United States
Department of
Agriculture

Soil
Conservation
Service

Northeast NTC
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Subject: ENG - Review of "Longe Farm Spring Contamination Study" by The Johnson Co.

Date October 23, 1990

To: John Titchner
State Conservationist
Soil Conservation Service
Winooski, VT

File code 210-16-11

At your request, I have reviewed the technical adequacy of the subject report, dated Nov. 1989, which alleges that the Gervais animal waste facility is the source of the nitrate contamination of the Longe Spring.

In summary, the study is seriously flawed by failing to adhere to practices, standards, and methods customarily exercised in the ground water monitoring industry, and by conspicuously ignoring past agronomic and fertilizer practices in the vicinity of the spring. Their conclusion that the Gervais animal waste facility created elevated nitrate concentrations in the Longe Spring is based on improperly collected ground water samples, technically weak interpretations, and unverified assumptions that critically undermine the credibility of the investigation.

My specific comments follow.

1. The Observation Wells.

There are no as-built, detailed drawings to indicate exactly how the observation wells were designed and constructed. The report indicates on page 6 that the observation wells were not designed, installed, or developed according to industry-accepted standard practices. The latest, state-of-the-art reference, "Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells" by the US EPA and National Water Well Association (June, 1989), states that to achieve water sample integrity, the well intake, filter pack and annular seal must be installed using appropriate techniques. There is nothing in the Johnson report to indicate that a critical component, the annular seal, was installed. The annular seal in a properly installed monitoring well is placed above the filter pack in the annulus (the borehole space between the formation and the exterior side of the casing). The seal is installed to:

(a) provide protection against infiltration of surface water and potential contaminants from the ground surface down the casing/borehole annulus;

(b) to seal off discrete sampling zones, both hydraulically and chemically; and

(c) to prohibit vertical migration of water.

A good annular seal must (a) be easily worked and placed, (b) develop strength quickly, creating a positive seal, (c) be chemically inert and physically stable, and (d) be impermeable. Neat cement/concrete or bentonite seals have been used with success; however, shrinkage-compensated cements (ASTM C-845, type K, M, and S) and Intraplast-N (an expanding grouting aid) are rapidly becoming the industry choices (Calhoun, in Water Well Journal, Feb 1988).

There is nothing in the report to indicate that a properly designed filter pack was installed in the observation wells. The grain size distribution of a properly designed filter pack is based on two times the d_{50} size of the finest formation sampled, and has a uniformity coefficient between 2 and 3, according to Ground Water and Wells (Driscoll, 1986, 2nd ed.). They substituted a "filter sock" for an artificial filter pack; filter socks are not used in the ground water monitoring industry and are not recommended by the US EPA or in standard references, such as Ground Water and Wells. Filter socks are only used in agricultural subsurface drainage applications and only in extremely limited and well-defined soil types.

The collapse and mixing of upper soil zones with lower zones by the churning action of the solid stem flight auger can compromise the chemical integrity of the materials that ultimately come to rest against the outside of the well casing adjacent to the zone of interest. Unless the well is properly developed, the water samples extracted will not be chemically representative of the zone intended for sampling.

Thus, three vital components of proper monitoring well design and installation are lacking: the annular seal, the filter pack, and adequate well development. Consequently, there is no assurance that the waters sampled are representative of in-situ ground water that would be free from surface contamination by non-point sources. The report identifies several sources of non-point sources of contamination within the watershed of the spring, including manure deposition on the pasture, manure spreading by Mr. Longe on his adjacent hay/corn field, fertilizer application to neighboring lawns, and neighboring on-site septic systems. We do not know with certainty what ground water zones were sampled and whether they are truly representative of those zones. Since standard laboratory test methods do not differentiate non-point sources of nitrate from point sources (nitrate is nitrate), it is essential to follow good design and installation protocol to ensure that appropriate ground waters are being sampled, and that surface water, soil water, vadose water and phreatic water are not intermixed.

2. The Field Soil Logs.

The name of the logger is not identified. It is standard professional practice to sign the logs.

The drill holes were not logged according to standards employed in the ground water monitoring industry. The Unified Soil Classification System, ASTM D-2488 (field) and ASTM D-2487 (lab) are the accepted practices for the description and classification of soils for engineering purposes. The logs in the Johnson report misapply the USDA soil classification (useful for describing agronomic properties of soils, not engineering properties) and uses meaningless, unquantifiable colloquial jargon for descriptors.

In no drill hole (by power auger) was bedrock identified with certainty; all references to depth-to-bedrock were question-marked by the logger. Given the extremely stoney character of the glacial till overburden and the drilling method employed (solid stem flight augers), they may very well have been hung-up on a boulders at "refusal". They also attempted to determine depth to bedrock with hand-augers (page 11); it is interesting to note that while they were uncertain of its position when using the power auger, they were able to identify its position with certainty using hand tools. Again, given the stoney character of the till and the methods of drilling, depth-to-bedrock data from all these borings are highly questionable.

3. The Nitrate Data.

That the samples were collected from improperly installed observation wells is established by their own admission. The nitrate data support the probability that proper annular seals were not installed in the wells. For example, the reported nitrate concentrations are within the same order of magnitude as that of the Longe Spring itself. Given the tremendous amount of flux in the nitrogen cycle, and the fact that all their nitrate concentrations are within the same order of magnitude, there is no basis to draw the conclusion that the Longe Spring has "elevated" nitrate levels. The data show no conclusive trends which, in turn, can be attributed in part, to a lack of sample integrity as a result of poorly installed observation wells.

Additionally, the land use of the true ground-water drainage of the spring is not documented. Dick Croft and I reviewed ASCS aerial photo files which reveal that the field above the spring was in corn production in 1986. The Johnson report fails to quantify Mr. Longe's past fertilizer and animal waste application rates on this field. Considering that organic nitrogen in manure may take more than a year to mineralize and leach out of the root zone, nitrate would continue to show up in the spring wa' r as a result of carry ov. from previous years.

4. The Shape of the Water Table.

The water table elevation data are probably reasonably accurate considering that the measurement of water levels is less sensitive to poor construction techniques than water quality sampling, and considering that the hydraulic conductivities of the soils are not especially slow. If one draws lines orthogonal to the water table contours (using the map on p. 7 of the Johnson report), the direction of ground water flow can be determined. A water table divide is thus established approximately 100 feet west of the eastern margin of the map, between the 4" well and OW-1, and between OW-3 and OW-2D. This ground water divide also corresponds with the surface topography; in the field one can readily see the topographic ridge in this area. The shape of most water table aquifers is a subdued reflection of the surface topography, and indeed, this is the case at this site. Furthermore, there is at least one other surface ridge between the blacktop road and the Gervais manure facility.

Their water table data indicate that the ground-water drainage area of the Longe Spring and the watershed in the vicinity of the Gervais facility are hydraulically separate ground-water systems. The Longe Spring, therefore, does not receive recharge from the Gervais area. For some unexplained reason, the Johnson report (Figure 1, p. 2) shows the drainage area of the Longe Spring determined from an area above a point at the unnamed perennial stream taken at about 500 feet downstream of the spring. Using their map, I estimate this area to be apprximately 92 acres. Using surface contours as a guide from the 7.5 minute USGS topo sheet, I estimate the surface drainage area above the spring to be only approximately 11 acres; this figure is consistent with the ground water drainage area based on the Johnson water table map.

5. The Local Bedrock.

The report fails to adequately address the significance of the structural geology of the local bedrock with respect to ground water movement. The rock type directly under the Gervais manure facility is phyllite; the orientation of the foliation (the parallel, planar arrangement of textural or structural features that results from the flattening of the constituent grains of metamorphic rock) is north-northeast, dipping steeply (70°) to the east-southeast. Most non-carbonate, metamorphic crystalline rocks have very low porosity. In this case, the foliation is oriented against the direction of alleged flow, making it unlikely for any alleged seepage from the manure pit to migrate in the direction of the spring by following micro-voids along the foliation.

The alleged east-west fracture trace has not been adequately proven by on-the-ground techniques. Irregularly deposited glacial till is a ubiquitous characteristic of ground moraine in the upland areas of Vermont. To identify a linear swale in this kind of deposit is hardly noteworthy. It is purely conjectural to state that this swale is a function of a major fracture in the bedrock buried beneath a cover of glacial material. Two hand borings in glacial till materials do not constitute a credible depth-to-bedrock survey because of the poor choice of technique and the inadequate number of observations; to further claim that a fracture has been identified in the rock on this basis alone is absurd. An electromagnetic survey and a ground penetrating radar survey conducted by trained personnel using a tight grid (several hundred observation points), would probably locate a major fracture beneath the till cover; test trenches or pits would need to be dug to the rock surface in order to verify suspected areas.

The occurrence of a fracture trace does not necessarily imply that the fracture is a conduit to ground water flow; if formed by faulting, the fracture surface may contain finely ground-up rock material, called mylonite, that can actually be a barrier to ground water flow. Thus, the assertion that a fracture trace occurring between the spring and the manure pit is speculation, and needs additional field investigation to verify such an assumption.

Conclusions

In summary, the Johnson report has too many inadequacies to be viewed as a credible professional hydrogeologic site investigation. Their conspicuous failure to follow industry standards in soil logging as well as monitoring well design and installation, and their meager geologic field investigation provides a seriously deficient basis from which to draw meaningful scientific conclusions.

In the final analysis, the source of nitrate in the Longe Spring must be conclusively determined on direct evidence as opposed to unscientific speculation. Unequivocal evidence can be provided by releasing a separate tracer at each of several selected areas above the spring, including the fields where Mr. Longe spreads manure, the septic systems, the adjacent fields, and the Gervais animal waste facility. By systematically monitoring the Longe Spring for the appearance of the tracers, the source or sources is thus determined with certainty.

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