URBAN RUNOFF
Getting to the Nonpoint

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Abstract

Mandates for water-quality improvement have forced regulators and planners to confront the problem of urban runoff, still an important source of water pollution. This article discusses those mandates and how to meet them, and provides examples of ongoing nonpoint water pollution control programs in the San Francisco Bay Area. These examples suggest that cleanup of urban runoff may require more comprehensive regional planning to encourage a development pattern conducive to pollution control.

Introduction

In 1972, Congress enacted the Federal Water Pollution Control Act, now known with its subsequent amendments as the Clean Water Act (CWA). With the goal of "fishable and swimmable waters," the Clean Water Act requires states to manage not only discrete (point) sources of emissions—especially industries and sewage treatment plants, which discharge directly into open water—but also diffuse emission sources, or so-called "nonpoint sources," of water pollution. It was not until 1987, however, that federal clean water laws made nonpoint source pollution a high enough priority to ensure implementation of controls on nonpoint water pollution.

This article will examine responses by San Francisco Bay Area agencies to the mandate for cleanup of nonpoint runoff. In pursuit of this goal, the region's government agencies—including local governments, special districts, and its Regional Water Quality Control Board—have a variety of options from which to choose. Those choices are conditioned not only by technical and financial considerations, but also by calculations of political feasibility. The region's response to nonpoint water pollution has been incremental and constrained by local political priorities, and reflects a long-standing bias toward project-oriented development reviews. Responses that will unequivocally allow the region to meet or exceed nonpoint pollution targets—including an entirely different pattern of new development—remain off the agenda for political reasons. As a result, the Bay region's water quality may stabilize or even improve marginally, but will not meet federal water-quality goals.

The article begins with a discussion of the legal framework for nonpoint pollution controls, focusing on current requirements for local and state action. In the second section, I summarize the strategies that can be used to curtail nonpoint water pollution, including the possibility of trading between point sources and nonpoint sources in the urban context. The final sections are devoted to a discussion of Bay Area responses, concluding that without a better regional structure for land-use and transportation planning, current efforts to achieve "fishable and swimmable waters" will fall short of that goal.

The Clean Water Act of 1972 and its Amendments to 1987

In 1969, when the Cuyahoga River in downtown Cleveland, Ohio, caught fire, Congress was compelled to find a new approach to water pollution. For the previous two decades, the prevailing political balance between Washington and the states was in the states' favor. The Federal Water Pollution Control Act (1948) and its amendments (1956) funded construction of local sewage treatment plants, but allowed the states to set their own water quality goals. The 1965 Water Quality Act went further by requiring states to set water-quality standards, but still allowed states to set those standards and determine how to achieve them (Freeman 1990: 98-103). The 1972 Act represented a dramatic shift in Washington's willingness to dictate how states should handle water quality problems. It set the goal of "restor[ing] and maintain[ing] the chemical, physical and biological integrity of the Nation's waters,"[1] making for "fishable and swimmable waters" by 1983 and eliminating the discharge of all pollutants by 1985[2] (Thompson 1989: 17). To attain these goals, pollution standards would be set by the recently created Environmental Protection Agency (EPA), based on EPA's determination of achievable levels of treatment from available technology.

The 1972 Act sought mainly to clean up so-called "point sources" of pollution, especially factories and municipal wastewater treatment plants. The law currently defines point sources as:

> any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural stormwater discharges and return flows from irrigated agriculture.[3]

However, clean-water responsibility does not end with point sources; it also extends to "nonpoint sources," which include all pol-

lution sources not defined as point sources. In 1983, contributions from nonpoint sources exceeded those from point sources in such important pollutants as nitrogen, fecal coliform, iron, oil, and total suspended solids (Freeman 1990: 109). By reducing nonpoint water pollution from agriculture, silviculture, mining, grazing, and urban runoff, the nation would derive such benefits as enhanced recreational opportunities; protection of water storage and navigation facilities; protection of commercial fisheries; reduced flooding; and reduced damage to water conveyance and treatment facilities (US EPA 1984: 1-17). Urban runoff—the biggest concern for planners in metropolitan areas—is associated with at least six main classes of pollutant: sediment, salts, pesticides/herbicides, nutrients, metals, and bacteria (US EPA 1984: 1-10–1-11). Urban runoff can come from lawns and parks, construction sites, roads, rooftops, and illicit or accidental discharge of toxic materials into storm sewers, among other sources.

As early as 1972, the CWA contained provisions establishing that "to the extent practicable, waste treatment management shall be on an areawide basis and provide control or treatment of all point *and nonpoint* sources of pollution, including in place or accumulated pollution sources"[4] (Thompson 1989: 16; emphasis added). But Congress and EPA paid much more attention to point sources than they did to to nonpoint pollution. Because point sources are easily identified, they represent logical candidates for dominant pollution-control techniques: filters, scrubbers, and other "end-of-pipe" solutions. It was also easy to argue from an externality-based economic standpoint that polluters should clean up their effluent, since the public at large—rather than the polluters—bore the cost of the poisons contained in it while not necessarily reaping enough associated benefits to compensate them. Furthermore, politicians and regulators could easily score points with their constituencies for demanding cleanup of factories and sewage plants.

Nonpoint sources, on the other hand, present a series of complex problems for regulators and politicians. First, a much larger number of people and firms contribute to nonpoint pollution sources. It is therefore more difficult to assign economic or political responsibility for nonpoint sources of pollution than for point sources. Without a specific source to target, the externality-based argument becomes more difficult to support, because the same population both contributes to and suffers from nonpoint pollution.

Nonpoint pollution control also suffers from two information-related problems: natural variability, and difficulty in monitoring and measurement. The former problem results from weather variability

and technological uncertainty. Monitoring and measurement problems "are associated with the inability to observe directly individual emissions or to infer them from observable inputs or from the ambient concentration of the pollutant" (Xepapadeas 1992: 22). Identification of nonpoint source problems is hindered because a certain portion of nonpoint runoff comes from natural sources. Furthermore, baseline information is lacking, and it is difficult to segregate the impacts of point and non-point sources. Some streams appear to have been dominated by nonpoint sources for as long as there are records available; sediments and other pollutants released and redeposited long ago may continue to cause water contamination (US EPA 1984: 1-17).

An additional vexing problem of nonpoint water pollution is pollutant transport. Since baseline information on nonpoint pollution is sketchy even within particular basins, it should come as no surprise that regulators and scientists know even less about the effects of transport from other hydrographic basins to downstream parts of the system. In the San Francisco Bay Area, for example, regulators and cities are currently mired in controversy over the significance of transported copper and other heavy metals from mining tailings from the northern Sacramento River Valley to the Bay.[5] Under these circumstances, regulators must determine whether additional regulation of urban nonpoint sources will prove sufficient to attain ambient water quality standards.

Congress took until 1987 to work up the political will—including an override of President Reagan's veto—to strengthen requirements that the states clean up all kinds of nonpoint pollution and redouble efforts at controlling urban runoff. Pursuant to Section 319 of the Clean Water Act, each state must now develop and submit to the EPA a plan for dealing with nonpoint water pollution sources. Section 319 also commits the federal government to help finance state and local efforts to clean up nonpoint source pollution. In their plans, states must identify waters that "without additional action to control nonpoint sources of pollution, cannot reasonably be expected to attain or maintain applicable water quality standards or the goals and requirements of this Act"[6] (Thompson 1989: 23). The plans must further identify specific sub-categories of nonpoint pollution and develop detailed management plans to address the problem, including best management practices (BMPs) and other regulatory and nonregulatory programs (Thompson 1989: 24).

Urban runoff is usually associated with stormwater control. According to the Clean Water Act, localities are required to obtain stormwater discharge permits under the National Pollutant Discharge

Elimination System (NPDES). The 1987 amendments to the Clean Water Act included new rules for the issuance of permits, which now must be obtained for all stormwater discharge if it is (1) associated with an industrial activity; (2) part of a municipal separate storm sewer system serving a population of at least 100,000; (3) a State- or EPA-determined contributor to a violation of water quality standards; or (4) is a significant contributor of pollutants to U.S. waters (APWA 1992: 1-5).

For municipal separate stormwater drainage systems serving populations of 250,000 or more, municipalities with populations over 100,000 must prepare permit applications in two stages, with EPA review of the first part informing preparation of the second part. The first part must include general information on the applicant; source identification information, including a description of watersheds, land-use information and growth projections, and the location of sewer outfalls and structural controls; discharge characterization; a description of existing management programs; and a discussion of fiscal resources available to complete the second part of the application and to implement the proposed stormwater management program. The second part must contain more details on discharges and outfalls, a proposed management program, demonstration of legal authority and fiscal capacity to implement that program, and estimated pollutant loading resulting from best management practices. The program must include:

> structural and source control measures to reduce pollutants in stormwater discharges; a program to detect and remove illicit discharges; a program to monitor and control pollutants from municipal landfills, hazardous waste treatment, disposal and recovery facilities as well as other priority industrial sites; and a program to control pollutants in construction site stormwater discharges.[7]

To avoid duplication of efforts, local governments in many areas have formed "consortia" to submit a joint application in conjunction with the agency responsible for the stormwater drainage system.

Managing Urban Runoff

There are four main classes of measures which municipalities and private interests can use to control urban runoff, none of which need be used to the exclusion of the others: education and housekeeping, land-use and site planning, transport and treatment, and economic approaches. These measures are bound to be costly, prompting planners and economists to look for nontraditional ways—especially market-based strategies—to clean up urban runoff.

Strategies for Runoff Control

Well within the control of local governments, *educational and housekeeping measures* are attempts to clean up streets and gutters and to educate the public about direct connections between storm sewers and the open water. These efforts include anti-littering ordinances, recycling programs, increased street sweeping, increased cleaning of storm drains, chemical use/storage ordinances, spill prevention ordinances, accident response programs, and public education programs.

Land-use and site planning measures, broadly speaking, include all attempts to change the surface of the land (including its buildings) to prevent runoff from occurring in the first place and to decrease the total amount of runoff. Part of the reason runoff is such a serious problem in many metropolitan areas is that so much land is covered with impermeable surfaces. Localities can use the general plan, the zoning ordinance, and the local subdivision ordinance to reduce runoff. For example, general plans can be written to encourage compact development that decreases impermeable cover, thereby allowing rainfall to soak directly into the soil. General plans can also attempt to ensure that development take place above the most impermeable soils, and away from open water. Zoning ordinances can include incentives for clustering in their planned unit development requirements. Along with these planning tools, communities can also buy certain lands to prevent development if development will lead to unacceptable levels of runoff.

Site and building planning require local governments to incorporate new criteria into their subdivision review and permit approval processes to minimize runoff. The use of such measures would be limited to new development, although some hold potential for retrofitting existing buildings and sites. Site-planning controls include controls on slope stabilization and grading, the use of permeable and modular pavement in areas with underlying permeable soils, construction of on-site infiltration and detention basins (see Schueler *et al.* 1985 for a discussion of the relative effectiveness of these measures). Even building designs can be modified to promote detention of water on rooftops and to direct downspouts toward permeable surfaces (Tourbier and Westmacott 1981: 1.2). A final area for control in the development process is the construction site, a prime source of urban sediment runoff.[8]

Runoff from existing urban land uses will be much more difficult and expensive to control than that from new development, which constitutes only a small fraction of all land uses in many of the urban

areas where nonpoint water pollution is a significant problem. Parking lots and gas stations, for example, contribute significantly to urban runoff problems; separators for oil and grit have been installed in some parking lots, but landowners often defer maintenance, reducing the effectiveness of separators. A program to retrofit parking lots and gas stations without oil and grit separators will require a huge political and financial commitment.

Some observers even question the wisdom of these measures, when adopted on a project-by-project basis. For example, unmanaged detention basins can increase sediment loading instead of reducing it; basins usually fill gradually, but a major storm can wash the accumulated sediment into open waters, whereas this sediment might otherwise have been deposited over a wider land area. In general, decentralized measures are difficult to monitor, maintain, and enforce, and may be cumulatively more expensive than an integrated system. Nonetheless, judging from efforts in the San Francisco Bay Area, site-planning measures seem to be among the most common urban runoff solutions.

Because planning controls can only take effect gradually, with new development and redevelopment of urban areas, most metropolitan areas will need to supplement these solutions with *transport and treatment measures.* A small but important category of controls concerns the maintenance and operation of the storm sewer system itself. Storm sewer outlets can also be cleaned of litter and vegetative matter, much like storm drains. Once urban runoff has exited the pipe, however, the only remaining options are to treat it or to allow it to enter open waters. Treatment can include any combination of physical, chemical, and biological measures (Oberts 1977: 13-14). One biological system that has received much recent interest is the use of natural or created wetlands for treatment of urban runoff (Heliotis 1982). Wetlands may, however, be unacceptable treatment areas, for a number of technical and social reasons. Some wetlands that are quite effective in the short term for nutrient treatment may comprise ecological systems that would be severely damaged by nutrient-rich wastewater. Furthermore, planning and control of development around wetlands almost inevitably involves political battles.[9]

Costs of Runoff Control

Table 1 summarizes an estimate by the American Public Works Association (APWA) of some of the costs of various strategies for dealing with nonpoint water pollution. With startup costs of about $150 million nationwide, educational and housekeeping strategies

Table 1.

Estimated National Costs (USA), Measures for Nonpoint Water Pollution Control, in Millions of 1992 Dollars

	Capital Cost	Annual O&M Cost
Educational and "Housekeeping" Measures	$146.9	$1,155.6
Operation and maintenance of existing controls and detention	$0.0	$31,361.9
Construction/maintenance of new controls for buildings & parking lots	$82,992.4	$53,625.8
Construction of new detention basins and wetlands treatment areas	$7,991.4	$3,863.7
Filters and chemical treatment in detention basins and wetlands	315,604.0	451,939.2
Grand Total	**$406,734.7**	**$541,946.2**

Note: This estimate does not include additional costs for site and land-use planning, which constitute an important mechanism for control of nonpoint water pollution.

Source: American Public Works Association, Southern California Chapter, Water Resources Committee, *A Study of Nationwide Costs to Implement Municipal Stormwater Best Management Practices* (Los Angeles [?]: APWA, May 1992), Table 4-3, p. 4-28.

are among the least expensive nonpoint water pollution controls; operation and maintenance of these measures, however, are estimated to carry a higher price: at least $1.1 billion annually. For complete control of urban runoff, national capital spending on detention basins with outlet protection and new wetlands treatment areas will have to rise to nearly $8 billion, with another $3.9 billion annually needed for operation and maintenance. The total needed for retrofitting the nation's parking lots and rooftops for nonpoint pollution control adds $83 billion in capital costs and $53 billion annually in operation and maintenance costs. The costs of treatment are even higher. To apply lime precipitation, filters, and chlorination-dechlorination to all the detention basins and wetland areas built to control urban runoff would add an estimated $315 billion in capital costs, and $452 billion in annual operation and maintenance costs (APWA 1992: 4-28).

If we are to believe these estimates, the price for preventing, reducing, or mitigating urban nonpoint water pollution will be very high, especially if local governments emphasize structural controls; the estimated total new spending amounts to $407 billion in capital costs and $542 billion annually in operating and maintenance costs (APWA 1992: 4-28). Unfortunately, although the APWA report in-

cludes unit costs of all these controls, its estimates include no measures of cost-effectiveness. Neither does the APWA estimate recognize that most municipalities will choose among many of these measures, and will not consider implementing all of them. Cost savings that result from local governments' selective use of the APWA's menu of BMPs and supplementary use of preventive measures might, however, be outweighed by the engineering, administration, land acquisition, and permitting costs not included in the APWA estimates (APWA 1992: 4-28).[10] In many areas, a limited group will bear the costs of preventive land-use and site planning; depending on the demand characteristics of the market for new urban and suburban developments, the costs might be borne by landowners, developers, homebuyers, users of business space, or any combination of these groups.

Using Markets as an Alternative Means of Control

Given the high estimated costs for direct action against nonpoint water pollution, economists have begun to consider how incentives in a market system might supplement or supplant command-and-control regulations as tools for controlling ambient levels of pollutants from nonpoint sources (Segerson 1987). An incentive system for pollution control has several advantages; it involves a minimum of government interference in daily operations of firms and treatment plants, and firms (or municipalities) are free to choose the least-cost pollution abatement techniques, leading—theoretically—to more efficient outcomes. It also ties incentives to ambient levels instead of directly to emissions, thereby avoiding the difficult problem of establishing cause-effect relationships between sources and ambient levels.

The most promising market-based system for nonpoint pollution control is the potential for trades between point and nonpoint pollution sources. Chances are good that additional controls on point sources of pollution (including wastewater treatment plants) will carry high marginal costs, and that these costs may be greater pound for pound than the costs of eliminating nonpoint pollution, despite the admittedly high costs of many nonpoint controls. In such a situation, many economists recommend that regulators allow point-source polluters to pay for nonpoint source cleanup rather than install additional pollution control systems at the point sources. If point and nonpoint sources do not produce the same pollutants, however, it may be much more difficult to determine how precisely to value each pollutant for the "trade" (Letson 1992).

Only in the past five or 10 years have economists begun to consider market-based measures to encourage the reduction of nonpoint water pollution. Some potentially serious obstacles remain. But given

the expense of controlling nonpoint pollution through command-and-control measures, these obstacles may appear more surmountable than the need for billions of dollars in capital and operating and maintenance expenditures for new control technology—especially considering that Congress provided less than $150 million between the 1990 and 1992 fiscal years for nonpoint pollution control (Letson 1992: 227).

Ongoing Bay Area Efforts: Alameda and Santa Clara Counties

Many of the Clean Water Act's provisions for urban runoff prevention and cleanup are implemented not at the municipal level but through consortia of jurisdictions responding to a state or regional water quality agency. California jurisdictions have been ahead of the curve in responding to the nonpoint pollution cleanup mandate. According to the Bay Area Regional Water Quality Control Board (RWQCB), two Bay Area consortia—those in Alameda and Santa Clara Counties—are further advanced than others in the region. All of Alameda County's cities and the County itself participate in its consortium, with the County coordinating the effort. In Santa Clara County, the County and all but two of the cities participate in the consortium.[11] In both cases, best management practices (BMPs) are developed within the consortium and adopted by local policy or ordinance by all the cities. Thus far, neither of the consortia has faced difficulties from jurisdictions that refuse or are unable to implement the measures, but the current budget crisis, exacerbated by the State's retention of local property tax receipts, may test local commitment.

Public Education, Information, and Housekeeping Measures

Of all the possible responses to nonpoint pollution, Santa Clara and Alameda Counties have both placed heaviest emphasis on public information and education. Santa Clara County's program, coordinated through the Santa Clara Valley Water District, integrates nonpoint source public information with other programs, such as the water district's water conservation program and other utility mailings.[12] In Alameda County, public information has been the most important activity, targeting such things as used oil dumping and car-washing in the street.[13] Both consortia have also had aggressive storm-drain stenciling programs; by now, storm drains throughout the region are tagged with the warning: "No Dumping! Drains to the Bay!" This educational process extends not only to the public but also to local staff, including employees who work in street cleaning.

A second important set of activities in both Alameda and Santa Clara has focused on abatement of illegal dumping through educa-

tion, monitoring, and establishment of safe dumpsites. Alameda County has selected three locations in different parts of the county—Oakland, Hayward, and Livermore—for free hazardous household waste disposal. The Santa Clara program investigated over 700 cases last year of illegal dumping and has followed up selectively with fines and information on appropriate places for disposal of motor oil and household hazardous wastes. The Santa Clara consortium has also focused efforts on illicit connections to the storm drain system that should have been made to the sanitary sewers. About 70 of these connections were abated in 1992-93.

Santa Clara appears to have a well-developed program for helping industrial firms reduce stormwater runoff. The program has worked successfully with about 500 local industrial firms to ensure that they are aware of proper techniques for avoiding runoff. These industries are already accustomed to a high level of regulation, and are required to respond to nonpoint controls when they file other water-quality compliance permits. Alameda County's consortium has also recently conducted workshops and outreach to help local industries reduce their runoff.

Land-Use Measures for New Development

Local governments already often require runoff control measures in large developments. The California Environmental Quality Act (CEQA), one of the strongest of the mini-NEPAs, has long allowed project planners to request information from project sponsors on their proposals' probable effects on all aspects of the environment (Landis *et al.*, forthcoming). CEQA requires incorporation of all "feasible" measures to mitigate or prevent adverse environmental impacts, and these measures often include both construction-related and long-term BMPs for control of nonpoint water pollution.

Runoff control is only one aspect of environmental protection, however, and can be obscured in the thicket of adverse effects many planners and regulators find in new development. To ensure that local planners pay more consistent attention to runoff in the development review process, the Santa Clara and Alameda County consortia both started working fairly early to address runoff from new development. The Santa Clara program, for example, distributed a manual to local governments containing construction and new development BMPs. It also staged several workshops and conducted an internal training program for inspectors in the 15 public agencies participating in the consortium.

In April 1994, the Regional Water Quality Control Board distributed its *Staff Recommendations for New and Redevelopment Controls for Storm Water Programs* ("Recommendations," for short) to municipalities in the region. The RWQCB asks, first, that local governments adopt watershed-protection policies to:

- avoid conversion of areas particularly susceptible to erosion and sediment loss,
- preserve areas that provide water quality benefits and/or are necessary to maintain riparian and aquatic biota,
- promote site development that protects the natural integrity of topography, drainage systems and water bodies, and
- promote integration of storm water quality protection into construction and post-construction activities at all development sites (California Regional Water Quality Board, San Francisco Bay Region, 1994a, 2-3).

The RWQCB also recommends that localities adopt specific programs, including:

- site-planning practices that minimize impervious cover, protect areas susceptible to erosion and with water quality benefits, and limit land-disturbance activities;
- construction BMPs that minimize erosion and protect natural drainage systems and watersheds;
- post-construction BMPs to prevent erosion, control sources of runoff, treat runoff, and protect wetlands;
- requirements for reports from all development-project sponsors, including a *map* of existing and proposed vegetation, existing and final site contours, other proposed land disturbance, areas of potential water quality impact, proposed and required setbacks and easements, and proposed construction BMPs; a *schedule* for BMP construction, operation, and maintenance; and the *assumptions* used to arrive at the BMPs;
- requirements for additional reports from sponsors of larger developments (five or more acres) specifying the funding mechanisms for permanent BMPs and a contingency plan in case of heavy rain; and
- case-by-case review of redevelopment and infill projects (California Regional Water Quality Board, San Francisco Bay Region, 1994a: 3-4).

Rather than require localities to adopt its Recommendations, the Board decided to begin with a two-year trial period for use of the Recommendations and implementation of their suggested management practices. Explicitly recognizing local governments' authority

over land-use decisions, the Board's Executive Officer noted in a letter of transmittal to local agencies:

> Municipalities are expected to integrate the policies and practices presented in the Recommendations as appropriate for the storm water quality issues, sensitive resources, land uses, and development review and approval processes unique to their jurisdiction. Municipalities have flexibility in establishing local practices and programs. *The Regional Board is likely to require less justification and evaluation of storm water quality control effectiveness, at the individual municipal level, for municipalities that base their programs on the Recommendations* (California Regional Water Quality Board, San Francisco Bay Region, 1994b: 1; emphasis in original).

Given this language, many local governments in the Bay Area will undoubtedly use the RWQCB's manual for many of their decisions about land use, to forestall any arguments with the Board over the effectiveness of their runoff control programs. Since so many localities already use CEQA to determine and mitigate the contribution of new development to water quality problems, local governments are not likely to find the Recommendations particularly burdensome; developers, on the other hand, might protest any added cost imposed by the requirements.

Notably, the Recommendations include very little discussion of local land-use planning measures. The Board's Implementation Priorities (California Regional Water Quality Board, San Francisco Bay Region 1994c) focus on ensuring that local governments adopt the project-review measures during 1994 and early 1995. Only then, in the second year, does the Board place any priority on development of a "watershed management plan" (WMP). The WMP may include identification of water-quality problems and existing management practices, development of additional management practices, addition of a storm water section or element to the local general plan, designation of "sensitive areas," and establishment of site-development standards (California Regional Water Quality Board, San Francisco Bay Region 1994c: 4). The Implementation Priorities also imply that "storm water quality master planning" might at times be preferable to "on-site facilities," and call for local governments—again, in the second year—to "develop an operation, maintenance, and inspection program and public agency financing options" (California Regional Water Quality Board, San Francisco Bay Region 1994c: 4). But the Recommendations are vague and tentative about area-wide measures, while they are quite specific about project-level controls. Although the Recommendations are not silent about planning, the Board's or-

dering of priorities—controls on projects now, land-use and watershed planning later—emphasizes project-level review.

Planners have long been concerned about the sprawling pattern of urban development (Clawson 1962; Real Estate Research Corporation 1974; Breslaw 1990). Many planners advocate the development of a more compact urban form (Calthorpe 1993; Greenbelt Alliance 1983). In theory, zoning and planning for urban runoff control could mesh well with compact development goals; although higher-density uses result in higher per-acre runoff, they achieve lower per-capita runoff rates. But without clear mandates to encourage compact development through zoning and planning, and in the presence of other incentives to plan for lower-density land uses, localities will more likely use site-planning and engineering measures to control runoff. In practice, this will almost certainly translate into lower-density development, especially of housing, because developers' expertise and the housing market conditions—not to mention the desires and expectations of nearby residents—will encourage development of a similar housing type on a smaller portion of the same site. In this way, the approach taken to control urban runoff in the Bay Area could undermine efforts to build more compact communities, as the current built form is replicated over an ultimately larger land area.

Point-nonpoint "Trading" and Water-basin Planning

Markets for reducing nonpoint water pollution have not yet been established in the Bay Area; one current effort may, however, herald a shift toward market approaches. Industries in Silicon Valley use large amounts of copper in their production processes. The industries can reclaim some, but not all, of the copper before it enters the wastewater stream. The region's three publicly owned wastewater treatment plants, in turn, cannot remove all the copper before discharging treated effluent to the Bay. According to the industries and wastewater plants, the plants are currently removing all the copper they can afford to; however, the Regional Water Quality Control Board holds the treatment plants responsible for removing an additional 950 pounds of copper per year from the wastewater stream.

Copper also comes from urban runoff, especially runoff from streets; automotive brake linings often contain copper, and as drivers slow down in the area's heavy traffic, the brake linings shed their copper to the roads and highways. Staff at the Santa Clara Valley Nonpoint Source Program estimate that as much as 75 percent of copper runoff comes from brake linings, with additional contributions from deposited automotive and diesel exhaust emissions. Swimming pools also constitute an important nonpoint copper source, because

their copper-bearing waters are often drained directly into storm sewers (Drury interview, 1994).

Taxpayers and ratepayers in Santa Clara County ultimately pay for either an improvement in the treatment plants' copper-removing capacity or additional nonpoint source reductions, offering an incentive for the treatment plants and the Nonpoint Source Program to work together toward a solution of the copper problem. Since early 1993, the Santa Clara Valley Nonpoint Pollution Program and the three wastewater treatment plants have been discussing the most efficient way to achieve the additional 950-pound reduction currently assigned to the treatment plants. Although these efforts have thus far yielded no agreement, the Regional Water Quality Control Board will allow them to continue for the near future. Progress toward the 950-pound reduction will probably come almost entirely from reductions in nonpoint sources of copper, in addition to the 3,500-pound reduction already required of nonpoint sources in Santa Clara Valley.

Because ultimately there is only one "bottom line" at stake (*i.e.*, water rates and taxes paid by Santa Clara County residents), any agreement between the Nonpoint Source Program and the treatment plants cannot be viewed purely as a market "trading" scheme. Rather, it is a public-sector management issue. Given a particular goal—removal of 950 pounds of copper from the South Bay—the responsible public sector agencies negotiate and plan for the most efficient way to reach the goal. The ultimate outcome, however, in an era of extremely constrained budgets, will have much in common with a market solution, because the basic criterion for both the point sources and the Nonpoint Source Program is to achieve the least-cost solution. Thus the copper dialogue may serve as a precursor to, or a limited example of, future trading schemes that look more like the market arrangements discussed above.

Not everyone agrees that a South Bay copper agreement would be appropriate. San Francisco-based Citizens for a Better Environment (CBE) has raised concerns about the timing of the trading scheme, primarily because the treatment plants discharge copper all year long, whereas stormwater runoff in the Bay Area is confined mostly to the six-month rainy season (November to April). During the dry summer months, the treatment plants will continue to discharge water with elevated levels of copper; with neither direct rainfall into the Bay nor runoff from the urban areas, those copper levels will be undiluted—and therefore will violate federal standards—from May to October.[14]

Staff from the RWQCB concede that the treatment plants' dry-season discharges will continue to present difficulties, but that the treatment plants would be committed by the terms of any trading agreement to progress toward lower copper discharges. Since the RWQCB will monitor trends in copper levels in the south Bay, it will be able to call for changes in or even a halt to the trading agreement if no reduction can be demonstrated.[15] Furthermore, the parties may agree to diversions of some swimming pool water from storm drains to treatment plants; one would assume that most of these diversions would occur during the dry summer months, helping spread the gains from nonpoint source reductions throughout the year.

According to CBE's staff, real progress toward copper cleanup may require more radical changes than the incremental approach the RWQCB has sanctioned. Land-use and transportation planning may need to shift dramatically, to discourage automotive transportation and eventually to eliminate much of the pavement that currently covers urban areas and to focus development in more intensive nodes. CBE is also working on programs to promote cleaner and more "sustainable" manufacturing.

Summary of Bay Area Efforts, and Future Prospects

Efforts at cleaning up nonpoint water pollution in the Bay Area have been limited mostly to keeping streets and gutters free of litter and abating unintentional or unwitting dumping of household and industrial pollutants into the storm sewer system. In the next several years, however, land-use based controls on new development will become more widespread, as the Regional Water Quality Control Board encourages—and perhaps demands—local development controls to prevent and contain urban runoff. Both kinds of measures may receive additional financial and political support from new arrangements between point and nonpoint pollution authorities and sources.

Until now, the RWQCB has allowed consortia to develop their own programs and to demonstrate that their programs are contributing to better ambient water quality conditions. This flexibility extends to trading between nonpoint and point sources as has been done in the South Bay. The RWQCB could take a more confrontational path; on several occasions in the 1970s, for example, the Board denied sewer hookups and stopped new construction to prevent sewage discharges into the Bay. Instead of this direct and confrontational approach, however, the Board has preferred to encourage gradual progress toward meeting ambient water-quality goals. If the Board feels local governments are not making progress toward these goals, the Board may take increasingly strong action to force local governments to plan

and implement stormwater cleanup measures—perhaps even including imposing moratoria.[16] This seems unlikely to the consortia, given the small contribution of new development to the overall problem.[17] The Board might not need to justify a moratorium based on the quantitative contribution of new development to ambient water quality standards, however; it could be a punitive measure aimed at localities that fail to cooperate.

None of the regulators and planners interviewed foresees any likelihood of treatment plants for stormwater, and none mentioned the use of wetlands as an alternative treatment method. Stormwater treatment at the end of the pipe would involve both enormous expense and potential environmental damage; in the Bay Area, treatment facilities would have to be constructed on wetlands next to San Francisco Bay or on new fill, neither of which represents a politically acceptable alternative at present.[18]

Staff at the Santa Clara program suggest that the RWQCB's attention will be directed only to those localities that do little or nothing to address nonpoint source water pollution; in their opinion, the Regional Board should judge local entities on the basis of their efforts and programs, not on actual progress toward the ambient water quality goals.[19] But this might contradict provisions of the 1987 Clean Water Act amendments calling for real progress toward meeting the goals, and would raise questions about how to measure local effort. The most likely standard for measurement is expenditure, but this might simply encourage localities to pursue expensive but measurable structural solutions that fail to address the problem, rather than the land-use planning and other institutional changes that will be necessary to address the problem but do not carry an obvious price-tag.

Given the language and intent of the CWA, as well as the constant vigilance of environmental groups in the Bay Area, the RWQCB may grow more draconian over time. Perhaps the Board will adopt or adapt a plan from another region, one that involves much more direct intervention by the Board in local planning and maintenance activities. The actual response, however, will be tempered by political considerations, since the RWQCB is comprised in part of locally elected officials.[20] These individuals will represent a strong voice for moderation and local control, and may ward off direct Board intervention into local land-use planning. Of the controls that are not currently in wide use—community-level land-use planning, construction of new treatment facilities, retrofitting existing uses, and widespread trading among point sources and nonpoint sources—the most politically palatable control that also seems economically feasible is community-

level land-use planning. Whether the Board will have the political strength to intervene in that traditionally local prerogative, however, remains to be seen.

The next-most-acceptable solution—one favored by businesses and perhaps by local governments, but greeted with skepticism by some environmentalists—may be expansions of the trading ideas pioneered in the South Bay. Here, too, many questions remain: about the true contribution of any particular source to ambient water quality standards, about the balance between incentives to continue polluting and incentives to abate some other pollution source, and about the proper level of abatement for all sources. However, local resistance to regional or state interference with land-use planning, combined with the inability of new development controls to improve ambient water quality, may encourage early acceptance and more widespread use of market-type solutions to water pollution.

Conclusion: The Need for Institutional Change

The nation has in recent years shifted its focus from what comes out of the pipe to the quality of the water body into which the pipes flow. This shift in attention has renewed recognition that polluted runoff from the nation's streets, forests, mines, and farms contributes much more to poor water quality than does the effluent from wastewater treatment plants and factories. But this pollution—to which many people contribute, and which comes from almost everywhere—resists the technological controls on which clean water regulation has traditionally relied.

This discussion of efforts in the San Francisco Bay Area reveals that the problem of nonpoint water pollution resists not only straightforward technological solutions but also the capabilities of the region's institutions. Two kinds of controls have been promoted thus far: housekeeping measures, which are both relatively inexpensive and potentially popular; and project-by-project development review, which has been the region's preferred method for assessing and mitigating adverse environmental effects for a generation. Both of these controls have been bolstered by the Regional Water Quality Control Board's politically and economically pragmatic decision to allow Silicon Valley treatment plants to continue to discharge copper-laden water into San Francisco Bay, pending an agreement with the county's nonpoint source program on additional reductions. Together, these programs will help keep water quality from deteriorating further, and may achieve some progress toward water quality goals.

For the region to meet or exceed those goals will require a bigger commitment. Comprehensive watershed-based land-use plans that encourage compact development throughout the region, with fewer roads, fewer cars, and higher-density housing would—in some advocates' opinions—be a more effective antidote to urban runoff than the current menu of project-specific regulation and housekeeping measures. The political landscape will not easily accept such planning; the gradualism of the RWQCB, which is timid about even project-by-project review, reflects its constrained political environment. And the political difficulty of comprehensive regional planning of new development may pale by comparison to that posed by programs to clean up existing sources' contributions to nonpoint pollution. Thus far, rebuilding the existing urban fabric has earned no more than a token place on the agenda, although such a dramatic step may be the only one that can allow the region to meet water quality goals.

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NOTES

[1] CWA § 101(a), 33 U.S.C. § 1251(a).

[2] CWA § 101(a)(1), 33 U.S.C. § 1251(a)(1).

[3] CWA § 502(14), 33 U.S.C. § 1362 (14) (quoted in Thompson 1989: 17).

[4] CWA § 1281(c).

[5] Personal communication, Dave Richardson, CH2M Hill.

[6] CWA § 319(1)(A), 33 U.S.C. § 1329(a)(1)(B).

[7] APWA 1992: 2-2.

[8] See Tourbier and Westmacott 1981: 2.1 for basic principles of construction-site management.

[9] For a recent summary of wetland planning requirements and politics, see Blaesser 1994.

[10] Although capital costs usually include engineering, land acquisition, permitting, and administrative costs, the APWA explicitly excluded these costs from its estimates (APWA 1992: 4-28).

[11] Two cities in Santa Clara County—Morgan Hill and Gilroy—and part of the unincorporated County are in the Monterey Bay watershed and are thus subject to another set of institutional requirements and planning efforts.

[12] Information on the Santa Clara program from interview with Keith Whitman, Program Manager for the Santa Clara Nonpoint Source Program, April 1993, and a summer 1994 update from David Drury, Associate Civil Engineer with the Santa Clara Program.

[13] Information on the Alameda County program from interview with Ralph Johnson, Senior Civil Engineer for Alameda County and coordinator of the Alameda County Program.

[14] Interview with Greg Karras of Citizens for a Better Environment, summer 1994.

[15] Interview with Tom Mumley, planner with the Regional Water Quality Control Board, summer 1994.

[16] Interview with Tom Mumley, planner with the Regional Water Quality Control Board, spring 1993.

[17] Johnson interview, 1993.

[18] Mumley interview.

[19] Whitman interview.

[20] Of the nine members on the Regional Water Quality Control Board, two are associated with local government (one from a city and one from a county). Other members include one person associated with water supply, conservation, and production; one associated with irrigated agriculture; one associated with industrial water use; one from a responsible nongovernmental organization associated with recreation, fish or wildlife; and three from the public not specifically associated with any of the foregoing categories, two of whom must have special competence in areas related to water quality problems (Morrison & Foerster 1992: 15).

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