Letters

Water Proposals for New York

Thanks to Gerard's imaginative presentation of the coastal reservoir concept ("Potential freshwater reservoir in the New York area," 19 August, p. 870), many groundwater geologists, public health scientists, and engineers will doubtless take a closer look at their local coastal geography. As Gerard states, "There are no doubt many estuaries and other water bodies where hydrologic and oceanographic principles can be applied to control and use large parts of the normal runoff." One such body which would surely provide an important adjunct to Gerard's Long Island Sound reservoir, insofar as it presently contributes to New York's domestic water supply, is the Hudson River and its estuary.

The Hudson River has a very low gradient, dropping only 5 feet (1.5 m) in the 150 miles (241 km) between Albany and New York City. Tide ranges in the order of 2 feet are recorded at Albany. The main river channel is, on the average, more than 30 feet deep and more than 500 yards (457 m) wide in the lower (estuarine) 70 miles or so of the river. Outside of the main channel the river varies from 1500 to about 15,000 feet in total width. In times of normal runoff the discharge of the Hudson has been estimated at about 22,000 cubic feet (616 m^3) per second. Thus it is rather ironic that New York City has been worried from time to time about water "shortages" with this great river flowing all the while through the city limits. As a result of the 1965 water shortage, the City finally began using Hudson water via its pumping station at Chelsea (50 miles upstream from Manhattan), which is located very close to the inland limit of estuarine salt water incursion. Townsfolk in Poughkeepsie and other nearby areas were fearful that the Chelsea pumping would cause further inroads by salt water—a possible threat to their own Hudson-derived domestic water supplies.

If a dam with locks were to be built across the Hudson just north of Manhattan, that great long wide river course could became another tideless freshwater reservoir of immense capacity. The cost of building such a dam would be quite reasonable, and waiting time for the Hudson to flush out the estuarine salt water would obviously be much shorter than for Long Island Sound; and reservoir level could be quite easily maintained and/or regulated. In short, this would add yet another reservoir to the New York area, one that has the obvious geographic advantages of straddling the present water supply tunnel system. Such a reservoir would bring many financial and other benefits similar to those enumerated by Gerard. Perhaps the Hudson could be dammed first, so that it could be used while the Sound was filling with water according to Gerard's plan.

For those who would protest the idea of damming the Hudson as a reservoir because it is polluted (or the Sound because of Connecticut and Housatonic pollution), it should be pointed out that a number of communities including New York (via Chelsea) are presently using Hudson water. There should be many benefits if the Governor's new pollution control program is successful, but at least the great volumes of water in the present estuaries should not be polluted uncontrollably by salts from the sea. With such resources at hand, there need be no water shortage in the New York region.

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The potential benefits and costs of any plan of converting Long Island Sound into a freshwater reservoir must be compared with all the alternative approaches. Some modified configuration may well achieve the best benefit-to-cost ratio. The average salinity of the Sound is less than that in the open ocean, due mainly to tides: the average "mix" is about 80 percent sea water to 20 percent fresh. One obvious way to increase the dilution without building any dam at the seaward end of the Sound would be to divert the Hudson River through Hell's Gate by building two relatively cheap dikes across the Hudson River and the East River below the Harlem River. The Harlem River itself would also have to be enlarged to accommodate the Hudson's flow, which averages about 30,000 cubic feet (850 m^3) per second. This flow would increase the influx of fresh water to the Sound from 24,000 to 54,000 cubic feet and it would also block one of the routes by which sea water enters the Sound.

The tidal mixing rate can also be decreased without building a complete dam at the eastern end of the Sound. A cheaper alternative would be to close most of the gap by means of a dike, leaving a relatively narrow opening of about 1 km over the deepest part of the Sound. The tidal inflow would be cut down substantially, and the average salinity of the Sound could probably be decreased to less than 10 parts per thousand.

The costs of processing saline water to make it potable are likely to be a function of its salinity. The major savings here would have to be measured against the cost of converting the mixture of fresh and salty water into drinking water. There would also be less inconvenience to coastal shipping, but locks would be required to connect the Sound with the East River and, of course, the Hudson River and New York Harbor.

Another alternative is the "total enclosure" concept including the Hudson and East River dams. The freshwater inflow would be much greater, resulting in a more rapid approach to potability and a greater dilution of the badly polluted water from the Connecticut and Housatonic Rivers.

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Gerard noted that the time for the Long Island reservoir to reach potability "would depend greatly upon the hydraulic works and practices employed" and apparently envisaged the Sound being flushed out by lighter, fresher water spilling over the tops of dams.

The expected salinity-density stratification can serve to shorten rather than lengthen the sterile 7.5 years minimum flush-out Gerard estimated for rapid mixing. If temporary multiple sluices were provided within both dams at appropriate depths, the Sound could be purged through them rather than by spillover. Because of salinity-density stratification, the water flowing through the submerged sluices would be considerably more saline than surface overflow. For sluice flow to match flow into the reservoir, the water level in the fresher Sound must be sufficiently above that in the sea to more than offset the pressure head of the denser sea water overlying the sluices. Furthermore, the sluices must have sufficient capacity for the effective pressure difference to handle reservoir influx. These requirements, considering the lack of tide in the reservoir, seem practical without land encroachment.

Fresh water influx can pump out saltier water than that which would overflow the dams in the plan suggested by Gerard.

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One possible benefit that Gerard does not mention is the creation of a freshwater harbor by removal of material needed to build the dam. A dam 20 m high, 50 m wide at the top, 90 m wide at the bottom, and 12.8 km long would contain 18×10^6 m^3 of material. This is sufficient to create a hole, which might be used as a harbor, 18 m deep and 1 km square. Such a harbor near the mouth of the Connecticut River could provide sufficient capacity to relieve some of the congestion in New York Harbor.

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Chemotaxis: Divided and Defined

At one time I sided with Disraeli's "I hate definitions." Now it seems as though science proceeds by application of the razor and hone to definitions and I have switched to Emerson: "He shall be as a god to me, who can rightly divide and define." Chemotaxis, as defined by Fraenkel and Gunn (*1*), is a "directed orientation reaction," and implies something about the mechanism of the response. It is not yet clear whether the responses shown by *Escherichia coli* are directed or random in orientation, but Adler ("Chemotaxis in bacteria," 12 August, p. 708) proposes that the mechanism used by *E. coli* is the "avoiding reaction," which Fraenkel and Gunn (*2*) favor as a random *kinesis.* Since Adler's data are not concerned with responses per se, but with the end result of the responses, I suggest that these and other similar results be described as aggregation, or better yet, chemical attraction, a phrase which describes the end result with no commitment to mechanism. A general definition of chemical attraction which may be useful to others in this field is: responses that serve to bring and keep organisms within the vicinity of an attractant (*3*).

Such quibbling over words does not detract from the elegant nature of Adler's experiments. But I feel there is something to be gained by adhering to Fraenkel and Gunn's definitions of chemotaxis and related terms, or improving these definitions.

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References

1. G. S. Fraenkel and D. L. Gunn, *The Orientation of Animals* (Dover, New York, 1961), pp. 10, 53.
2. ———, *ibid.*, p. 57.
3. A. J. MacInnis, *J. Parasitol.* **51**, 733 (1965).

Of Porpoises and Bedbugs

This is a time for rejoicing. Our military researchers (who will spend $7 billion during the next year) have discovered that the porpoise can be used to find enemy submarines by differentiating metals (New York *Times*, 23 April), and the bedbug, by its "yowl" when sensing human flesh, may help to hunt the Vietcong (New York *Times*, 6 June).

An Office of Military Zoology is clearly needed to cultivate this new frontier of science. What valuable spillover for civilian technology may come from these efforts! Perhaps the new Office of Military Zoology could give us the boon of an anti-bedbug (ABB), a zoological equivalent of the anti-ballistic missile (ABM).

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