Columbia Research Corp.

PAYMENTS FOR WATERSHED SERVICES:
A Tool to Help Resolve Complex Water Problems

A White Paper

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I. An Alternative Approach to Resolving Water Disputes

Anyone involved in a complex water dispute in the United States will recognize this chain of events:

A state (or perhaps a city, irrigation district or utility) wants more water from a river than a neighboring state wants to allow. The dispute becomes politicized. The governor (or mayor or senator) gives a speech, promising to defend his state's interests and vowing that no one is going to push him around. This leads to more political posturing.

Eventually, the parties turn to their lawyers and file lawsuits. Other parties with a stake in the dispute intervene. There are now half a dozen or more law firms filing motions, wanting to do this or that, or objecting to something that another lawyer filed. The legal gladiators are in charge. Perhaps the parties cannot even agree on which court should hear the dispute. After months of litigation, the parties receive an opinion from a district court. Then, someone files an appeal. Eventually, the appeals court renders its decision.

Is the dispute resolved? No. Inevitably, one party is unhappy with the decision and asks the court for a rehearing, which takes more time and expense. Or perhaps one party is unsatisfied with how another party is implementing the court's decision. Soon the parties are back in court again. In other words, the parties have engaged in an extended political and legal wrestling match that typically produces very little. A decade or more is lost.

But there's an alternative.

It's called Payments for Watershed Services ("PWS"), and it offers a more modest and less confrontational approach. The parties come to a practical financial agreement about the issues. One party agrees to buy a service from the other. Money changes hands. The parties may not like each other – they may carry historical grudges – but they decide it's better to compromise and sign a contract that gives each party at least a portion of what it wants.

The Columbia Research Corp. has studied PWS transactions in the United States and around the world, and we have established a network of technical specialists to analyze and help resolve water disputes.

What follows in this White Paper is a description of the problems facing water managers as they address a range of challenges, from water supply to water quality. We provide examples of PWS transactions in the United States, Europe, Australia, Canada, Latin America and China. And we describe how our services can inform and guide decision-makers as they seek to develop a non-litigation strategy.

First, a definition. We use the term "watershed" to mean the area of land that drains into a stream, river, lake, estuary or coastal area. The term is the same as a "river basin" or "drainage basin" or "catchment area." Watersheds come in all shapes and sizes, from small corners of a state to large areas of territory, like the watershed of the Mississippi River, which drains approximately 41% of the continental United States.

II. The Boundary Problem

Look at a map of virtually any watershed in the world and you will see a mosaic of states, provinces, districts, territories, cities and towns. The boundaries of those jurisdictions crisscross the river and its watershed, and divide the natural landscape into idiosyncratic units. The situation gets even more complicated if you examine the territories of electric utilities, water supply agencies and irrigation districts that serve basic human needs.

This fragmented landscape makes it difficult to address complex water problems. Who manages the river? Who analyzes the entire ecosystem? Fifty or one hundred years ago, the answers to those questions were not as pressing as they are today. But the competing needs for water and the uncertain effects of climate change put pressure on decision-makers to understand water resources in the whole watershed, not just within the parochial boundaries of their own agency.

What can decision-makers do? What types of management tools are available for them to address issues within an entire watershed?

One of the most promising but little-studied mechanisms is a Payment for Watershed Service. PWS transactions are not the solution for all water resource challenges but they are a tool that should be considered carefully.

III. What is a Payment for Watershed Service?

A Payment for Watershed Service is an agreement in which one party buys services or benefits from another party in a river basin. The subject of the transaction is water quantity or water quality or both. One party pays another party to do something that increases the supply of water or that improves water quality. The parties to a PWS transaction may include the federal or state government, water supply agencies, electric utilities, corporations, cities, farmers, environmental groups or others. They put their agreement in writing and it becomes a binding contract.

PWS transactions are much broader than "payments for ecosystem services," a market-based mechanism that seeks to capture environmental benefits such as biodiversity. PWS transactions, in contrast, are a tool for addressing the entire range of existing and potential impacts in a watershed, including irrigation, sewer and stormwater discharges, power generation, salinity, navigation, industrial pollution, runoff from pesticides, climate change and flood control.

Although most PWS transactions implicate some sort of environmental issue, the primary motivation for the parties to sign a PWS transaction is usually financial or operational. The parties do not necessarily see themselves as executing an environmental agreement. They're signing a business arrangement. They want more water for irrigation, or more water for power generation, or better protection from the risk of floods, or they want to promote the more efficient management of infrastructure, such as dams, locks and canals.

Some PWS transactions are voluntary – the parties are not seeking to comply with federal or state mandates. Instead, they want to execute a PWS transaction because they believe it is in their long-term economic interests. In Eugene, Oregon, for example, the Eugene Water & Electric Board ("EWEB") has proposed a voluntary program to protect its watershed in the McKenzie River Basin. EWEB wants to buy riparian corridors and development rights now rather than wait 10 or 20 years to address pollution problems after the properties have been suburbanized.[1]

Other transactions, however, are part of a regulatory effort to improve water quality.[2] Most water quality trading programs fall into this category. The parties believe PWS transactions are the least-cost alternative of complying with regulations and/or avoiding protracted and expensive legal battles to challenge stringent government rules.

No matter what the format or the size of the transaction, the general principle remains the same: someone buys a watershed service or benefit. A city, for example, might pay upstream farmers to reduce the amount of pesticide runoff or sediment in a river to protect the city's drinking water supply. Or an electric utility could buy additional flood control protection from an upstream utility. Or a city could adopt a trading program to implement Best Management Practices ("BMPs") for reducing stormwater (e.g., runoff from parking lots and streets).[3] In Washington, D.C., for example, the municipal government requires developers to install on-site stormwater retention and soil erosion facilities (e.g., improved landscaping and roof gardens) or pay for improvements elsewhere. The purpose of the BMPs is to reduce runoff during storms and help the water quality of the Potomac River and its tributaries.[4] The D.C. program, approved in 2013, allows developers who voluntarily exceed their stormwater reduction obligations to sell credits to other property owners.[5]

IV. Sample PWS Transactions

PWS transactions are remarkably diverse. Some agreements are complex, multiparty international accords. Other transactions reflect local efforts to improve water quality on small streams or lakes.

Here are sample transactions from the United States:

- **Water supply**. In the lower Colorado River Basin, water supply agencies signed interstate "water banking" agreements in the late 1990s that permit one state (or water district) to pay another state (or water district) to store ("bank") water for future use. The water banking agreements allow for the more efficient management of the river during droughts.[6] This tool is used elsewhere in country, too. Water supply agencies in metropolitan Washington, D.C., pay an upstream agency in Maryland to maintain and operate a dam on a tributary of the Potomac River in exchange for the right to obtain extra water during drought. The additional water helps D.C. maintain adequate supplies to meet its needs.[7] In yet another example, the Susquehanna River Basin Commission in Harrisburg, Pennsylvania, has purchased reservoir storage rights at two dams owned by the U.S. Army Corps of Engineers. The Commission can release water in drought conditions for two nuclear power plants and other uses.[8]

- **Temperature offsets and mitigation**. In the Tualatin River in northwest Oregon, a wastewater (sewage) utility has established a program to reduce the temperature of the river and help preserve and restore fish and aquatic wildlife habitat. As part of the mitigation, the utility releases extra water from two reservoirs that are upstream of its treatment facilities. In addition, the utility has planted trees and shrubs along 35 miles of stream banks in the basin. Those efforts are less expensive for the utility than the proposed alternative, which involves cooling the effluent from its wastewater treatment facilities. The program was implemented in response to regulations adopted by the Oregon Department of Environmental Quality.[9]

- **Protection of farm land and erosion control**. The U.S. Department of Agriculture pays farmers to reduce erosion and preserve riparian wildlife habitat. This effort – the Conservation Reserve Program – is one of the oldest PWS programs in the nation. Its goal is to protect the top soil on millions of valuable farm acres.[10] Similarly, New York City buys land for preservation and pays upstream landowners in the Catskill-Delaware River watershed to reduce siltation and runoff. The watershed supplies about 90% of the city's water supply. The program allows New York City to avoid building an expensive filtration plant to remove sediment.[11]

- **Fisheries and recreation**. A number of "water trusts" – nonprofit groups that buy water rights – seek to improve and protect stream flows and water quality for fish. These groups, such as the Washington Water Trust, work in cooperation with farmers and others to purchase water for "in stream flows."[12]

- **Aquifer storage**. A number of local government agencies have developed their own Aquifer Storage and Recovery ("ASR") projects where they store water underground and pump it back up to the surface when needed. In several instances, one government entity pays another to store the water. In Nevada, a water district creates "water savings accounts" for neighboring agencies by pumping water into underground wells for recovery.[13] In Georgia, several private entities have created the Etowah Water Bank and proposed storing water there for the metropolitan Atlanta area.[14] In California, Cadiz Inc., a private company that owns 34,000 acres in the Mohave Desert, proposes to store water in a large aquifer there.[15]

- **Pollution control and nutrient trading**. In Chesapeake Bay, the U.S. Environmental Protection Agency has begun efforts to reduce the flow of nutrients and sediments and to restore marine "dead zones." EPA is using its authority to establish Total Maximum Daily Loads ("TMDLs") for the Bay and its tidal tributaries. The states in the watersheds must prepare implementation plans, and those documents may (but are not required to) include market-oriented mechanisms to ensure compliance.[16] Maryland, Pennsylvania and Virginia have already established a nutrient trading scheme within their own borders.[17] The Chesapeake Bay TMDL is likely to become the largest pollutant trading program in the country. Existing nutrient trading programs elsewhere include Long Island Sound.[18] Numerous other states are now considering trading programs within their jurisdiction.[19]

- **Wetlands banking**. To comply with the Clean Water Act, developers must offset the unavoidable impacts to wetlands by purchasing wetlands elsewhere for preservation. The developer buys these "mitigation credits" in order to proceed with its development, such as dredging a harbor or building a road. The provider of these credits is a "mitigation bank" that has purchased or restored wetlands. There are several hundred such banks in the United States at present.[20]

- **Irrigation improvements**. In southern California, the San Diego County Water Authority paid the Imperial Irrigation District to help line the All-American Canal, a conveyance channel built in the 1930s that leaked water. In exchange, the irrigation district shared the water savings with the San Diego County Water Authority. The transaction was signed pursuant to the 2003 Quantification Settlement Agreement, a multi-party agreement that included the U.S. Department of Interior.[21]

- **Flood control and power generation**. Electric utilities in the United States paid approximately $317 million in the 1960s to Canada to build dams on the upper Columbia River for flood control and power generation that would benefit the United States. Construction of the dams in the Province of British Columbia allowed it to generate more electricity for its own uses and also allowed the United States to generate more power from *its* dams.[22]

There are also multiple examples of PWS transactions around the world:

- **Aquifer protection**. In northeast France, Nestle Waters pays farmers to adopt better agricultural practices in an effort to prevent nitrates and pesticide residue from seeping into the groundwater and harming the supplies from which the company bottles Vittel mineral water.[23]

- **Environmental flows**. In Australia, the Parliament in 2007 established the Commonwealth Environmental Water Holder to purchase water rights from farmers for environmental flows (e.g., for fish and wildlife habitat) in the Murray-Darling River Basin, the dominant river in the southeast part of the country.[24]

- **Pollution control and trading**. In the Province of Ontario, Canada, the South Nation River watershed employs a phosphorous trading program that enables municipal sewage treatment plants to comply with pollution limits. In addition, the program allows dairy farmers that build new manure storage facilities to generate credits they can sell to the municipalities.[25] Other examples include the Hunter River Valley in Australia, where the State of New South Wales has implemented a salinity trading program. The valley is home to numerous wineries and some of the world's largest coal mines. Although salt occurs naturally in rocks and soils there, the discharge of coal mining residue significantly increases the salt content of the river. The trading program limits discharges during low flows and allows the parties to discharge salt in periods of high flow.[26]

- **Water supply**. In Latin America, water utilities and other public agencies, working in cooperation with the Nature Conservancy and others, have established water trusts to buy land to protect municipal watersheds. The trusts pay upstream ranchers and farmers to restore riverside forests and to reduce the use of fertilizers and chemicals that threaten water quality.[27]

- **Protection of forest lands**. The People's Republic of China has implemented a number of PWS transactions to restore degraded forest lands and reduce flooding. These programs include the Forest Ecological Compensation Fund, which allows the central government to pay farmers and lower landowners to reduce siltation.[28]

- **Salinity control**. The countries bordering the Rhine River in Europe signed an agreement in 1991 to address the dumping of salty potash mine residue (chlorides) by France. The Netherlands, the downstream state, demanded a halt to the practice in order to preserve its domestic water supplies. The solution was a treaty that split the cost of an expensive chloride removal system in France among four countries: France, Germany, the Netherlands and Switzerland. In the end, France decided to close the potash mines. Nonetheless, the treaty remains important to this day because it represents a basin-wide approach to a pressing water quality problem. The Netherlands did not insist solely on the principle that the "polluter must pay." Instead, the Netherlands agreed to underwrite part of the clean-up effort because it was cheaper for it to invest in pollution abatement in France than it was to build water purification facilities in its own country.[29]

V. The Litigation Quagmire

In most watersheds, the stakeholders – water supply agencies, electric utilities, farmers, shipping companies, environmental groups, fishermen, flood control agencies and regulators – all have their own set of objectives for managing a river or lake. But few bodies of water can meet all of those demands, particularly during times of drought.

Watershed allocation is often seen therefore as a "zero sum game." If someone "wins" by withdrawing more water from the river, someone else "loses." Extra withdrawals for irrigated agriculture, for example, mean less water in the river for power production. Larger flows in the river for navigation may conflict with the needs of a city that wants to withdraw water at the same time.

Water pollution problems are equally difficult to resolve. The downstream entity – public or private – usually bears the cost of the upstream polluter. Those costs are then shifted to the homes and businesses in that community which have to pay to remove the pollutants from the water.

The disagreements can linger for decades. In some parts of the world, water disputes can inflame (or are inflamed by) long-standing historical or ethnic grievances. Litigation and political posturing may also add to tensions, provoking a new round of lawsuits or public statements that make a negotiated settlement more difficult to achieve.[30]

Even if a court rules clearly in favor of one entity, the parties will spend a large amount of time, money and effort on their claims. And when they are done, the changing river conditions (e.g., drought, flood or diminishing environmental quality) may render the court decision irrelevant.

VI. The PWS Option

PWS transactions are an alternative to extended litigation or protracted regulatory disputes. They represent a different approach. The parties – by themselves or under the umbrella of a federal or state program – negotiate an economic arrangement. Someone buys a watershed service, such as reservoir space, a water right or a wetland. And that service has tangible value to the purchaser.

A PWS transaction therefore requires the parties to place a monetary value on the product or service. If an upstream state, for example, foregoes using part of a reservoir behind a dam for power production and instead leases part of the reservoir to a downstream state, the parties will need to calculate the value of this transaction.

The bottom line: In a PWS transaction, the parties sign an agreement – a business deal – in which they both seek to benefit, and at the same time, to implement cost-effective solutions that allow them to better manage their collective water resources.

VII. The Manager's Dilemma

In the last 20 years there have been significant advances in natural sciences and engineering. As a result, we have a much better understanding of watershed hydrology; the movement of pollutants in the environment; the protection of aquatic habitat; and the management of water resources for multiple objectives.

In addition, advances in computer modeling allow us to understand the interaction of surface water and groundwater, and we can assess how the ecosystem responds to the changing operation of man-made infrastructure. We now have a more sophisticated set of scientific tools to design and implement innovative water management practices.

Unfortunately, many reports on individual PWS transactions are not written in a manner that makes sense to someone outside of the watershed where the transaction occurred. It is often difficult to understand how much money has traded hands; how value was assigned to the watershed services; and whether the payments and implementation have achieved their desired effect.

The lack of information on PWS transactions poses a problem for river managers, utility executives, city officials and others. Suppose a river manager wants to learn more about PWS transactions to reduce flood risk. Where would he or she start their research? If a water agency manager wants to learn more about PWS payments to enhance irrigation efficiency, where does he or she turn to learn more? Suppose a city official wants to better understand the PWS mechanisms that his community could adopt to create a market-based system to reduce stormwater runoff. Where would he seek advice?

The manager would face three key "information gaps":

- There is no comprehensive database of major PWS transactions in the United States, let alone one that includes other nations. Some environmental groups have compiled a data base of PWS agreements that involve biodiversity in certain regions of the world. Those agreements are important but are limited in scope, and they do not address the myriad of other river management problems.[31]

- Many PWS studies focus on transactions to preserve forest or wildlife, not on operational agreements to foster more efficient use of water or to minimize the effects of pollution.[32]

- Many of the PWS reports do not answer the "lessons learned" question. The reports are vague – they have stunning photographs but little financial information. Have the PWS transactions worked and why? How much did they cost? Were the services and benefits delivered at the expected cost?

The managers can, of course, attempt to do their own research, but they may not have the budget or expertise to engage in the time-consuming effort of compiling and evaluating the information by themselves:

- Suppose that meteorological studies suggest that climate change will reduce the water supply by 20-30% in the coming decades within a watershed. Suppose, also, that river managers believe the watershed's population is expected to grow by 20-30% by 2030. What types of innovative river management agreements have been adopted elsewhere that might allow the basin states or water agencies to address this crisis? What kind of agreements would be most appropriate for their watershed? Do existing laws and regulations allow for the implementation of PWS transactions?

- Cities in a watershed are facing increased regulatory pressure to comply with federal mandates and to cut back on the amount of chemicals and nutrients they discharge into a river or lake. They want to establish an offset or trading program that allows them to buy and sell compliance credits. Where in the United States have cities experimented with this approach? What are the lessons learned?

- A downstream utility is concerned about the impacts of an existing dam owned by an upstream utility. The upstream utility – predictably – does not want to relinquish control over the operations of its dam. Suppose, however, that the downstream utility offers to pay money to lease a portion of the upstream reservoir (and thereby obtain rights to water which the downstream utility can release when it wants). Where has that type of arrangement been used? What payment options could the parties consider?

- The states or local governments in a watershed agree that fish and wildlife habitat is deteriorating, but they cannot agree on a joint funding mechanism to protect and restore the habitat. What types of joint funding arrangements have been used elsewhere?

The "information gap" is even more important if the water resources manager wants to prepare or implement an Integrated Water Resource Management ("IWRM") plan that examines the entire watershed as an ecological unit.

The typical IWRM plan seeks to integrate the major existing and potential uses (e.g., irrigation, power generation, navigation, flood control, fisheries and environmental protection) of the river. The plans – at least in theory – are a good vehicle for analyzing the range of problems in the watershed and identifying innovative solutions, like PWS transactions.[33]

Developing an IWRM plan, however, is easier said than done. How should the parties – particularly those in a watershed that crosses city, state or international borders – seek to resolve conflicts? Many IWRM plans do not address this subject, nor do they examine PWS transactions.

VIII. Closing the Information Gap

Closing the information gap involves different tools and disciplines: economics, law, water resources engineering, finance, computer modeling and others. There are a suite of skills that can help decision-makers to identify and analyze appropriate PWS transactions.

But PWS alternatives need to be tailored to the needs and objectives (and the political realities) of each watershed. What works in one watershed may not work in another. Information by itself is not a panacea.

That's where we come in. Over the years, we have studied water conflicts and solutions in the United States, Australia, India and elsewhere. To help water resource managers make more informed decisions, we have established a network of technical specialists who can bring expertise to the task at hand.

We offer three types of services to guide decision-makers through the process of identifying and implementing PWS transactions:

1. We can assess the current situation in a watershed and recommend potential PWS arrangements that can address water supply or water quality problems.

2. We can identify potential technical and regulatory pitfalls that the decision-maker is likely to encounter if it goes down the PWS path.

3. We can suggest pragmatic solutions that move the PWS agenda forward.

There are no easy "fixes," and the decision-maker will need a team of trusted and knowledgeable advisors. If you're interested in learning more, please contact us.

ENDNOTES

[1] www.eweb.org/sourceprotection/vip. EWEB is not using eminent domain (condemnation) to acquire property nor is it seeking to regulate private property owners (i.e., by imposing a setback on construction near the river). This is a voluntary program between willing property sellers and EWEB.

[2] The Clean Water Act, 33 U.S.C. § 1251 et seq., is the primary federal law in the United States governing water pollution. The U.S. Environmental Protection Agency ("EPA") administers the law, which consists of two separate programs. The National Pollutant Discharge Elimination System ("NPDES") program is a technology-based, end-of-pipe approach for individual facilities that have "point sources" of pollution (e.g., a pipe, ditch, conduit, container or other discrete conveyance). The Total Maximum Daily Load ("TMDL") program refers to the cumulative amount of a pollutant that can be legally discharged ("loaded") in a watershed from point *and* "non-point sources" (e.g., runoff from city streets, excess fertilizer from farms, sediment from forests, waste from livestock). The TMDL program represents an ecosystem approach, based on the water quality of the entire water body, and is invoked for impaired waters. The "load" limitations (e.g., for nitrogen or phosphorous) are then allocated to the various sources that contribute to the problem. EPA describes this approach as a "pollution diet." EPA, however, has no authority to implement or enforce TMDLs from *non-point* sources. That authority vests with the states.

[3] "Stormwater" refers to water that does not soak into the ground but runs off the streets and other impervious surfaces after a heavy rain. It is sometimes called "urban runoff." The water often contains oil residue, litter, pet waste and other materials. "Best Management Practice" is a term of art in the water pollution treatment and control industry in the United States. BMPs include engineered systems (e.g., filters) and non-structural modifications to a site (e.g., modified landscaping to reduce runoff). For a database of international stormwater BMPs, see http://bmpdatabase.org.

[4] An estimated 43% of Washington, D.C, is covered by pavement and other impervious surfaces (e.g., rooftops). Each year, the city's aging sewer system sends an average of 3.2 billion gallons of sewage and stormwater into nearby rivers during periods of heavy rain.

[5] http://ddoe.dc.gov/node/610572. Unlike the traditional approach of managing stormwater (e.g., by conveying the runoff from streets into the public sewer system), the D.C. program requires commercial property owners to retain stormwater on site by using a menu of BMPs so the water can be absorbed by soil.

[6] The largest water bank in the lower Colorado River Basin is owned by the Arizona Water Banking Authority ("AWBA"), www.azwaterbank.gov. Interstate banking (e.g., between Nevada and Arizona) takes place pursuant to federal regulations adopted by the U.S. Bureau of Reclamation, 43 CFR § 414.

[7] Daniel Seligman, *Laws of the Rivers: The Legal Regimes of Major Interstate River Systems of the United States*, Colorado River Commission of Nevada (2006), pages 223-234. For additional information, see the Interstate Commission on the Potomac River Basin website, www.potomacriver.org.

[8] *Id*. at pages 213-222.

[9] The utility is Clean Water Services, www.cleanwaterservices.org. It pays local conservation districts to plant trees along the river bank. The shade from the trees offsets the utility's TMDL limits. For information about the State of Oregon's TMDL program, see www.deq.state.or.us/wq/tmdls/willamette.htm. The Tualatin River is a subbasin of the Willamette River.

[10] www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=crp.

[11] www.nyc.gov/html/dep/html/watershed_protection/index.shtml. See, *The New York Times*, "City's Catskill Water Gets 10-Year Approval," April 13, 2007.

[12] http://washingtonwatertrust.org. See, also www.coloradowatertrust.org (Colorado) and www.thefreshwatertrust.org (Oregon).

[13] Since 1987, the Las Vegas Valley Water District has recharged water in an underground basin for itself and other members of the Southern Nevada Water Authority. See LVVWD's Water Resource Plan, www.lvvwd.com/about/wr.html.

[14] www.etowahwaterbank.com.

[15] The Cadiz proposal was developed in collaboration with the Santa Margarita Water District ("SMWD") and other water providers, www.cadizinc.com/water-project.

[16] www.epa.gov/chesapeakebaytmdl.

[17] Chesapeake Bay drains parts of six states (Delaware, Maryland, New York, Pennsylvania, Virginia and West Virginia) and the District of Columbia. The TMDL seeks to significantly reduce the levels of nitrogen, phosphorus and sediment released into the bay. For additional information about TMDL implementation activities in Maryland, see www.mde.state.md.us/PROGRAMS/WATER/TMDL/CHESAPEAKEBAYTMDL. For more information about implementation activities in Pennsylvania, see www.portal.state.pa.us/portal/server.pt/community/chesapeake_bay_program.
For information about nutrient trading in Virginia, see www.theexchangeassociation.org.

[18] The States of Connecticut and New York have implemented a nitrogen control program to limit the detrimental effects of hypoxia (low levels of dissolved oxygen) during summer. To reduce the TMDL of nitrogen, Connecticut relies on a Nitrogen Credit Exchange, established in 2002. www.ct.gov/dep/cwp/view.asp?a=2719&q=325572&depNav_GID=1635.

[19] According to EPA, there are 27 states with fledgling pollution trading schemes in place or under development. http://water.epa.gov/type/watersheds/trading/tradingmap.cfm.

[20] The National Mitigation Banking Association compiles a list of the mitigation banks in the United States, www.mitigationbanking.org.

[21] For more information, see www.sdcwa.org/water-transfer.

[22] Details of the transaction were spelled out in the Columbia River Treaty, ratified in 1964. For more information, see www.crt2014-2024review.gov. For additional background information, see Daniel Seligman, *World's Major Rivers: An Introduction to International Water Law with Case Studies*, published by the Colorado River Commission of Nevada (2008), pages 209-213.

[23] Numerous studies have examined Nestle's Vittel payments. See, for example, Daniele Perrot-Maitre, *The Vittel payments for ecosystem services: a 'perfect' PES case?*, International Institute for Environment and Development and the Department of International Development (2006).

[24] www.environment.gov.au/ewater/about/water-use.html.

[25] The trading program is managed by South Nation Conservation, a community-based watershed agency, www.nation.on.ca/en/about-us.

[26] http://waterinfo.nsw.gov.au/hunter/trading.shtml.

[27] www.nature.org/ourinitiatives/regions/latinamerica/water-funds-of-south-america.xml In 2011, the Nature Conservancy and its partners announced the creation of the Latin American Water Funds Partnership, in cooperation with the Inter-American Development Bank and the Global Environmental Facility, to create 47 water funds to protect watersheds on which approximately 50 million people rely. www.prweb.com/releases/2012/3/prweb9280276.htm The Nature Conservancy efforts began in 2000 in Quito, Ecuador, and have expanded to other countries. See, Goldman, R.L., Benitez, S., Calvache, A., and Ramos, A., *Water Funds: Protecting watersheds for nature and people*, The Nature Conservancy (2010).

[28] Qinfeng Zhang and Michael T. Bennett, *Eco-Cooperation for Watershed Services in the People's Republic of China*, Asian Development Bank (2011).

[29] Daniel Seligman, *World's Major Rivers: An Introduction to International Water Law with Case Studies*, published by the Colorado River Commission of Nevada (2008), pages 206-209.

[30] Two examples – one from the United States, the other from India – demonstrate how long litigation can drag on. In 1901, Kansas sued Colorado for diverting so much water from the Arkansas River in the central United States that the river ran dry in summer. The two states eventually signed an interstate compact (a contract) with each other but they became embroiled in a dispute over what the terms of the agreement meant. Legal battles continued intermittently until the U.S. Supreme Court issued a decision in 2004. The disputes over the Cauvery River in

India began in 1807. The disagreement eventually led to an 1892 agreement, followed by another dispute, an arbitration decision, an appeal of the arbitration decision to the Secretary of State in London, and then another agreement in 1924. The agreement ultimately proved inadequate to solve modern-day needs and led to a new round of disagreements, which continued intermittently until a tribunal issued a decision in 2007, two hundred years after the first recorded disagreement. The dispute continues to this day because several parties have filed appeals in the Supreme Court of India. For additional details, see Daniel Seligman, *A Comparison of the Way India and the United States Address Disputes on Interstate Rivers*, Working Paper (2011), published by the Institute of Water Policy, Lee Kuan Yew School of Public Policy, National University of Singapore, and available at http://lkyspp.nus.edu.sg/iwp/publications/working-papers.

[31] There are a number of limited databases, but they contain only environmental transactions or they focus on a specific region of the world. Typically, these databases contain limited financial information (e.g., it is difficult to tell who paid what to whom). See, for example, the Natural Capital Project, www.naturalcapitalproject.org. The project is a partnership created in 2006 between Stanford University, the Nature Conservancy and the World Wildlife Fund. See, also the Conservation Registry, an online repository of conservation projects in the United States, www.conservationregistry.org.

[32] The Katoomba Group, for example, has produced informative reports, but they are usually limited to environmental transactions rather than broader PWS agreements involving power management, irrigation and pollution control. See *Charting New Waters: The State of Watershed Payments 2012*, available at:
www.ecosystemmarketplace.com/pages/dynamic/our_publications.landing_page.php

[33] The Global Water Partnership in Stockholm, Sweden, is a source of information about IWRM activities around the world, www.gwp.org.