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March 25, 2024

Zoning Board of Appeals
68 Prospect Street
Ridgefield, CT 06877

RE: Hydrologic Concerns Raised by Adela and David Booth Regarding Installation of an Inground Swimming Pool on the Adjacent Bronfield Property

Adjacent Homeowner: Steven Bronfield

Location: 5 Palmer Court; Ridgefield, CT
Property abuts Norwalk River

Lat.: 41°18'25.40" N Long.: 73°27'57.21" W
(UTM Zone 18; 628420mE 4573976mN)

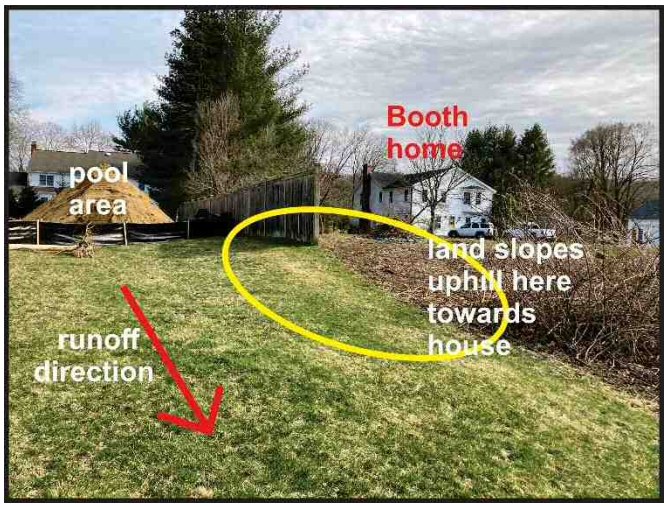
Back of Bronfield home facing Norwalk River.

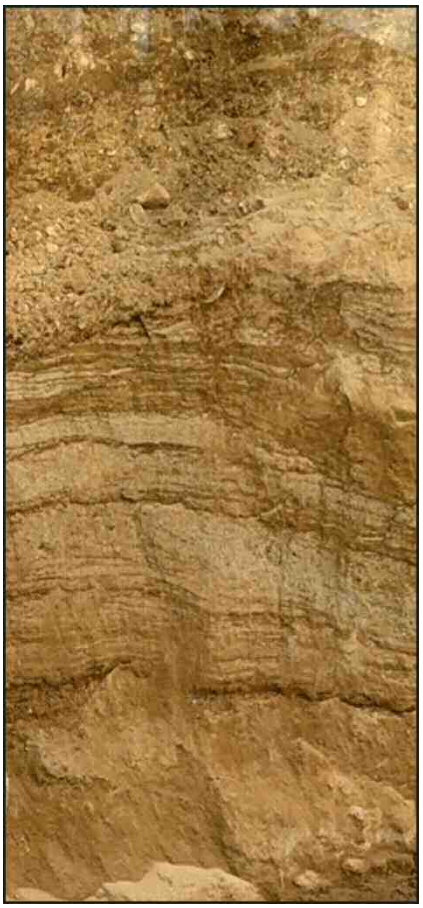
Issues: Adela and David Booth of 7 Palmer Court, Ridgefield CT submitted a letter to the ZBA dated 2-01-24 objecting to issuance of a variance for installation of an inground swimming pool on the neighboring 5 Palmer Court property (attached). The two properties are separated by a tall wooden privacy fence. The Booth' letter raises several hydrologic issues designed to support denial of the variance requested by Steven Bronfield. While the hydrologic assertions raised by the Booths' are, no doubt, of concern to them, they are based on hydrologic misconceptions. Herein, their concerns are addressed based on hydrologic principles known and accepted throughout the hydrology profession. Also, site and area-specific data are provided for additional clarification. All told, the Bronfield property is well-suited for inground swimming pool installation. There is no hydrologic basis for concern and no supportive empirical evidence that pool construction will in any way adversely impact the Booths.

Palmer Wetland segment of Norwalk River

Booth Concern Raised: "*We **feel** that an underground pool will cause more water to flow toward our property."* (emphasis added)

Response: Map A shows a small portion of the expansive watershed that flows toward the Booth property from the northwest, inclusive of Ridgefield Brook and its tributaries. The water flow incident to the "*Palmer Wetland*" and the Booth property depicted on Maps B and C dwarfs any minor amount of surface runoff that might flow from the Bronfield swimming pool toward the receiving Norwalk River. However, as shown in the photo to the right, most surface runoff that might not be collected in the inground pool would flow northwestward toward Norwalk River.





Stratified loamy sands beneath gravelly silt loam.

All or most of an inground swimming pool would be situated within the unsaturated sediment zone above the groundwater table. Two lines of evidence document this. First, the 8-foot-deep foundation hole on the northwestern side of the Bronfield home, observed on 3-22-24, was completely dry as its invert is elevationally higher than the nearby Norwalk River. The heavy rains of 3-23-24 did not flood the foundation hole. Highly permeable stratified loamy sand present throughout most of the foundation hole would have been flooded if it were below the level of Norwalk River.

Sediment from within the foundation hole was classified using the USDA Soil Texturing method, the Unified Soil Classification System, and Munsell Soil Color Charts. Stratified sediments (depicted to the left; 8-foot sequence) were determined to be 7.5YR 5/4 brown loamy sand. The average loamy sand is comprised of 80% medium sand (0.5 to 1.0 mm), 10% silt, and 10% clay. Gravel/pebbles within the loamy sand range from 10.8 mm to 31 mm. As such, it is highly permeable. **Thus, as the groundwater table rises in response to infiltrating rain or snowmelt, it will rise laterally and vertically throughout the sequence.** If rising groundwater encounters a basement foundation, it will seek to equalize the water table throughout the basement through all available seams, cracks, and sumps. A nearby swimming pool would have no bearing on this.

Bronfield soil classification.

Gravel to 18 cm in upper silt loam.

Medium sand to 1 mm in loamy sand.

Gravel to 3.1 cm in lower loamy sand.

Classification of Bronfield sediment provides valuable insight into the hydraulic properties and permeability of stratified sediments within which construction of an inground pool was purported by Booth to result in increased groundwater flow toward and exacerbated flooding of their home. **Site-specific sediment classification and hydrologic characterization document that such assertions are unfounded.**

On 3-22-24, the static water table level present in the Bronfield's 505-foot-deep well was measured as being 26.42 feet below the ground surface. This indicates that the well has penetrated a confined fractured bedrock aquifer with deep groundwater far below the level of the nearby Norwalk River and far below the planned bottom depth of the Bronfield inground swimming pool. Thus, both shallow and deep hydrologic evidence document that for all but the wettest flood events, the swimming pool will be above the water table in the unsaturated sediment zone. Pool installation will not cause water flow toward the Booth property.

Booth Concerns Raised: *A contractor told the Booths that they do not see the total river. "The Norwalk River not only surrounds our properties but flows under all of Palmer Court." The construction of an in-ground pool constitutes an underground dam.*

Response: Open channel river flow does not occur within or beneath river banks. When rivers flood and overflow their banks, river water may infiltrate into permeable sediment banks filling pore spaces around sediment particles. By analogy, groundwater surrounding soil particles may be envisioned much like a jar full of marbles to which water is added. Water fills the pores spaces between the marbles. Classification of the local sediment profile (e.g., Bronfield property and, by geologic setting, Booth) documents the high permeability of the sediments present. During flood events, river water may infiltrate into permeable sediment banks, thereby temporarily raising the level of the groundwater table. When basements are situated close to river banks, groundwater may infiltrate into them through cement cracks, foundation seams, sumps, and any open piping. The maximum likely range of near river rise in groundwater level in response to Norwalk River flooding was likely observed during Hurricane Floyd in September 1999. At that time, Steven Bronfield noticed that the level of the Norwalk River reached the decking of the foot bridge close to his property (Map C), some 3.20 feet above its 3-22-24 level. At that time (1999), he noticed 1-2 inches of water in his basement. Situations like this provide hydraulic pressure beneath and against basement foundations, often resulting in basement flooding. Installation of an inground swimming pool would not impact the groundwater table or flooding of nearby basements.

Under low and moderate river flow conditions, rivers derive much of their water from groundwater influx from upgradient areas (base flow). High groundwater tables are common adjacent to rivers within whatever strata is present (e.g., unconsolidated deposits, fractured bedrock). It is groundwater that is beneath river riparian areas, NOT flowing river water. The only geologic setting where river or stream-like water flows beneath properties is in carbonate bedrock (e.g., limestone, dolomite) within karstic/cave systems. This is not the physical setting present.

Sometimes land areas adjacent to rivers and streams, and elsewhere, have highly variable groundwater levels seasonally or following large precipitation or snowmelt events. In response to the downward infiltration of this water (aquifer recharge), groundwater levels rise temporarily. In highly permeable sediments, such as those the Booth and Bonfield basements are constructed within, groundwater levels may episodically rise above the floor levels of basements. When this occurs, pore spaces present within the soil/sediments surrounding foundations become saturated. In situations where basement foundations are not adequately sealed or drained (passively or via sump pumps), pressurized groundwater will infiltrate upward or laterally through basement cracks, seams, or sump holes. Should groundwater levels rise, under episodic flood situations, to the level of an inground pool - it will not function differently from a basement. Water would rise alongside it. In no way would it or a home basement comprise an underground dam.

Booth Concern Raised: "*When a river takes a curve usually it is because there is an unseen object underground (like a boulder) refusing to yield to the water, thus changing the course of the river. In effect this would be a consequence of a subterranean solid wall of concrete."*

Response: In hydrologic assessments, it is always important to examine the full hydrologic picture to wholly understand and conceptualize the merit of perceived concerns. To put Booth concerns in perspective, Maps B and C were constructed. The border of the wetland illustrated was carefully delineated through assessment of several years of high resolution orthoimagery, with emphasis on the relatively leaf and algae/plant-free years of 1991, 2006, and 2009. Map B has a 2009 image base. Map C has a 1991 image base. The wetland border is reasonably approximated and is depicted within Geographic Information System (GIS) map bases using ESRI software.

Recall, as discussed above, a Bronfield pool cannot function as a groundwater dam because it would largely, if not completely, be constructed within the unsaturated sediment zone above the water table. Also, except for karst/cave settings, rivers do not flow through sediments or bedrock outside of their channels. Briefly, ignoring these basic hydrologic principles, it is possible to examine the concept of a pool somehow functioning as a boulder capable of changing the course of the Norwalk River. Map B shows the approximate location of the proposed Bronfield pool. The pool would have dimensions of 20 feet by 40 feet, equating to 800 ft^2. In contrast to this, the Palmer Wetland has a maximum width of 570 feet and a calculated area of 20 acres or 871,200 ft^2. The Norwalk River flows through this wetland that has an area some 1,089 times larger than the footprint of the proposed swimming pool. Clearly, even if river flow were to somehow flow outside its channel, rising through sediment to an artificially elevated groundwater table, a pool sized rock would do nothing to change the course of the river.

There are many factors that contribute to the courses and types of rivers and streams. These include channel gradient, channel material, geology, topography, bedrock structure, entrenchment ratios, width/depth ratios, sinuosity, watershed size, and soil mantle thickness. David Rosgen's Applied River Morphology book provides detailed assessment of the interrelationship of these factors. A lone large boulder (aka inground pool) is not sufficient to alter channel course, particularly so in the wide channel of the Norwalk River (Maps B and C). Locally, this is especially true because the substrate is a finely laminated/stratified loamy sand almost certainly deposited subaqueously and later capped/overridden with a pebble and cobble rich silt loam. These highly permeable sediments would readily convey flow around boulders.

Discussion and Conclusions

Hydrologic misconceptions were advanced by the Booths, albeit almost certainly without consultation with professional geologists and hydrologists. Reliance on statements presented by a contractor lack supportive empirical data. Concepts such as an inground swimming pool acting as a dam within an underground river are contrary to established hydrologic principles. Similarly, the concept of a Bronfield inground pool acting as a dam within highly permeable, **unsaturated**, sediments (i.e., above the water table) has no merit. This letter report provides both field and hydrologic-based assessment of empirical measurements, sediment analysis, and observable data with conclusions reflective of known and well-established hydrologic principles.

Flooding of the Booth basement will continue to occur during times of high groundwater tables (i.e., following heavy rains and snowmelt) unabated until appropriate remedial measures are undertaken. Booth basement flooding is completely unrelated to the potential installation of an inground swimming pool.

The Bronfield property is well-suited for inground swimming pool installation. Most or all its construction would be above the water table. There is no concern that its construction will in any way adversely impact the Booths. Again, periodic flooding of the Booth basement will, as it has for years, continue unabated unless suitable remedial measures are taken. **Consideration should be given to approving the variance sought by the Bronfields.**

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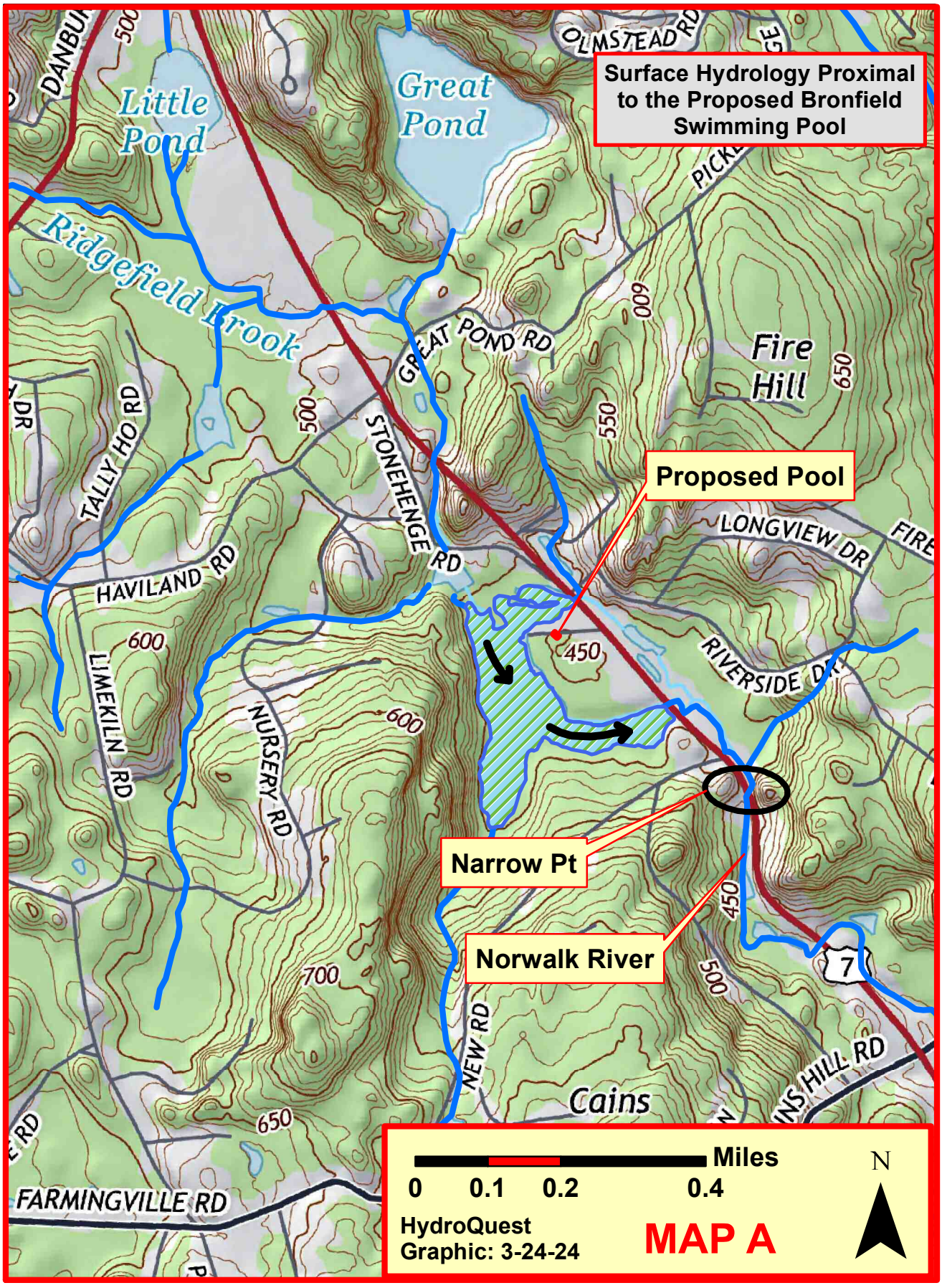
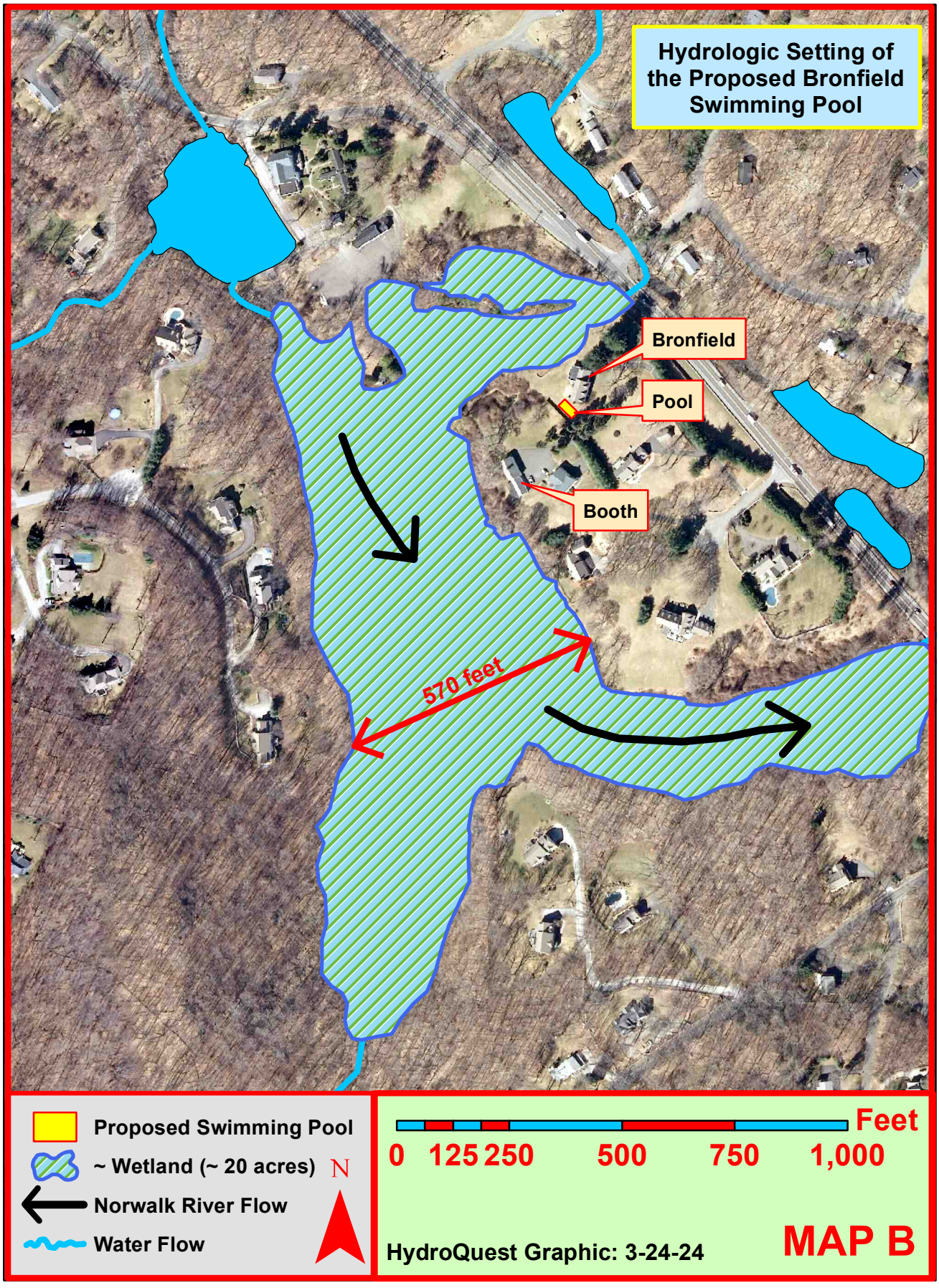
Paul A. Rubin: Hydrologist/Hydrogeologist Qualifications

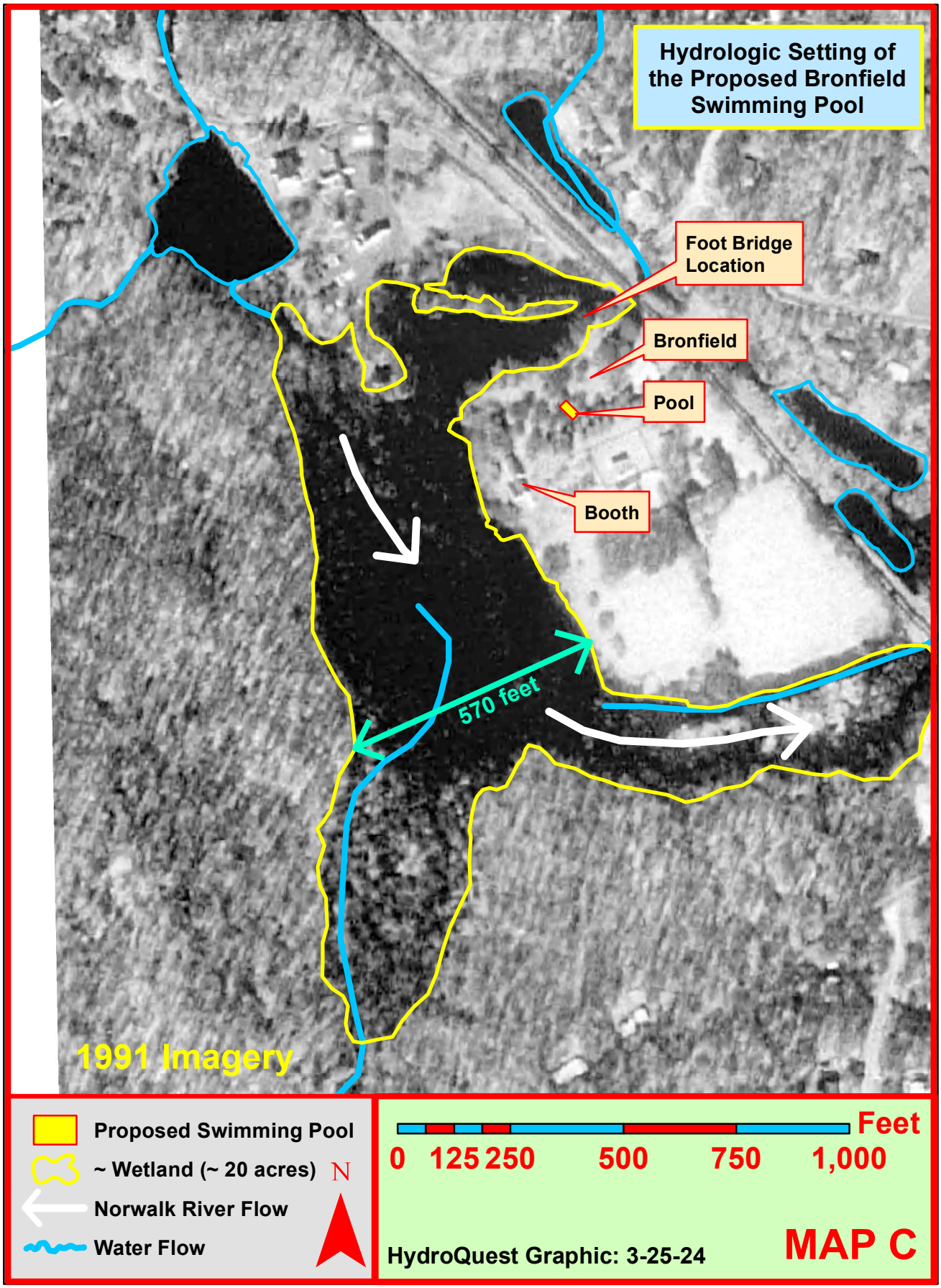
HydroQuest is a sole proprietorship company, of which I serve as principal. I have over 42 years of professional hydrologic, geologic, hydrogeologic, and cartographic experience. This work includes providing expert advice relative to environmental risks to aquifers, surface water resources, ecosystems, individuals, and communities. My expert reports, affidavits, papers, presentations, and testimony have been provided in projects throughout NY, PA, NJ, MD, FL, AL, GA, TX, SC, VA, and WV. They have been presented in court, at press conferences, as a panel member, and before the Legislature, Governor's executive staff, and the NYS Assembly, as well as before a delegation from the People's Republic of China. I am a licensed Professional Geologist in the State of New York. My curriculum vitae and assorted work products may be reviewed on my web page at: http://hydroquest.com.

As an independent geologic and hydrologic consultant, HydroQuest provides hydrologic, geologic and hydrogeologic consulting services to environmental groups, Towns, business associations, law firms, and individuals. HydroQuest assists groups in identifying issues and developing strategies designed to protect groundwater and surface water resources, community safety, and wildlife habitat. This work includes assessments of land use and community character.

I earned a B.A. degree from the State University of New York at Albany in 1977 and an M.A. degree in geology with a specialty in hydrogeology from the State University of New York at New Paltz in May, 1983. My professional experience includes work conducted for the New York State Attorney General's Office (Environmental Protection Bureau) and Oak Ridge National Laboratory (Environmental Sciences Division), and work as an environmental consultant as President of HydroQuest. I have extensive experience in surface and groundwater hydrology, including the assessment of groundwater flow, stream flow, runoff, watersheds, aquifers, and water supply. This experience includes analyses for multiple reports, professional guidebook papers, affidavits, public presentations, field work, trial exhibits, and expert testimony. As part of my work, I routinely review and interpret environmental reports, groundwater issues, surface water flow and flooding issues, aquifer analyses, aerial photography, and topographic maps.


Surface Hydrology Proximal to the Proposed Bronfield Swimming Pool
Little Pond
Great Pond
Ridgefield Brook
GREAT POND RD
OLMSTEAD RD
Fire Hill
650
600
550
500
STONEHENGE RD
TALLY HO RD
HAVILAND RD
LIMEKILN RD
NURSERY RD
LONGVIEW DR
RIVERSIDE DR
Proposed Pool
450
Narrow Pt
Norwalk River
NEW RD
Cains
700
FARMINGVILLE RD
7
Miles
0 0.1 0.2 0.4
N
HydroQuest
Graphic: 3-24-24
MAP A


Hydrologic Setting of the Proposed Bronfield Swimming Pool
Bronfield
Pool
Booth
570 feet
Proposed Swimming Pool
~ Wetland (~ 20 acres)
Norwalk River Flow
Water Flow
N
Feet
0 125 250 500 750 1,000
HydroQuest Graphic: 3-24-24
MAP B


Hydrologic Setting of the Proposed Bronfield Swimming Pool
Foot Bridge Location
Bronfield
Pool
Booth
570 feet
1991 Imagery
Proposed Swimming Pool
~ Wetland (~ 20 acres)
Norwalk River Flow
Water Flow
N
Feet
0 125 250 500 750 1,000
HydroQuest Graphic: 3-25-24
MAP C

Zoning Board of Appeals
66 Prospect Street
Ridgefield, CT 06877

1 February, 2024

Dear Zoning Board of Appeals,

We are in receipt of your letter dated January 24, 2024. We thank Kelly Ryan for meeting with us on January 30, 2024.

If you would be so kind, please consider our objections to the variance petitioned by 5 Palmer Court, home of Steven Bromfield.

- We feel that an underground pool will cause more water to flow toward our property.
- The construction of an in-ground pool constitutes an underground dam.
- Our property, the Bromfield property and all properties on Palmer Court are on the Norwalk River.
- As it is, most Palmer Court homes have flooding challenges already, and we have experienced more in recent years.
- Topography and geography of our area has the Norwalk River flowing south. When a river takes a curve usually it is because there is an unseen object underground (like a boulder) refusing to yield to the water, thus changing the course of the river. In effect this would be a consequence of a subterranean solid wall of concrete.
- We were told by the contractor who installed our trenched underground basement pump system (<$20,000) that what we see is not the total river. The Norwalk River not only surrounds our properties but flows under all of Palmer Court.
- We continue to be plagued with hydrostatic flooding (as opposed to surface flooding, i.e the Norwalk River comes up through the foundation in our basement.)
- We feel that an underground dam in the form of an in-ground pool will exacerbate and possibly cause more detrimental flooding than what is already occurring.

Consider this: What if we were to approach our neighbors about installing a subterranean bunker/root cellar/cement structure, 20' X 30', 20-12' deep that could possibly act like a dam, 14' from their property line, that might, with a high degree of probability, divert the underground river to their backyard, front yard and home? Would they have a problem with us asking for a variance? And please note, the water has to go somewhere. Predictability is the issue here.

Similarly, we would like to know what recourse we have if the variance is granted and indeed the inground pool exacerbates flooding in our home.

We are asking the Town of Ridgefield to honor the 25' setbacks.

Respectfully submitted,
Adela and David Booth
7 Palmer Court, Ridgefield CT