Groundwater Conservation: Conundrums and Solutions for the New Millennium

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"[T]he key issue is no longer resource development and water quantity but resource allocation and water quality."[1]

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The views expressed in this Article are solely those of the author and do not necessarily reflect the views of Mattioni, Ltd. or its clients.

1. R. MARIA SALETH & ARIEL DINAR, THE WORLD BANK GROUP, WATER CHALLENGE AND INSTITUTIONAL RESPONSE: A CROSS-COUNTRY PERSPECTIVE at iii (1999), *at* http://www.worldbank.org [hereinafter WATER CHALLENGE].

I. INTRODUCTION

In the 1960s, groundwater evaluation dealt with water quantity.[2] This changed in the 1970s, when groundwater quality, i.e., chemical contamination, became the major source of legal and scientific activity.[3] In the late 1990s and in this century, water quantity has come back into the fore: it is the new challenge.[4] For example, the United Nations has recognized that "water stands today as one of the most critical dangers, one of the most critical breakdowns of peace between nations. It has replaced the threat of war over oil."[5] The problem is not new. In 1979, the respected author and futurist, Isaac Asimov, noted that "[h]uman requirements . . . are rising rapidly. The use of water in the United States has increased ten fold in [the twentieth] century and at this rate it should not be many decades before need will be pressing hard upon supply."[6]

In rural United States, most of the population gets its potable water from groundwater.[7] Thus, "[i]n Louisiana more than 570,000 residents, comprising one hundred percent of the rural population, derive all their drinking water from private wells supplied by groundwater";[8] in Nebraska, groundwater "provides approximately 85 percent of the water used for human consumption."[9]

However, urbanization, urban sprawl, climate change,[10] and droughts worldwide[11] are stressing groundwater systems and sources. There are "three main causes of the impending . . . water crisis,"[12]

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2. R. ALLAN FREEZE & JOHN A. CHERRY, GROUNDWATER 1 (1979).

3. *See, e.g.*, Clean Water Act § 101, 33 U.S.C. § 1251 (1994); Resource Recovery and Conservation Act of 1976 § 1, 42 U.S.C. § 6901 (1994); Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 U.S.C. § 9601 (1994).

4. *See, e.g.*, Eric Planin, *Water War Engulfs the Missouri River: Bid to Divert Flow for Barges Under Fire*, WASHINGTON POST, May 20, 2002, at A3.

5. Wally N'Dow, Secretary General of the United Nations, Remarks at Habitat II Conference in Istanbul (June 1996), *quoted in* Steve Lonergan, *Forces of Change and the Conflict over Water in the Jordan River Basin*, *in* WATER IN THE MIDDLE EAST: A GEOGRAPHY OF PEACE 52-53 (Hussein A. Avery & Aaron T. Wolf eds., 2000).

6. ISAAC ASIMOV, A CHOICE OF CATASTROPHES 304-05 (1979).

7. ALBERT J. FRITSCH, RENEW AMERICA, COMMUNITIES AT RISK: ENVIRONMENTAL DANGERS IN RURAL AMERICA 1-2 (1989).

8. Itzchak E. Kornfeld, *Groundwater and Hazardous Waste Landfills Do Not Mix*, 5 TUL. ENVTL. L.J. 557, 559 (1992) (citation omitted).

9. William L. Kranz et al., *Understanding Groundwater*, *at* http://www.ianr.unl.edu/pubs/water/g1128.htm.

10. *This Year Was the 2nd Hottest, Confirming a Trend, U.N. Says*, N.Y. TIMES, Dec. 19, 2001, at A5; Robert Hanley, *The Drought Is Official, but No Restrictions Are Imposed*, N.Y. TIMES, Dec. 19, 2001, at D5; *Hotting Up*, NEW SCIENTIST, Feb. 19, 2000, at 23 ("The Earth's temperature has risen by 1°C over the past 500 years and half of the warming took place in the 20th century.").

> 1. Rapid urban population growth, increasing at the rate of 170,000 persons per day in developing countries [and hundreds per day in Arizona, California and Florida];
> 2. Fifty percent of all potable water is being wasted or lost in the developing world [and much is lost in the developing world due to an aging infrastructure]; and
> 3. Pollution, with over 2 million tons of human excrement and an ever-increasing volume of untreated discharge going into urban water supplies every day [as well as nitrogen and phosphorous from fertilizers, fecal matter flowing into streams in the U.S. and internationally].[13]
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> In the developing world, more than 1 billion people do not have access to clean drinking water, and 1.7 billion people lack access to adequate sanitation facilities. The U[nited] N[ations] [notes] that dirty water causes 80 percent . . . of diseases in the developing world and kills 10 million people annually.[14]

Humankind faces other perennial problems related to groundwater. Overpumping of aquifers[15] has caused land subsidence in cities such as Mexico City, Mexico, and Bangkok, Thailand, complicating the dilemma.[16] In coastal states such as Florida and California, over pumping of aquifers has led to saltwater intrusion,[17] increasing the salinity of the groundwater.[18] Overpumping of wells also triggers a decline in the water table.

> At a minimum, it adds to pumping costs and increases the amount of energy needed for pumping. More importantly, a lower water table reduces

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11. *See, e.g.*, U. S. DEP'T OF AGRIC., WORLD AGRICULTURAL OUTLOOK BD., WORLD AGRICULTURE WEATHER HIGHLIGHTS, *at* http://www.usda.gov/oce/waob/jawf/wawh/0007wawh.pdf (July 12, 2000) (reporting severe drought in Manchuria and South Korea); MARQ DE VILLIERS, WATER 5 (2000) ("In the 1990s the Kalahari region and Angola [both in southwestern Africa] suffered from the worst drought of the century."); PA. DEP'T OF ENVTL. PROT., DROUGHT WARNING DECLARED IN 17 SOUTHEASTERN PA COUNTIES, *at* http://www.dep.state.pa.us/newsreleases (Oct. 27, 1997) [hereinafter DROUGHT WARNING]; Deborah Sharp, *Florida Drought Scares Officials*, USA TODAY, Feb. 27, 2001, at 3A.

12. Lonergan, *supra* note 5, at 53.

13. *Id.*

14. *Id.* (citing WORLD RESOURCES INST., WORLD RESOURCES 105 (1996)).

15. "An aquifer is a saturated permeable rock layer that will provide water in a useable quantity for a well or spring." Kornfeld, *supra*, note 8, at 569.

16. Lonergan, *supra* note 5, at 54.

17. *See, e.g.*, Friends of the Earth v. Corps of Eng'rs, 109 F. Supp. 2d 30, 39 (D.D.C. 2000) ("[T]he increased draw on aquifers could lead to saltwater intrusion into the groundwater."); Artesian Water Co. v. New Castle County, 659 F. Supp. 1269, 1283 n.23 (D. Del. 1987) ("[A] moratorium on increased pumpage to limit salt-water intrusion.").

18. FLA. ST. UNIV. PROGRAM FOR ENVTL. POL'Y & PLANNING SYS., STRATEGIC ASSESSMENT OF FLORIDA'S ENVIRONMENT (SAFE), *at* http://www.pepps.fsu.edu/safe/environ/wqn4.html (last updated Jan. 22, 2002).

> pressure in the aquifer and permits lower quality water to flow inward and contaminate the fresh water of the aquifer. [For example Israel's] Coastal Aquifer in its natural state is 3-5 m[eters] above sea level, a level that, with the force of gravity, creates an outward pressure that blocks the inflow of seawater. Pumping, or more accurately overpumping, has lowered the fresh water level below sea level so that this effect is reversed, and salt water from the Mediterranean can now be found 1-3 km [kilometers] inland.[19]

Saltwater intrusion is polluting aquifers around the world. For example, saltwater or chlorine salt levels in the Coastal aquifer[20] has risen to concentrations which are three times the World Health Organization (WHO)-recommended levels.[21]

This Article addresses a number of the problems/issues related to conservation of groundwater, e.g., agricultural contamination of aquifers, intensifying salinity of groundwater, construction runoff, and suggests a number of conservation strategies for aquifers. Part I sets out the worldwide problem, with a focus on Israel, a country that has experienced a chronic water shortage for most of its fifty-three years of statehood. Part II suggests some sustainable or conservation methods aimed at protecting aquifers, Smart Growth solutions, recycling water, and importing water.

II. AQUIFERS UNDER ASSAULT

A. Growing Decay: The Agricultural Revolution

"If we had our time again we would do it differently."[22]

We must all eat. And every country due to national pride or national security seeks to be agriculturally self-sufficient, sometimes to its own folly. Thus, in many regions, water intensive crops, like cotton, whose ecological niche is the water rich Nile and Mississippi deltas, have been transplanted and encouraged to grow in water-poor deserts, e.g.,

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19. STEPHEN C. LONERGAN & DAVID BROOKS, WATERSHED: THE ROLE OF FRESH WATER IN THE ISRAELI-PALESTINIAN CONFLICT 105-06 (1994).

20. The Coastal Aquifer is situated along the Mediterranean coastline in Israel, from Caesarea, which lies south of Haifa, and trends southward past Gaza and into Egypt. Aaron T. Wolf, *"Hydrostrategic" Territory in the Jordan Basin: Water, War, and Arab-Israeli Peace Negotiations*, *in* WATER IN THE MIDDLE EAST: A GEOGRAPHY OF PEACE 65 (Hussein A. Avery & Aaron T. Wolf eds., 2000); LONERGAN & BROOKS, *supra* note 19, at 32.

21. AMERICAN UNIVERSITY TRADE & ENVIRONMENT DATABASE, ISRAELI WATER USE AND EXPORTS, *at* http://www.american.edu/ted/ISRAELH2.htm (last updated June 1, 1998) [hereinafter ISRAELI WATER USE].

22. Michael Parfit, *Australia—A Harsh Awakening*, NAT'L GEOGRAPHIC, July 2000, at 9, 10.

California and Israel.[23] In developing and developed countries alike, agriculture accounts for the majority of all water use, including that of groundwater. For example, in Mexico agriculture accounts for 66% of the total groundwater use;[24] Spain's agricultural share of water is 81%;[25] in Morocco, of the total water utilized, agriculture accounts for 90%;[26] Israel's share of water is 63%;[27] in South Africa agriculture accounts for 55% of the water use, including 37% of total groundwater currently developed and utilized;[28] and in Australia agriculture accounts for approximately 80% of the total water use.[29] Given these total percentages, not very much is left for domestic or industrial use.

As populations increase, domestic consumption will require a greater share of the water and certainly the groundwater water budget. In Florida, where the population is increasing by over 500 people per day;[30] in Chile, where the domestic consumption currently runs at about 6%;[31] and in Israel, where the domestic share of water is approximately 30%,[32] the assured increase in population will demand that more water will need to be allocated for domestic consumption.

The situation in Israel is illustrative of the problem. "As Israel has already exhausted its fresh water supply, the only additional supply sources available within its borders are the indirect supplies from treated sewerage and water saving effected from strict demand-side management."[33] Additionally, the Israeli example serves as another portend of things to come.

> Since domestic and industrial sectors have higher priority, the fresh water allocation to agriculture is declining but the allocation of brackish and treated sewerage waters is increasing. With relative water scarcity and high

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23. For example, California's Imperial and Coachella valleys have bloomed with cotton and other water-intensive crops made possible by irrigation from the Colorado River, via the All American Canal, a distance of over eighty miles. In 1964 Israel constructed "an integrated system of large diameter pipes and reservoirs," called the National Water Carrier, that "carries water from Lake Kinneret [the Sea of Galilee] to the central and southern regions of the country." LONERGAN & BROOKS, *supra* note 19, at 61.

24. WATER CHALLENGE, *supra* note 1, at 6.

25. *Id.* at 11.

26. *Id.* at 13.

27. *Id.* at 15.

28. *Id.* at 16.

29. *Id.* at 22.

30. *See* STRATEGIC ASSESSMENT OF FLORIDA'S ENV'T (SAFE), ABSOLUTE POPULATION GROWTH, *at* http://www.pepps.fsu.edu/safe/environ/popl.html.

31. WATER CHALLENGE, *supra* note 1, at 7.

32. *Id.* at 15.

33. *Id.* at 14.

> cost of fresh water for irrigation, the irrigation sector . . . is constantly substituting capital and technology for water.[34]

"Long-term and intensive development of agricultural activities in arid climates may lead to . . . decreas[es] of agricultural productivity due to the deterioration of groundwater quality and increasing of soil salinity."[35] Examples can be seen in the Arava/Araba[36] Valley of Israel and Jordan, as well as the Jezreal Valley of Israel. In the Arava/Araba Valley alluvial aquifers are being invaded by brackish water following thirty years of intensive agriculture, which is causing such high soil salinity that farmers are forced "to look for newly developed salt-tolerant crop species, and to adopt advanced yet expensive, irrigation technology."[37]

In Israel's Jezreal Valley wetlands and marshes were drained and filled at the turn of the twentieth century.[38] Following the fill, large drainage systems were constructed turning the area into the most fertile land in the northern part of the country.[39] Due to the construction of large water storage reservoirs, used for treated effluent, farmers were able to cultivate and grow water intensive crops such as cotton and corn.[40] In the 1970s high groundwater levels caused by the storage reservoirs spawned large saline areas "forc[ing] farmers to abandon large cultivated areas . . . [which enhanced] upward leakage of brackish water to the topsoil."[41]

Similarly, near Perth in Western Australia, the clearing of forests of eucalyptus trees has caused shallow layers of salt in the soils of the country's wheat belt.[42]

> When farmers cleared millions of acres of land and the trees no longer protected the aquifers, the water table rose to the surface, bringing the salt up with it. . . . Today about 10 percent of the wheat belt of Western Australia has been affected by salt, a total of about 4.5 million acres.

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34. *Id.* at 15.

35. Eilon M. Adar, Maintaining Long-Term Water Quality for Sustainable Development of Rural Communities and to Avoid Desertification, presented at the University of Bonn, Expo 2000-Global Dialogue Conference 2 (Aug. 16-17, 2000), *at* http://www.zef.de/gdialogue/program/papers/papers_day2/sid-water-adov.pdf.

36. Israel refers to the area south and west of the Dead Sea as the Arava. Jordan refers to this area and the area to the east and south of the Dead Sea as the Araba.

37. ADAR, *supra* note 35, at 3.

38. *Id.* at 4.

39. *Id.*

40. *Id.* (citing Eilon Adar et al., *Modeling of Salinization Processes and Flow Patterns in Semi-Arid Shallow Aquifers by Isotope Hydrochemistry*, *in* APPLICATION OF ISOTOPES AND NUCLEAR TECHNIQUES TO THE STUDY OF HYDROLOGY IN ARID AND SEMI-ARID REGIONS (Isotope Hydrology—IAEA ed., 1989)).

41. *Id.*

42. Parfit, *supra* note 22, at 9.

(Another 1.75 million acres are affected in southern and eastern Australia).[43]

But the damage is not yet done. Scientists estimate that as much as 40% of Western Australia's wheat belt may be damaged within a few decades.[44] "This not only wrecks fields but also threatens to turn city supplies salty."[45] In an effort to stop the damage and to lower the water table, some farmers are planting trees[46] similar to those cleared since the 1930s. However, because this effort is not widespread, "farmers will have to accept further engineering losses, while cities build diversions and other works to protect their drinking water supplies."[47]

"What makes hindsight so poignant . . .? Perhaps it's that a part of the originality of [the land] has been lost to human error."[48] As the Israeli and Australian examples demonstrate, the impacts of farming, building and other activities can cause unintended consequences.

B. The Bottled Water Explosion

Bottled water consumption has increased exponentially over the last several years, making it a $6 billion-a-year business, expending over 5 billion gallons of water in the year 2000 alone.[49] As one industry spokesperson pointed out, "bottled water . . . could surpass staid, mature milk and established, stable beer to become the second most consumed commercial beverage in the U.S. within just a few years."[50] As with any nonrenewable resource the more that is used, the less remains in place. The effects of such overuse has already been felt in regions such as British Columbia, where "the Canadian Beverage Corp. has been mining the groundwater of the region so relentlessly that local residents and orchard growers say the company is 'draining their water supply dry.'" [51] In the United States, "proposals by bottlers to pump huge amounts of water from rural communities—in some cases as much as 500 gallons

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43. *Id.*
44. *Id.*
45. *Id.*
46. *Id.*
47. *Id.* at 10.
48. *Id.*
49. *See* JOHN RODWAN, INT'L BOTTLED WATER ASS'N, THE FACTS ABOUT BOTTLED WATER 2, *at* http://Bottleldwater.org/public/pdf/USAToday_fined.pdf (last visited May 10, 2002); *see also* ERIK D. OLSEN, NATURAL RESOURCES DEFENSE COUNCIL, BOTTLED WATER: PURE DRINK OR PURE HYPE? 1 (1999).
50. RODWAN, *supra* note 49, at 2.
51. Maude Barlow, Council of Canadians, Blue Gold: The Global Water Crisis and the Commodification of the World's Water Supply, *at* http://www.canadians.org/blueplanet/publications/eng_bluegold-theglobal.html.

per minute—have drawn intense opposition in Michigan and at least five other states: Florida, New Hampshire, Pennsylvania, Texas and Wisconsin."[52]

Water movement in aquifers is determined by the "hydraulic gradient or slope of the water surface between two points in an aquifer . . . . Groundwater moves from high water surface elevations (high pressure or head) to low water surface elevations (low pressure or head)."[53] Thus, any new wells drilled in order to exploit new supplies would drain the aquifer so that it could not drain laterally to feed streams or springs within the watershed.[54]

As bottled or spring water use intensifies, aquifers will become more and more depleted and stream flow will decline. This phenomenon will then cause greater withdrawal pressure on aquifers and the cycle will continue.[55]

C. Rebuilding Construction

The main contributors to groundwater contamination in the last century have been leaking underground storage tanks, landfills, and septic systems.[56] These storage facilities are now closely regulated by the federal government following the enactment of the Resource Conservation and Recovery Act,[57] and the potential harm they offer should diminish accordingly. However, urban sprawl remains for the most part uncontrolled and as a phenomena only grows.[58] In many metropolitan areas of the United States, as the older ring of suburbs are extended and green fields are converted into housing stock, the recharge of aquifers is either inhibited or polluted as a result of water being diverted by new concrete and asphalt covers required for roads, sidewalks, and parking lots.

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52. Joan Lowry, *Water Wars Pit Bottlers vs. Residents*, GRAND RAPIDS PRESS, Sunday, Mar. 31, 2002, at A1, *available at* 2002 WL 4769952.

53. Kranz, *supra* note 9.

54. Interview with M. Dukes Pepper, Jr., Supervising Attorney, Office of Chief Counsel, Pennsylvania Department of Environmental Protection (Nov. 3, 2001).

55. *But see* RODWAN, *supra* note 49, at 2 (stating that "the amount of groundwater withdrawn in America by the bottled water industry is statistically insignificant and dwarfed by that of other industries such as energy, agriculture, food processing and manufacturing." However, bottled water demand is estimated to be increasing by at least 10% annually. *See id.* Such growth can only exacerbate the shortages some local communities are already experiencing. See Lowry, supra note 52.

56. *See generally* EPA, NATIONAL WATER QUALITY INVENTORY: 1996 REPORT TO CONGRESS (1997).

57. 42 U.S.C. § 6991 (1998).

58. *See* Rose A. Kob, *Riding the Momentum of Smart Growth: The Promise of Eco-Development and Environmental Democracy*, 14 TUL. ENVTL. L.J. 139, 141-43 (2001).

However, the Clean Water Act has influenced land use patterns, thereby impacting governmental attempts to encourage "smart growth."[59] "Smart growth" is an approach "to development that emphasizes greater density, mixed uses, redevelopment of underused areas, transportation choices, and open space protection."[60] It has been suggested that the stormwater permit program of the Clean Water Act[61] can be used effectively as a smart growth tool.[62]

In reauthorizing the Clean Water Act in 1987,[63] Congress enacted provisions which established a schedule for the permitting of industrial and municipal discharges of stormwater.[64] The first phase of the scheduled permitting regulates discharges from large municipal separate stormwater sewer systems (MS4s), industrial activity, and activities at large construction sites discharges. Phase two, enacted in 1999,[65] regulates discharges from MS4s "in smaller urbanized areas and activities at smaller construction sites."[66] The Industrial and Urban Stormwater Permitting Program, and the Combined Sewer Overflow/Sanitary Overflow (CSO/SSO) programs, deal with "pollution effects resulting from precipitation running off urban and industrial land, and the lack of treatment for some sanitary sewage in waste water treatment systems that also convey substantial stormwater."[67]

Another program is the Total Maximum Daily Load (TMDL) Program under the Clean Water Act's § 303(d),[68] "which requires states to

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59. JAMES M. MCELFISH, JR. & SUSAN CASEY-LEFKOWITZ, NORTHEAST-MIDWEST INSTITUTE, SMART GROWTH AND THE CLEAN WATER ACT 3 (2001), *at* http://www.nemw.org/sgcleanwater.pdf [hereinafter SMART GROWTH]; *see* Clean Water Act § 101, 33 U.S.C. § 1251 (1994).

60. *Id.*; *see also* NAT'L GOVERNOR'S ASS'N, NR-13, PRINCIPLES FOR BETTER LAND USE POLICY (1999), *available at* http://www.nga.org/nga/legislativeupdate/1,1169,C_POLICY_POSITION^D_662,00.html.

61. The permit program is termed the National Pollution Discharge Elimination Permit or NPDES. *See* 33 U.S.C. § 1342. NPDES Storm Water Discharge Permits may be issued for construction activities requiring the "implementation of an approved, site specific erosion and sedimentation pollution control plan, which included maps, plans, profiles, specifications, and any approved amendments thereto." *Leeward Constr., Inc.*, No. 99-257-L-CP, slip op. at 2 (Pa. Envtl. Hearing Bd. Oct. 1, 2001) (final admin. review).

62. SMART GROWTH, *supra* note 59, at 3.

63. Pub. Law No. 100-202, 405 Stat. 1987 (codified as amended at 33 U.S.C. § 1342 (1994)).

64. 33 U.S.C. § 1342(p).

65. National Pollutant Discharge Elimination System—Regulations for Revision of Water Pollution Control Program Addressing Storm Water Dischargers, 64 Fed. Reg. 68,722 (Dec. 8, 1999) (to be codified at 40 C.F.R. pts. 122-124); *see also* EPA Pub. No. 833-F-99-020, REDUCING POLLUTED RUNOFF: THE STORM WATER PHASE II RULE (1999).

66. SMART GROWTH, *supra* note 59, at 3.

67. *Id.* at 9.

68. 33 U.S.C. § 1313(d).

establish wasteload allocations for point sources and load allocations for nonpoint sources that are contributing to the failure of identified waters to meet water quality standards."[69]

These Clean Water Act Programs were promulgated with the intent of improving water quality; some communities are meeting the goals of these programs by reducing the amount and extent of impervious surfaces.[70] Limiting the extent of those surfaces reduces runoff quantity and improve water quality, provides new or rehabilitated infrastructure capacity sufficient to capture and treat untreated sewage discharges and reduces rainwater inflow into older systems carrying sanitary sewage. The reduction of impervious surfaces allows more pervious area for recharge and infiltration of water into aquifers. When aquifers are recharged, by definition, they are able to produce more water for domestic and other consumption.

III. SOLVING THE IMPASSE

A. Smart Growth Solutions

1. Charlotte, North Carolina

Charlotte, North Carolina, and its metropolitan area have embraced Smart Growth principals in order to cope with the impacts of rapid population growth, which has led to both sprawl and the degradation of surface water quality from storm water runoff.[71] The Charlotte-Mecklenburg Metropolitan area is one of the fastest growing in the nation. The county grew from 419,000 in 1990 to more than 660,000 residents in total in 1997, according to the county's State of the Environment Report.[72] Additionally, that report projected an addition of 200,000 people and 120,000 homes in the next twenty years.[73] This rapid rate of growth is projected to cause increased pollutant loading into the county's creeks, turning all of them into "mere urban conduits for stormwater runoff and waste simulation."[74]

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69. SMART GROWTH, *supra* note 59, at 9; *see also* Oliver A. Houck, *TMDLs: The Resurrection of Water Quality Standards-Based Regulation Under the Clean Water Act*, 27 ENVTL L. REP. 10,392 (1997).

70. *See* Tahoe-Sierra Pres. Council, Inc. v. Tahoe Reg'l Planning Agency, 122 S. Ct. 1465, 1471-73 (2002); Friends of the Earth, Inc. v. U.S. Corps of Engineers, 109 F. Supp. 2d 30, 37 (D.D.C. 2000).

71. SMART GROWTH, *supra* note 59, at 26; *see also* Mecklenburg Country Dep't of Envtl. Protection, Surface Water Improvement & Mgmt., *at* http://www.co.Mecklenburg.nc.us/coenv/water/swim_background.htm.

72. *Id.*

73. *Id.*

74 *Id.* (citation omitted).

Charlotte received a Phase 1 NPDES stormwater permit in 1993, which required the implementation of a management plan to reduce pollution from its MS4.[75] In 1995, the Charlotte-Mecklenburg Metropolitan area created the Surface Water Improvement and Management (SWIM) program to protect regional surface waters through the utilization of a basin approach.[76] SWIM had two components: first an educational campaign and then the establishment of a "Creek Use Policy" designed to restore surface waters such as streams and lakes.[77] As part of the Creek Use Policy, erosion control and stream buffer requirements were put into place for development activities.[78]

The next phase in the county's implementation of Smart Growth principles was the adoption of measures to implement the Creek Policy "including aggressively seeking to protect greenways and buffers along waterways and supporting stricter permit limits for discharges."[79] Thereafter, in 1999, both Mecklenburg County and the City of Charlotte adopted a plan to set aside buffer zones and to establish mitigation requirements, which are to be used in development and to effect public infrastructure in stream side areas.[80] Furthermore, the plan also created development incentives such as the dedication of open space in development and reducing setback requirements to accommodate encroachment of the buffer on the buildable parcel.[81]

"Other approaches include cluster development, conservation development, and related designs that site structures closer together on the smaller portion of the tract. Usually, this preserves more open space, makes it possible to separate impervious surfaces from natural waterways, and reduces the total impervious surface."[82]

2. Lacey, Washington

Lacey, Washington, pioneered a performance-based approach that offers "zero effective impervious surface projects" as an alternative to drainage basins, stormwater ponds, maintenance regimes, and other

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75. *Id.*
76. *Id.*
77. *Id.*
78. *Id.*; *see also* N.C. Emergency Mgmt. Case Study—Mecklenburg County Water Quality, *at* http://ncem.org/mitigation/case_Mecklenburg.htm.
79. *Id.*
80. *Id.*
81 *Id.*
82 *Id.* at 27 (citing generally RANDALL ARENDT, RURAL BY DESIGN (1994)).

stormwater controls.[83] The town implemented an ordinance that "allows the waiver of these requirements when the project design uses alternative techniques to eliminate stormwater collection and discharge impacts."[84] Thus, a developer may replace "all driveway and parking areas with pervious materials; native landscaping and planting with greater capacity for slow runoff and take up and transpire the water; smaller rooftop exposures and/or rooftop gardens; or narrow roadways with substantial vegetative berms."[85]

3. More Diamonds in the Rough

Other strategies include linking stormwater fees to the size of impervious surfaces. This is done in many communities, including Takoma Park, Maryland; Boulder, Colorado; Lansing, Michigan; Durham, North Carolina; and Portland, Oregon.[86] In Portland, Oregon, for example, "stormwater fees are linked to land use by assessing all non-residential properties at a rate of about four dollars per 1,000 square feet of impervious area. In 2000, the City is considering revisions" to the plan.[87]

These novel and expansive methods are now combating the old ways of developing property.

B. Recycling Water

One solution to the problem of aquifer depletion is water reuse. This type of recycling represents a practical and reliable means of extending water supplies in areas experiencing water shortage.

> Sonoma County, in the heart of California's wine country, is reusing water to assure adequate supplies for drinking water, commercial and agricultural uses. The three million gallons per day (mgd) water reuse facility treats secondary effluent from a partially aerated lagoon treatment plant near the county airport in Santa Rosa. The reused water will irrigate fields near the airport and some of the many nearby vineyards.[88]

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83. *Id.* at 28; *see also* LACEY, WASH. MUNICIPAL CODE ch. 14.31 (1999).

84. *Id.*

85 *Id.* (citing Inside Washington Publishers, *Washington Towns Planned Test of Low Runoff Building Techniques*, REINVENTION REP., Oct. 20, 1999, at 6.)

86 *Id.* at 29; *see also* Smith Chapel Baptist Church v. City of Durham, 517 S.E.2d 874, 877 (N.C. 1999); Bolt v. City of Lansing, 587 N.W.2d 264, 277 (Mich. 1998).

87. *Id.*

88. Tom Wingfield & Jim Schaefer, *Making Water Work Harder*, ENVTL. PROT., Nov. 2001, at 30-31, *at* www.Environmental-center.com/articles/article1066/Article1066.htm.

The City of Chandler, Arizona, has recently attracted several large semi-conductor manufacturers by providing infrastructure necessary for their growth.[89] Chandler reclaims 80% of the waters used in the manufacturing process, which is used to recharge the local aquifer.[90] A portion of the remaining 20% is used for irrigating the landscape and for make-up water for cooling towers.[91] Similarly, Israel has reused water in its agricultural segment for years.[92]

Other solutions to slow the use of groundwater include drip irrigation, which is much more efficient than the usual irrigation, with canals and ditches.[93] For example, in China "90% of water used each day" is saved using this technique.[94] This technique also reduces "erosion, as compared to conventional irrigation, [s]o though it requires larger initial investments, drip irrigation is clearly a much less expensive way to farm for the long term."[95]

Additional conservation measures include reduction of water-intensive fruits and vegetables. For example, Amikam Nachmani, a water expert from Israel's Bar-Ilan University's Center for Strategic Studies recently stated "that by exporting water-intensive avocado, cotton, citrus and mango to Western European countries, Israel is in effect exporting water to places which have it in abundance."[96] Additionally, "reservoirs which collect runoff . . . or store treated sewage water can be an effective-and relatively low-cost means of preventing a worsening water shortage."[97]

1. Municipalities Should Be Encouraged to Do More Housekeeping

"Tons of water are wasted every year because of rusty or broken pipes which are not regularly replaced . . . local authorities don't funnel all the water and sewage taxes they collect back into the system . . . ."[98] In order to encourage municipalities and individuals to replace broken or

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89. *Id.*
90. *Id.*
91. *Id.*
92. *See generally* ADAR, *supra* note 35 and accompanying text.
93. Donovan Webster, *China's Unknown Gobi Alashan*, NAT'L GEOGRAPHIC, Jan. 2002, at 48, 70.
94. *Id.*
95. *Id.*
96. Liat Collins & Etgar Lefkovits, *To the Last Drop*, JEWISH TRIB., Dec. 1-7, 2000, at 12, 13.
97. *Id.* (quoting Shaul Arlosoroff, Chairman of the Water Engineers Association and the Public Committee for the Management of Water Resources in Israel).
98. *Id.* (quoting Raphael Semiat, Head of the Rabin Desalination Laboratory at the Technion University of Haifa's Water Institute).

old piping and fixtures both the federal, state and municipal governments should consider tax credits or grants such as the Clean Water Act's § 201 Grants for Construction of Treatment Works.[99] The grants program encourages employing the best practicable measures for waste treatment management, which helps clean surface waters in the United States.[100] Given the pervasive drought and overuse of water throughout the United States, Congress should consider a grant program, similar to the Marshall Plan, reinvigorating the replacement of pipes in cities and other municipalities, which in many cases are over 100 years old.

C. Importing Water

One other solution is to import water from water-rich areas to water-poor areas. This enterprise has been in use and also has been proposed in Texas.[101] David W. Yoskowitz has suggested that the "concept of water marketing is not new but has recently come into vogue as a means in which to transfer water to thirsty cities. The attractiveness is that in many, but not all, cases the price and quantity are set by the contracting parties rather than regulating agencies."[102] Dr. Yoskowitz also points out that

> marketing groundwater is no longer limited to a specific region. Mesa Water, Inc., and its owner, T. Boone Pickens, has proposed sending 200,000 acre-feet of water per year from the panhandle of Texas south to San Antonio. The pipeline to transfer this water would cover a distance of 665 miles at a cost of $2.5 billion. Even with the large infrastructure, the cost of delivery would be just in excess of $1,000 per acre foot. Currently, Edwards Aquifer Water Rights, the main source of water for [the city of] San Antonio, range from $700-$1000 per acre foot, making the Mesa water deal worth considering according to water utilities' personnel in San Antonio.[103]

Similarly, in January 2001, a delegation of Israelis traveled to Turkey to discuss importing water.[104] The water from Turkey would be pumped into large rubber balloons, strung together and towed by barge

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99. 33 U.S.C. § 1281 (1994).

100. *Id.* § 1281(b).

101. *See, e.g.*, David W. Yoskowitz, *Markets, Mechanisms, Institutions, and the Future of Water*, 31 ENVTL. L. REP. 10,237 (2001).

102. *Id.*

103. *Id.* at 10,241

104. David Rudge, *Delegation Going to Turkey to Discuss Importing Water*, JERUSALEM POST INTERNET ED. (Jan. 17, 2001), *at* http://www.jpost.com...ns/2001/01/17/News/News.19668.html.

from Turkey to Israel's southern port in Ashkelon.[105] Although this space age solution is being considered, the "most likely form of transport considered so far has been converting oil tankers and cleaning their holds thoroughly so they could take fresh water without it being contaminated."[106]

Importing water is not a new concept. The ancient Romans built aqueducts to transport water from one locale to another. However, importation will only continue in the future as long as there are water-rich communities willing and able to share their resources for an affordable price.

D. Can Our Thirsts Be Quenched? Limiting Groundwater Withdrawal

Limiting groundwater withdrawals will force people and businesses to appease their thirst and limit the use of this precious resource. It is not an unprecedented act. Droughts, especially severe ones, generally cause municipalities or state governments to limit car washing, as well as watering of lawns. People can manage quite well with limited use of water. For example, on December 18, 2001, the Delaware River Basin Commission (DRBC)[107] issued a drought emergency limiting Pennsylvania's withdrawals from seventy-six watersheds due to the 2001 drought.[108] The DRBC's rationale is premised on its Pennsylvania groundwater regulations[109] whose goal is to prevent depletion of ground water and rights of lawful users of the same water source, as well as to balance and reconcile alternative and conflicting uses of limited resources in the region.[110]

Similarly, in 1973 the Delaware Department of Natural Resources and Environmental Protection (DNREC) limited the Artesian Water Company's withdrawals from its Llangollen Wellfield, south of Wilmington, Delaware.[111] The restriction reduced the withdrawals from a peak of 5.35 million gallons per day (MGD) to 2.0 MGD.[112]

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105. *Id.*

106. *Id.*

107. The Delaware River Basin Commission is an interstate federal agency charged with managing and regulating waters in the Delaware Basin, incorporating Delaware, New Jersey, New York, and Pennsylvania. DEL. RIVER BASIN COMM'N, HOME PAGE, WHO WE ARE, *at* http://www.state.nj.us/drbc/whoweare.htm.

108. *See* DEL. RIVER BASIN COMM'N, DROUGHT EMERGENCY IN THE DELAWARE RIVER BASIN, *at* http://www.state.nj.usdrbc/drought121801_press.htm (last visited May 10, 2002).

109. 25 PA. CODE § 901.5 (2001) (incorporating 18 C.F.R. § 430 (2001)).

110. 18 C.F.R. § 430.3.

111. Artesian Water Co. v. New Castle County, 659 F. Supp. 1269, 1275 (D. Del. 1987).

112. *See id.*

These examples should be followed when times do not call for severe measures. It is like dieting. One becomes accustomed to eating less. If municipalities, states, and the federal government—on Indian lands and public properties—introduce a "water diet" there will also be a "rainy day" fund: more water for domestic consumption.

E. Planting Trees and Cleaning Water

It is no secret that vegetative and pervious ground maximize recharge.[113] However, development of exurbs and their concomitant sealing of greenfields with concrete and asphalt inhibit infiltration of water into aquifers. "Forests are a key to clean water. About 80% of the nation's fresh water sources originate in national forests, where the timbered land absorbs rain, resupplies underground aquifers, cleanses water, and slows storm runoff as it flows into streams and rivers."[114]

Tree planting has been a long-standing method of preserving the environment. For example, the Jewish National Fund, was established in 1901 "to acquire land for the Jewish people's resettlement in the land of Israel" and to plant trees.[115] The JNF has planted over 200 million trees reclaiming more than 300,000 acres. "To maximize meager Negev [desert] water resources, JNF has built dams and reservoir to capture floodwaters for irrigation and replenishment of underground aquifers."[116]

Tree councils in numerous cities have been established for "outreach and education that promotes responsible stewardships of trees and sustainability of community forest resources."[117] If we increase the pervious area of a region and plant it with indigenous trees we can attempt to restore the damage that has been done thus far. In desert areas the example of the JNF can be followed: the organization has "experimented with 'savannization' to develop an ecologically sound system for the management of desert eco systems"[118] and increase recharge into aquifers.

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113. *See Selling the Forests*, N.Y. TIMES, Dec. 29, 2001, at A32.

114. Paul Nussbaum, *To Protect Water Sources, U.S. Is Pushing Restoration of Forests*, PHILA. INQUIRER, Mar. 1, 1999, at C1.

115. INT'L ARID LANDS CONSORTIUM, IALC FOUNDING MEMBER INSTITUTION, *at* http// ialcworld.org./About/JNF.html (last updated July 13, 2000) [hereinafter IALC].

116. *Id.*

117. *A-C Looking for Community Tree Council Volunteers*, ATHENS (GA.) BANNER-HERALD (Oct. 7, 2001), *available at* http://www.onlineathens.com/stories/100701new_1007010063.shtml.

118. IALC, *supra* note 115, at 1.

IV. CONCLUSION

In many areas of the world, including various parts of the United States, shortage of water is perhaps the most critical environmental and development problem. There is only a finite amount of fresh water. Therefore, conservation and sustainable measures must be taken, at least to some degree. Agricultural pressures contribute to the depletion and degradation of water resources. "The problem of water . . . is not a legal issue, but rather one of circumstance."[119]

Crises almost always engender action. The persisting drought that has plagued parts of the world over the previous few years has caused governments to take action to preserve needed drinking or potable water. These measures include drastic steps aimed at preserving groundwater. For example, in Pennsylvania, where over fifty percent of the population gets its potable water from groundwater the Commonwealth's Department of Environmental Protection (PADEP) has instituted a drought watch.[120] Similarly, Israel has been hit by drought for the past three years, causing the Sea of Galilee to drop over 300 feet to 698 feet below sea level, the lowest it has been since the founding of the state.[121]

Novel solutions, e.g., Smart Growth solutions, recycling water, and rebuilding infrastructure such as pipes which recycle and preserve groundwater resources may engender the preservation, protection and conservation of the world's aquifers.

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119. ISRAELI WATER USE, *supra* note 21, at 1.
120. *See* DROUGHT WARNING, *supra* note 11 and accompanying text.
121. *See* Collins & Lefkovits, *supra* note 96, at 12.