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"LONG-TERM OUTLOOK FOR POLLUTION OF LONG ISLAND GROUNDWATER"*

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A reliable projection of the pollution of Long Island's groundwater in the future must be predicated first on a realistic and objective assessment of the present degree of degradation and the circumstances which caused it and second on an evaluation of the programs currently in place to prevent further degradation and the scope, effectiveness, and reliability of plans for management of the groundwater in the future.

This discussion is predicated primarily on information and data for Nassau County. Conditions are similar however, for the western portion of Suffolk County. The east end of Suffolk and Brooklyn and Queens have uniquely different problems which need to be addressed separately. The basic groundwater quality issues however, are addressed herein.

Perhaps the most significant problem with groundwater on Long Island is not its quality or quantity, but the widely varying perceptions which prevail concerning these issues and the sources of these viewpoints. First we must recognize that all of the positions emanate from the same information base - the studies, surveys, and operational data developed by federal, state, and local agencies with the preponderance of data generated by the Nassau and Suffolk Departments of Health. This information is variously misinterpreted, quoted out of context, and otherwise

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distorted by some individuals and groups to defend or promote parochial - The mass media is quick to publicize controversy and the public, presented with both sides of issues, generally fears the worst and becomes alarmed, skeptical, or complacent. It therefore behoves the really sincere and responsible groups and individuals to seek a true understanding of groundwater quality based on factual information.

There is no doubt that the extensive land development of Long Island spreading east from New York City, primarily in the last three decades, compromised the quality of groundwater to various degrees because the aquifers became receptacles for much of the domestic sewage, industrial and commercial wastewater discharges, as well as the repository for community wastes in the form of landfills, stormwater recharge, incinerator discharges, and highway deicing salt. Extensive pumpage of groundwater for water supply needs, together with municipal sewage plant discharges to marine waters also induced the landward intrusion of salt water from the sea, thereby contaminating the fringes of the natural underground reservoir of fresh water.

Considerable controversy exists in the Long Island community however, regarding the degree of groundwater defilement caused by these several sources of pollution and the effectiveness of regulatory programs and also the control measures instituted by municipalities to cope with the problems. Pollution control efforts have been challenged not only for the lack of comprehensiveness and sufficient priorities, but for the very approaches utilized. Critical examination of a few of the key issues serves to illustrate the wide range of viewpoints which exist and provides an opportunity to separate the facts from fiction.

Municipal sewering programs are disparaged in some quarters on the basis that huge volumes of treated sewage are discharged to marine waters thereby not only depleting groundwater reserves, but accelerating salt water intrusion from

the sea which will further contaminate the Long Island aquifers. Cesspools are stoutly maintained to be the more acceptable solution because the fine sands of Long Island will naturally purify the sewage while continuously replenishing the water supply aquifers without need for capital intensive sewering projects with associated community disruption. Cesspools are also defended as a minor source of nitrates compared to fertilizer.

The facts are that municipal sewer systems in Nassau County, notwithstanding a daily discharge of over 100 million gallons to sea, are not adversely affecting our groundwater reserves. Since the extensive drought of the mid-1960's, groundwater levels have been increasing steadily, restoring the deficit of 10 feet caused by the drought, and reaching pre-drought conditions of 1962[1]. This very reassuring phenomenum occurred moreover, during a period in which rainfall was only slightly above average and sewers served over 70 percent of the County's population.

The hydrological impact of the County sewering program was evaluated[2] with the prediction that complete sewering would cause a maximum ultimate drop in groundwater levels of 30 feet, a 30 percent reduction in stream flow, and salt water intrusion on the south shore of less than one mile in 20 years. More recent studies[3], based on improved analytical techniques, have demonstrated that the aquifer system in Nassau can supply 20 percent more water on a sustained basis than the earlier estimates. The feasibility and need for stream augmentation is also currently under study.

The touting of cesspools as a panacea for disposal of domestic sewage is equally unsupportable scientifically. While it is true that many sewage constituents are chemically altered, biodegraded, retained in the soil, and otherwise prevented from reaching the groundwater, others are not, notably, nitrates, chlorides, and other soluble chemicals some of which have maximum permissible levels in drinking

water standards. Adverse impact of inorganic sewage constituents from cesspools on groundwater quality have been demonstrated in several studies on Long Island[4,5]. Historically, the depths of public wells in Nassau County were gradually extended from a depth of 200 ft. down to 600 ft. during the 1950's due to the foaming, tastes, odors, and chemical characteristics of groundwater encountered at lesser depths in areas served by cesspools[6]. A residential density of one-half acre zoning has been recommended for unsewered areas in the direct recharge zone to assure that groundwater will not exceed the drinking water standard of 10 ppm[7]. Considering cesspools as sources of organic chemicals, a recent survey in Nassau County has disclosed as many as 250 consumer products in normal household use containing potentially carcinogenic organic chemicals which by use and disposal may contaminate groundwater[8]. This has added another important dimension to the threat to groundwater quality caused by cesspools.

Another controversial issue is the effectiveness of the regulatory programs to control industrial waste discharges to the groundwater. Programs in Nassau and Suffolk Counties have been criticized for not requiring testing of each industrial plant effluent for a full spectrum of possible pollutants - the 129 EPA Priority Pollutants[9], for inadequate discharge standards, lack of agressive enforcement, and other administrative weaknesses[10].

Criticism of regulatory control of industrial wastewater discharges on Long Island is basically without substance. Each specific charge has been clearly and objectively refuted[11] as invalid or applicable to an earlier formative state of the program. It should be recognized that the threat to groundwater from organic chemicals discharged by commerce and industry was only generally recognized in late 1976 at which time the complicated gas chromatography/mass spectrometry (GC/MS) laboratory analytical protocols were just being developed and were not yet perfected

to test for the high concentrations of organic chemicals found in industrial wastes. A comprehensive door-to-door survey of 3,500 potentially polluting plants was initiated in Nassau County starting in late 1976 and systematic controls instituted. These included new or modified discharge permits, segregation of organic chemical wastes from the wastewater stream for separate disposal, or elimination of the industry use of toxic chemicals.

Testing each industrial discharge for 129 possible pollutants is not economically feasible but, more importantly, completely unnecessary. It is only appropriate to monitor for those chemicals which have a reasonable possibility of being present. Thirty wells countywide with likelihood of extensive contamination are however, being studied for a broad spectrum of toxic organic and inorganic chemicals. Findings to date, with the project 50 percent complete, reveal the presence in a few wells of only three organic chemicals other than those which are routinely monitored. These chemicals moreover, are at concentrations less than 5 ppb.

Groundwater discharge standards under State law are very comprehensive and also contain a clause authorizing restriction for cause of any deleterious constituents not formally contained in the standards.

The accusations of inadequate enforcement are not valid insofar as they fail to recognize the high cost in staff resources required in gathering evidence and instituting and completing the enforcement process. Currently in Nassau 22 cases are referred to NYDEC for litigation and five cases are being adjudicated administratively. Of the 22 cases, five are essentially resolved.

As of the end of 1980 in Nassau County there were 54 industrial wastewater discharges to groundwater under permit and 20 pending. Hold and Haul type permits numbered 111 with 70 pending. Immediate abatement efforts were feasible in 92 plants. Furthermore, surveys had been completed of 314 dry cleaning plants with 141 scheduled for regulatory control. Over 1,000 automotive service stations remained

to be surveyed. The control process is complicated by a 10 percent annual turnover rate of plants which open and go out of business and by frequent process changes which occur at many plants. Nonetheless, at the end of 1980, more than 86 percent of industrial wastewater discharges to the groundwater were in compliance with standards. The permitted discharges totaled 9.9 million gallons daily. In addition, a total of 1,175,000 gallons per year of segregated residual sludges are routinely disposed of in an environmentally acceptable manner.

Sanitary landfills are an additional source of groundwater pollution, the extent of which is not clearly understood at the present time. Some interests have nevertheless, maintained that landfills are a severe threat to the quality of public wells from both inorganic and organic toxic chemicals. Others have advocated that landfills be banned in the direct recharge zones of the groundwater system. Evidence of methane migration beyond limits of landfill sites and erroneous reports of vinyl chloride in a Port Washington well and in the Whipperwell School in Hauppauge have excited the issue.

Present data on the type and extent of groundwater degradation caused by landfills is very sparse particularly for landfills located inland where the top of the groundwater is many feet below the bottom of the fill. Routine monitoring of existing public and private wells in the general vicinity of landfills in Nassau County has not revealed any indication of contamination by type and concentration which would directly implicate landfills as a major pollution source. An isolated case is an abandoned public well located adjacent to the Syosset landfill which has been shown to be contaminated by landfill constituents but at levels of toxic chemicals below drinking water standards. There has also been evidence collected documenting the presence of toxic constituents in the superficial groundwater directly under particular landfills. Overall, the variety and concentration of such chemicals has not demonstrated thus far that landfills pose a major threat to

groundwater quality. Monitoring programs are now in process at the Port Washington and Old Bethpage landfills in Nassau County to demonstrate the extent of the problem and establish the need for any corrective measures. The Nassau County Health Department is also about to launch a study of two abandoned landfills (in Syosset and in New Hyde Park) to ascertain the extent of groundwater contamination from inorganic and organic chemicals.

Recharge of stormwater runoff represents a potential source of groundwater contamination from both nitrates and organic chemicals insofar as animal wastes, fertilizer and organic chemicals are contributed from lands and roadways through the flushing action of rainfall. Control of animals, use of special street sweeping techniques, and restriction of fertilizer use by homeowners are proposed as corrective programs. Currently the control of stormwater runoff is being addressed in a comprehensive study under the National Urban Runoff Program (NURP) which is evaluating four basic control methodologies to minimize the adverse effects of stormwater on ground and surface waters. These are: ponds and other containment, in-line storage and recharge, street sweeping, and energy dissipation combined with vegatative filtration. Present tentative conclusions are that the nitrate contribution to groundwater from stormwater basins is minor.

Notwithstanding the relative contribution of contaminants from the several sources, the present overall extent of groundwater pollution, in terms of both the types of contaminants and extent of their presence, as well as their public health significance, is a critical consideration in predicting future quality and its implications.

Nitrates at levels between 1 and 10 parts per million are present in 71 percent of Glacial wells, 52 percent of Magothy wells, and 27 percent of Lloyd wells. Levels exceeding 10 parts per million (the drinking water

standard) are present in 22 percent, 17 percent, and zero percent of the Glacial, Magothy and Lloyd aquifers respectively. Overall, nitrate levels are increasing in all aquifers and predominantly in the Magothy, (1979 data).

Chlorides, a constituent of sewage sources and, in isolated instances from road salt storage, is generally in the range from 10 to 50 parts per million compared to drinking water standard of 250 ppm. Levels are increasing in 59, 54, and 31 percent of Glacial, Magothy, and Lloyd wells respectively.

Synthetic detergents measured as methylene blue active substances, (MBAS) are detected in 12 percent of wells tested including 11 public supply wells at levels below 0.5 ppm in 99 percent of wells. The MBAS standard for drinking water was 0.5 ppm but has been rescinded. All public wells positive for detergents show decreasing trends and all are below 0.5 ppm.

Heavy metals are variously present in wells in ranges between zero and 19 percent of wells tested except for zinc which is found in 68 percent of wells. Maximum levels of these contaminants are all below the prevailing drinking water standards and in most cases by one order of magnitude. These metals include the 10 listed in the standards consisting of arsenic, barium, cadmium, chromium, selenium, mercury, lead, silver, zinc, and copper.

Organic chemicals, primarily in the volatile halogenated group (VHOC) which are generally used as industrial solvents, are the most prevalent organic chemicals in the groundwater. Four of these are by far the most common - trichloroethylene, chloroform, tetrachloroethylene, and 1,1,1 trichloroethane - and are present in 16 to 18 percent of all wells tested. Total aliphatics, the C_4 to C_{10} compounds in gasoline, are also a

common contaminant present in 13 percent of wells tested. In all, 30 organic chemicals are tested routinely.

Sixty-three percent of total public supply wells tested (368) are not contaminated to the limit of detection of one part per billion (ppb) [representing VHOC, gasoline constituents, pesticides, and herbicides], 26 percent contain 10 ppb or less, seven percent contain between 10 and 50 ppb and four percent exhibit concentrations equal or greater than 50 ppb. Grouped by aquifer, organic chemical concentrations decrease with depth of wells. Sixty-two percent of Glacial public wells are contaminated, 35 percent of Magothy wells, and 24 percent of Lloyd wells (1980 data).

The human health risk from exposure to chemicals found in L.I. aquifers is variable. Inorganic chemicals have long established tolerance levels below which no adverse health manifestation is experienced. These maximum permissable levels are established in drinking water standards with a factor of safety of three. Thus nitrate, with the standard set as 10 ppm (as Nitrogen) does not produce toxicity below 30 ppm.

The health risk from exposure to organic chemicals in drinking water is less understood but represents a chronic risk, notably in the form of cancer. There is, furthermore, less known about the presence of a lower threshold value for organic chemicals below which no deleterious effects would be evident. The prevailing toxicological viewpoint therefore prudently maintains that risk is proportional to the exposure. An additional constraint is the lack of direct epidemiological evidence on which to base the specific human risk from any single chemical in drinking water. Health risk assessments are therefore based largely on animal studies. Specific organic chemicals in drinking water are, therefore, classified as "known human carcinogens," "suspected human carcinogens," and "animal carcinogens."

No organic compounds found in Nassau wells are classified as either known or suspected human carcinogens; three, however, are classified as animal carcinogens - chloroform, carbon tetrachloride, and trichloroethylene.[12] Lifetime cancer risk from exposure in drinking water is postulated to be in the order of 1 in 5,000,000 for each ppb concentration in the drinking water. These health risk assessments are extremely conservative and include the assumption that the average human is 10 times more susceptible than test animals and that the most susceptible human is 10 times more at risk than the average person.

Standards have been established for organic pesticides and herbicides and also for a group of organic chemicals called trihalomethanes (THM) which includes chloroform, at a total maximum concentration of 100 ppb. State informal standards (guidelines) cover VHOC's with limits of 50 ppb for individual chemicals and a total of 100 ppb except for benzene and vinyl chloride which are limited to 5 ppb.

The cancer risk from exposure in drinking water is extremely small compared to the total cancer risk from all sources. Based on present concentrations of organic chemicals in drinking water in Nassau County and the conservative health risk assessment, there would be less than 10 cancer deaths per year after the total population was exposed for 70 years. This compares to the present total annual deaths from cancer in the County of 2,732 (1978 data).

There have been allegations made nevertheless that "high" cancer rates in Nassau County may be directly linked to toxic pollutants in the drinking water. This charge is not only unwarranted, but irresponsible. The data supporting this allegation is for the 1950-1969 period and Nassau County cancer rates for that period are very similar to other communities in the populous, industrialized northeast - an extensive area served by a wide

variety of different water supplies with a wide divergence in water qulaity. Age-adjusted cancer rates between 1950 and 1975 in the County have, furthermore, undergone little change with the only significant increase related to lung cancer, which is not related to water consumption. Nassau is also served by many separate water supply systems, some with virtually zero levels of toxic chemicals. There are, however, no geographical variations in County cancer rates attributable to water quality.

The long-term outlook for pollution of groundwater, based on present degradation and trends, is that contaminants already in the aquifers will move, as the hydrologic forces and water pumping regimens dictate, relentlessly and slowly, progressively downward through the Glacial, Magothy, and Lloyd aquifers. In the direct recharge zone, representing the central and northern portions of the County, the movement will be largely vertical. Contaminants in the areas generally south of Sunrise Highway and in parts of the northern necks will move generally laterally out to sea.

The progressive control of sources of contamination will eventually cause the uppermost, Glacial, aquifer to be cleansed. Ultimately the Magothy and then the Lloyd aquifer will be gradually purged of contaminants.

The rate of degradation and subsequent recovery of each aquifer cannot be accurately predicted because of the complex hydrology involved even under pristine conditions on which is superimposed the variation induced by the operation of almost 400 public wells. Movement of water through the Glacial aquifer together with contaminants has been accelerated in the past three decades by the change in general use of aquifers. The Glacial was used predominantly in early stages of County development but gradually abandoned in favor of the Magothy, which today provides almost 90 percent of public water supply. Groundwater movement through the Magothy would, in turn, be accelerated should a basic change in groundwater management be adopted which

would authorize more general use of the Lloyd aquifer, now confined primarily to use by barrier island communities.

The current state of recovery in quality of the Glacial aquifer cannot be accurately assessed because of lack of sufficient wells in place to provide data. A comprehensive study of the quality of this aquifer has just recently been started by the Nassau County Department of Health, with State legislative funding, which will require the installation and intensive testing of 40 monitoring wells. Assessment of the potential best use of the Lloyd has been recommended.[3]

The determination of overall broad scale movement and purging of contaminants from the aquifer system is further complicated by ignorance of the definitive properties of individual chemicals in terms of the mechanics of movement into and through the aquifers. Nitrates and chloride apparently move more or less unabated in the reservoir system together with the groundwater. Synthetic detergents and several other chemicals are selectively retained on soil particles subject to being desorbed by a subsequent chemical with a higher affinity for the soil. The characteristics of organic chemicals in this regard are presently not known. The generally extremely low solubility in water of most organic compounds of concern would suggest that repositories of products in the soil above the groundwater table and in superficial portions of the groundwater would cause progressive leaching of these chemicals into and through the aquifer system, but at a slower rate than much more soluble inorganic contaminants. These phenomena need to be better understood to enable accurate projections to be made.

The loss of aquifer capacity caused by the landward movement of salt water as a consequence of lowering the water table does not appear to be a critical problem. The present position of the salt front in the lower aquifers is unknown but is of critical concern only in the southwestern

corner of the County. This front is situated progressively more seaward to the east of Long Beach. Modeling studies have projected salt water movement to be slight under conditions of full sewering in Nassau. Recommendations have been made to install an outpost well in Long Beach to specifically locate the salt front and monitor its movement.[3]

Accurate assessments of the levels and trends in groundwater contamination will provide a more reliable basis than presently available on which to base groundwater management decisions. This does not mean however, that the present state of knowledge is inadequate to make valid projections regarding the availability of adequate quantities of safe drinking water to supply future needs. Two arguments adequately support this thesis.

First, an assessment was made of the impact of proposed State standards for organic chemicals in drinking water on the existing waterworks structure in Nassau County.[12] The conclusion was, that based on the most rigid standard proposed, of a one in a million cancer risk level, 117 of the 389 community public wells in the County would be restricted. Of these 117, 20 are already restricted or otherwise not in use, and the remainder could be utilized or replaced by a combination of new wells, deepening of existing wells, inter-connection with adjacent supply systems, and blending with other wells of satisfactory quality. It can be predicted then with considerable assurance, notwithstanding the present levels and geographic distribution of toxic contaminants in the groundwater, that the water reservoir is capable of satisfying future water supply needs.

A second argument relates to a master water supply study[3] for Nassau County which proposes, among other strategies, the development of an intra-county system for development of supplemental water in the relatively pristine northeast portion of the County and the distribution of such water to areas of potential local insufficiency through a major water supply

loop. The study was predicated on projected deficiencies in supply primarily to prevent local salting of aquifers. This scheme would of course also be suitable to counteract deficiencies in water supply caused by local water quality problems.

It may be safely concluded, therefore, that on the basis of comprehensive programs in place to identify and correct or to prevent groundwater pollution from a variety of sources, that the groundwater system will gradually improve in quality, although the dynamics of the process may cause portions of the aquifer system to suffer some interim increase in pollutant levels. Further studies are in process and planned to more specifically define the dimensions of component problems and to find the most appropriate groundwater management solutions.

The residents of Long Island can be assured that the quality of our groundwater resources are adequate to supply both current needs and, with judicious management, the water supply requirements for the future.

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