershed Health Program. While working for the EPA in Washington, D.C., Ms. Soscia served on the team that developed and established the National Estuary Program, a collaborative effort to restore the nation's estuaries. Ms. Soscia also has worked for the states of Maryland and Wyoming. Ms. Soscia has a bachelor's of science degree in geography from Virginia Polytechnic Institute and State University and a M.S. in geography from the University of Maryland.

David L. Wegner has been involved in the design, coordination, and implementation of innovative scientific and river rehabilitation programs in the western United States and internationally since the late 1970s. Recently he established a company, Ecosystem Management International, Inc., that applies the scientific expertise developed in the Grand Canyon to river and terrestrial rehabilitation work focusing on endangered species and river process studies. From 1982 through 1996, Mr. Wegner coordinated the most extensive series of ecosystem studies and rehabilitation work ever attempted in the Colorado River basin. His expertise is in the areas of aquatic ecology, river engineering, and the application of science to risk assessment and adaptive management. His professional career includes work with the states of Minnesota and Utah and the U.S. Department of the Interior (DOI), and consulting with numerous Native American and environmental groups. He has received numerous commendations for public service, including recognition from the National Research Council, and is a recipient of the DOI's Bureau of Reclamation's Resource Management Award.

Philip B. Williams is president of Philip Williams & Associates LTD, an engineering and environmental planning firm he formed in 1979 that has offices in California, Oregon, and Washington. A professional civil engineer, he founded the San Francisco–based International Rivers Network in 1985. Dr. Williams has been engaged in a wide range of national and international hydrologic and engineering hydraulics work, primarily assessing the environmental effects of hydrologic change caused by dams and diversions and preparing feasibility studies, management plans, and environmental impact studies, related to river and wetlands restoration. He has directed more than 250 such studies, including projects on flood control, wetland restoration, river management, national park plans, water resources development, and estuarine management plans. He has authored or co-authored numerous papers on river management. He holds a Ph.D. in Hydraulics from the University of London's University College Civil and Municipal Engineering Department.

Craig S. Wingo is the national director for both the earthquake and dam safety programs within the Federal Emergency Management Agency (FEMA). He is responsible for the coordination of earthquake and dam safety activities at

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Eugene P. Zeizel has more than 22 years of service with the Federal Emergency Management Agency (FEMA) and Federal Insurance Administration (FIA). Initially, he worked for more than three years as a project officer for flood insurance studies in Region VI. From 1981 through 1997, Dr. Zeizel managed FEMA's hurricane evacuation studies, conducted jointly with the U.S. Army Corps of Engineers and National Weather Service. He later was the project engineer for Regions VII and X, managing and resolving appeals and protests to the FIA's flood insurance rate maps. Dr. Zeizel has been working in the National Dam Safety Program Office since January 1999 and is responsible for dam safety research and training projects. He is a member of the subcommittees on research and training of the Interagency Committee on Dam Safety. Dr. Zeizel holds a B.S. in geology, M.S. in hydrology, and Ph.D. in civil engineering specializing in water resources and planning.

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Sarah K. Baish, now working towards a master's degree in urban and environmental planning at the University of Virginia, was a research associate for The Heinz Center's Sustainable Oceans, Coasts, and Waterways program through January 15, 2002. Before joining the Center, she worked in a national park in Slovakia as an environmental management consultant with the Peace Corps. Her primary responsibilities included grant writing, organizing educational events, promoting interpretive visitor services, and developing international collaborations. Before that, she had interned with the National Oceanic and Atmospheric Administration, and her work contributed to the establishment of a humpback whale sanctuary in Hawaii. Ms. Baish holds a B.A. in environmental science from the University of Virginia.

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