H&K Quarry Project

Springfield Township, Bucks County, PA

Prepared for

Clean Air Council

135 South 19th Street, Suite 300
Philadelphia, PA

February 7, 2022

Barton&Loguidice

H&K Quarry Project
Clean Air Council, Bucks County

Diabase Quarry Report of Professional Opinion

February 7, 2022

Prepared for
Clean Air Council
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TABLE OF CONTENTS

TABLE OF CONTENTS

Section **Page**

TABLES AND EXHIBITS

ABBREVIATIONS

Agency or Entity Abbreviations

H&K	Proposed diabase quarry developer
NWI	National Wetlands Inventory
PADEP	Pennsylvania Department of Environmental Protection
PAGWIS	Pennsylvania Groundwater Information System
PASDA	Pennsylvania Spatial Data Access
USACE	United States Army Corp of Engineers
US EPA	United States Environmental Protection Agency
USGS	United States Geological Survey

Groundwater Model Abbreviations

TDD	Time Distance Drawdown
Modflow	A finite difference numerical model by USGS
Aqtesolv	Advanced Aquifer Test Analysis Software
WHAEM	Wellhead Analytic Element Model by US EPA

Measurement Abbreviations

FT BGS	Feet Below Ground Surface
FT MSL	Feet Above Mean Sea Level
GPD	Gallons per day
GPM	Gallons per minute

Geologic or Industry Terms or Abbreviations

Extraction Area	The area of planned diabase removal inside of the quarry property.
Geologic Contact	The location where two geologic units meet
Sill	A flat igneous intrusion that parallels the bedding of the adjacent rocks
Sheet	A massive diabase intrusion
Vertical Dike	Straight and often narrow igneous intrusion that cuts through rocks
Diabase (Jd)	An igneous rock that intrudes in the form of dikes, sills and sheets
Hornfels	A contact metamorphic rock near diabase and sedimentary boundaries
Brunswick (Trb)	Jurassic-aged sedimentary rock formation of the Newark Basin
Lockatong (Trl)	Jurassic-aged sedimentary rock formation of the Newark Basin
The Lookout	Reclaimed diabase mine in Springfield Twp NE of the proposed quarry
Coffman Hill Sheet	Massive diabase sheet in northeastern Bucks County
Boarhead Farms	Superfund site in NE Bucks County underlain by Coffman Hill sheet

1.0 SERVICES PROVIDED AND QUALIFICATIONS

Clean Air Council retained my services and the services of my firm, Barton & Loguidice, D.P.C. (B&L), by Agreement dated 12/16/2020. I was retained principally to review and evaluate the Preliminary Groundwater Model Report prepared by Val F. Britton for the H&K Group's proposed stone (diabase) quarry in Springfield Township, Bucks County, Pennsylvania. I was asked to provide hydrogeological review, field reconnaissance and hearing support, including an evaluation of the testimony and opinions Mr. Britton provided in connection with his report. The primary goal of this work was to determine whether Mr. Britton's testimony and report adequately assess risk to groundwater users, wetlands and water bodies from the potential effects of mining and dewatering the proposed quarry.

1.1. Qualifications: Amy Parrish, P.G., E.H.S.

As a licensed Professional Geologist (License Number PG004901) who is also a Maryland licensed Environmental Health Specialist (E.H.S.), I possess two decades of experience in soil and hydrogeological evaluations. As a Senior Managing Hydrogeologist at B&L, I am responsible for managing environmental and water resources projects, coordinating with project teams and regulatory officials, performing soil and hydrogeological analyses, preparing technical work product, and providing expert consultation and litigation support.

I have provided expert consultation and litigation support for cases of alleged environmental contamination and damages causation by horizontal directional drilling, wastewater discharges, and groundwater withdrawals. Testimony has been offered in administrative hearings, legislative hearings and public informational hearings.

A more complete list of my credentials and experiences is attached as (Exhibit A). Highlights of my experience include testifying as a hydrogeological expert before the Maryland state legislature, serving as a stakeholder on the PADEP Trenchless Technology workgroup, testifying at an administrative hearing on groundwater supply well impacts and serving as an industry member on the MD Board of Environmental Health Specialists. I routinely manage projects that use analytical modeling methods supported by field-collected soil and aquifer data. I also hold a 40-hour basic wetland delineation training certificate.

1.2. Summary of Opinion

My overall opinion in this matter is that Mr. Britton's report and testimony do not provide a sufficient basis to conclude that there will not be a detrimental effect on neighboring wells and hydrology features (including wetlands). I explain the bases of these opinions and my analysis in detail in the sections below.

In summary, my opinion is that Mr. Britton's report and testimony are insufficient because: (I) they do not recognize the inherent limitations in groundwater models; (II) the scope of the analysis was limited; (III) some key water resources (e.g. wetlands) were not considered; and (IV) some key pieces of the analysis in the model were flawed.

1.3. Services Provided and Documents Reviewed

As part of my services, I have reviewed the following:

- The H&K Quarry application,
- The Preliminary Groundwater Model Report prepared by Val F. Britton,
- The testimony and opinions provided by Mr. Britton,
- Publications on geologic and hydrogeologic conditions,
- The Upper Tohickon Creek conservation plan,
- Soil survey data,
- Geospatial data from PASDA and other online sources, and
- Parcel and topography information from Bucks County.

And I have provided the following services:

- Researched geologic and hydrogeologic conditions in the study area.
- Visited and mapped geologic, hydrologic and water supply features on private properties and from public rights-of-way.
- Analyzed the Val Britton report, model and testimony.
- Prepared GIS maps and tables sharing hydrologic, geologic, water supply, quarry, utility, preliminary groundwater model, and other information.
- Determined additional field tests and analyses that could be completed to assess risk with greater defensibility.

1.4. Field Visit

In preparation for my March 29, 2021 site visit, my focus was to identify parcels with well resources and potential access to other hydrologic points of interest such as wetlands, low-lying areas and water bodies. I began by identifying parcels to visit in every compass direction surrounding the proposed diabase quarry (Figure 1). Those owners who agreed to allow me and my team to perform limited field evaluations on their properties and information collected are summarized in Table 1. I also searched for public rights-of-way and identified the Upper Bucks Rail Trail as a viable location to observe points west of and adjacent to the quarry boundary. Equipment I used in the field included a soil probe, Munsell book, Brunton compass, rock hammer, fieldbook, GPS unit, Solinst water level meter, turbidity meter, and pH-conductivity-temperature meter. Photos taken during the site visit are in Exhibit B. Methods I used in preparation for and during the site visit included:

1. Educating neighbors on how to prepare for the visit. I asked owners to refrain from using major amounts of water overnight and on the day of our visit (e.g. refrain from showers, laundry, dishwasher use, etc.). This was intended to mitigate potential well water level drawdown or recovery cycles from interfering with the static water level

measurements. The levels I collected were unbiased by the overprint of domestic use cycles, accordingly.

2. Meeting with owners and interviewing them on their water resources including their knowledge of supply wells, hand dug wells, back up wells and other water resources (e.g. ponds, wetlands).

3. Measuring groundwater levels in drilled wells after first assessing whether the well was in a drawdown or a recovery cycle. I took measurements from the top of casing and recorded the distance from the top of casing to the ground surface. These data were used to convert readings to ft below ground surface datum and later to estimate groundwater elevations.

4. Measuring groundwater levels from grade or edge of well in hand dug wells and then measuring the above grade portion of the well to convert measurements to ft bgs. I also measured the depth of the hand dug wells which was later used to estimate soil and weathered bedrock thickness.

5. Purging and sampling wells for field water quality parameters: pH, temperature, turbidity and conductivity. Locations used for purging were outdoor garden hose or raw water tap such as a utility sink. Care was taken not to purge the wells before measuring water levels. Water quality was generally consistent with background water quality for Diabase and/or Brunswick, though in some cases the pH of the water was more basic than the maximum reported range for Brunswick or Diabase geology (Low and others, 2000).

6. Observing hydrology features including ponds, areas of ponding with overland flow and runoff, intermittent streams with flow and other streams.

7. Observing geologic features primarily at the rail trail west of the proposed quarry extraction area. There I identified a geologic outcrop (Figure 1 and Exhibit B) positioned east of the Brunswick-Diabase geologic contact. The formation was thin-to-thick bedded, hard, mafic, dark grey to greyish black with a strike measured N37°W dipping 43°NE and nearly vertical fractures oriented E86°.

8. Taking GPS points at the locations of drilled and hand dug wells, water bodies and wetland features and the geologic outcrop.

2.0 PRELIMINARY GROUNDWATER MODEL

I must conclude that any failure to robustly take the necessary steps to set up and run a model, renders a "modeled outcome" that is no more defensible (and in many ways less defensible) than a virtual universe of other outcomes. The Val Britton preliminary model was flawed for not performing a proper geological and hydrogeological analysis of the diabase, for conceptualizing the model with a biased boundary condition, for using a less conservative value for the most sensitive input parameter, for calibrating the model with a limited dataset, and for running the model under an idealized condition. To me, the greatest flaw is in overreliance on an economically prepared and poorly documented model for irrevocable decision-making. Experienced hydrogeologists understand and embrace the limits of modeling as a predictive tool.

Better protection for third-parties than reliance on the Britton preliminary groundwater model may be gained by:

1. Comparing modeled versus actual drawdowns from existing quarries (diabase or other similar geology) to establish a zone of influence or impact. Assess if the quarry dewatering model predictions are realized in operation. Use empirical data to establish a zone of influence.
2. Employing an intensive hydrologic and hydrogeologic field characterization program <u>before</u> developing and running a model, whether numerical or analytical or both.
3. Using multiple kinds of models to compare predictions with more than one method.
4. Base decisions on the most conservative condition and modeled scenario.
5. Establish an empirically, topographically-defined or and/or geologically-defined area surrounding the quarry. In this area establish a robust program for objective investigation by the approving authority, and funded mitigation by the quarry owner in the event of impact causation.

I routinely use computerized groundwater flow models to help assess the potential for adverse hydrogeologic impacts arising from groundwater withdrawals. Groundwater flow models are powerful tools when used wisely and judiciously by experienced hydrogeologists. But it must be remembered that they provide only mathematical simulations of aquifer conditions[1] executed under some predictive scenario.

Models are tools in the toolbox of groundwater resources management, but like any computer-driven simulation, are prone to misrepresent real-world conditions unless set up and used with care.

2.1. Model Types

Broadly, two kinds of models exist: numerical and analytical. Numerical models solve simultaneous equations of groundwater flow, typically across boundaries between layers, rows and columns in the model domain akin to the faces of the individual cubes within "Rubik's Cube." The power and potential defensibility of a numerical model lies in the capability to vary input parameters (through a process termed parameterization) to reflect the complexity of the natural environment. Analytical models use simplistic equations to predict an outcome.

[1] "Flow-only" models, of the type used herein, predict the distribution of water levels or changes in those levels (termed "drawdown") through space (in the subsurface) and time in response to stresses such as pumping.

2.2. Numerical Model Steps

To embark on a program of numerical modeling would require certain steps.

2.2.1. Model Conceptualization

The modeled boundary domain must be defined. It is scientifically supported when its boundary is inside the same watershed where the withdrawal is to take place. Val Britton's model did not define the boundary of the modeled domain topographically using natural drainage divides. That model was expanded into a watershed not contributing recharge to the quarry, to "make the model work." An imbalanced model potentially underestimates drawdown and potential adverse impacts.

2.2.2. Parameterization

Fieldwork is a critical first step prior to parameterization and one that the Val Britton model did not include. Parameterization includes the initial selection and assignment of values to the variables in the groundwater flow equations. Sources of data typically include field tested values from geophysical and video surveys of boreholes, slug tests, open-hole and isolated-zone pumping tests and collecting hydrologic and other field data, prior publications (e.g. Schreffler, 1996), and (where necessary) relationships reasoned from seasoned interpretations and/or interpolated from other locations.

2.2.3. Calibration

Calibrating to observations measured during different seasons and from locations that represent the modeled area is needed to make a prediction that is defensible. The Britton model was calibrated to a single condition and using a limited number of observation points and was flawed. Model calibration is a process through which inputs are adjusted within some reasoned or expected range of possible values to produce an outcome that matches an observed natural condition. In nature, groundwater conditions fluctuate and change through time and over the seasons.

2.2.4. Sensitivity Analysis

Sensitive parameters are those that can produce very different modeled results when changed. The most conservative values should be used for sensitive parameters and the Val Britton model is flawed by not doing this. The sensitivity analysis consists of modestly varying one model parameter while holding all others constant. If one parameter has an unusually drastic effect on the model, that parameter should be constrained with utmost care and precision. If the parameter is not well constrained, then additional data collection may be appropriate to ensure that the model is representative and will make the desired predictions within an acceptable range of accuracy.

3.0 THE BRITTON MODEL RELIES ON LIMITED DATA

As described above, the H&K consultant prepared a preliminary groundwater model report. Their model was reliant upon published hydrogeologic information and limited field-collected data (Britton, 2020). In summary:

1. It has been suggested by Britton that private third-party diabase wells with impacts may simply be deepened to intercept the more prolific underlying formation to mitigate groundwater losses. However, the depth of the transition from diabase to the underlying geology is not well documented in the study area, making the feasibility of this mitigation approach risky. The diabase thickness and elevation where it transitions to the underlying geology is not well understood nor well documented or studied by Britton.

2. To our knowledge, Britton did not provide a detailed hydrogeological evaluation of the proposed quarry site itself, relying instead on generalized information. The diabase hydrogeology is relatively unexplored at the quarry and the study site. Their preliminary groundwater model relied on published data and limited field evaluation of well location and water levels.

3. The Britton (2020) report did not investigate via boreholes the presence and character of the subsurface fractures beneath the proposed quarry pits. The report did not contain a fracture trace or lineament analysis (Clark et al, 1996). Modflow models by design assume the media is porous, but diabase has no primary porosity (Schreffler, 1996). Groundwater moves entirely through the network of interconnecting fractures in the diabase, which the model did not consider.

4. Britton used a lower horizontal hydraulic conductivity (Kh) value in the model and one less conservative than they might have used had they relied on field tested values in diabase (Low and others, 2000; Schreffler, 1996). Using a larger Kh value can increase the depth and extent of the drawdown and cause impacts to a greater number of neighboring wells and supplies.

5. Drought or abnormally wet recharge conditions were not considered in the preliminary groundwater model.

6. Per Britton the model domain boundary crossed the watershed divide to "account for drawdown across the divide." An ancillary effect is that doing so also could make the water in balance water out. Artificially expanding the domain to allow more water "in" may make the predictions indefensible and flawed. Neighboring water supplies are at risk because an imbalanced model may underestimate drawdown and potential adverse impacts.

7. The model relied on PAGWIS data which is a very limiting and incomplete data source.

8. Idealized conditions were assumed with only one quarry pumping at one time, while the reclamation of a mined quarry requires it to be dewatered and reclamation of the first pit is planned to happen while the second pit is being mined. The extent and depth of predicted

drawdown is underestimated for this reason, placing wells and water resources at risk of adverse impacts.

9. The model calibration was limited to simulating one set of climate conditions and used locations that did not represent the modeled area. The weak calibration calls into questions the reliability of the model's predicted outcome.

10. The model did not consider pumping of on-site wells and for this reason may underestimate the drawdown.

3.1. Location

The proposed H&K quarry is planned for development on 196 acres on four parcels near the southern edge of Coopersburg, 0.1 mile east of PA Route 309 in Springfield Township, Bucks County, Pennsylvania. Two separate excavations (e.g. pits) are planned; one is proposed to begin operations perhaps 20 years before the other. Rural residential areas abut a portion of the lands planned for mining. The quarry has applied for an application for condition use for a G-7 Quarry.

Our study area was generally within a 0.5-mile radius surrounding the proposed quarry boundary. Two mine pits are planned to reach base elevations of 400 ft msl for the purposes of extracting stone. Reclamation is planned post-extraction which we understand may include filling the dewatered the extraction pit(s) with soil, aggregate or other approved material. Most of the study area is not served by Coopersburg or Springfield Township public water supply areas and relies on private water supplies and sewage disposal systems, including the proposed quarry.

3.2. Geology

The desktop references cited by the Britton report did not rely on published geologic thicknesses data from multiple Bucks County sources (Schreffler, 1996, Lyttle and Epstein, 1987, Drake 1999, Bascom et al, 1931 pg. 38). Field measured thickness values or geologic boreholes on the quarry site were not described in the Britton report. The feasibility of an approach to deepen wells impacted by the quarry is risky for this reason. Geologic conditions within the study area are shown on Figure 1.

The study area is underlain by the Triassic-aged sedimentary Brunswick formation (Trb) which contacts the Jurassic-aged Diabase (Db) northwest of the proposed quarry extraction area. The Brunswick formation may be altered to black Hornfels adjacent to the contact. (Figure 1 and Exhibit B). In areas along intrusive contacts, the sedimentary formation may become extensively recrystallized, making diabase difficult to distinguish from Hornfels (Willard et al 1950, Bascom et al, 1931 pg 36).

Schreffler (1996) states on page 3,

"Diabase sheets in northern Bucks County generally form prominent hills and are discordant sheets with oval or ring-like outcrop patterns." The quarry site plan sections demonstrate the extraction areas are on hills, and likely are diabase sheets. H&K proposes to extract the diabase to a base elevation of 400 ft msl. Subtracting the proposed quarry base elevation (400 ft msl) from the topography (approximately 600 to 620 ft msl) suggests a minimum diabase thickness of 200 to 220 feet (Willard et al 1950, Britton, 2020).

USGS evaluated diabase thickness in six boreholes drilled in the Coffman Hill diabase sheet, which covers an area of Bridgeton, Tinicum and Nockamixon Townships in northeastern Bucks County. The Coffman Hill diabase sheet is approximately 80 to 115 feet thick near the geologic contact (edge) and thickens to 275 feet to 570 feet in the sheet interior (Schreffler, 1996). The study area diabase is at least 200 feet thick, but the Boarhead Farms site borehole geophysical logging and television surveys provided detailed diabase thickness data averaging 379 feet (Schreffler, 1996). The Brunswick formation or Lockatong formation underlies the diabase and outcrops at the edge of the Coffman Hill sheet. Like at Springfield, Hornfels is found at or near the contact.

A second diabase intrusion in the Quakertown quadrangle is closer and to the southeast of the study area. A geologic cross-section through this sheet suggests it is thin to thousands of feet thick (Lyttle and Epstein, 1987). And for a third Bucks County diabase intrusion named “Shelly Diabase Intrusion Springfield,” the mapped thickness ranges from 30 to 2000 feet thick (Drake 1999, Bascom et al, 1931 pg. 38).

It is apparent that the diabase thickness is highly variable and site specific, but generally is thin at the contact and thickens towards the interior of the unit. The quarry is positioned in the interior portion of the locally mapped diabase intrusion and thus the base elevation of the diabase may be thicker than indicated by the quarry extraction plan. Local domestic supply wells concentrated to the north, east and south of the proposed quarry pits are similarly positioned near the interior of the study area diabase sheet. Thus, and until facts prove otherwise, supply wells also may have thicker diabase than wells positioned near the geologic contact.

3.3. Diabase Hydrogeology

The desktop references cited by the Britton model did not consider multiple diabase hydrogeological data sources developed through intensive field testing (Schreffler, 1996, Low and others, 2000). Had these hydrogeologic sources been used in the model, the results would have had deeper and more widespread drawdowns than were otherwise predicted.

The detailed hydrogeological evaluation of a center portion of the Coffman Hill diabase at the Boarhead Farms Superfund site per Schreffler (1996) used the following methods in an investigation to characterize the hydrogeologic framework and determine hydraulic properties of the diabase aquifer:

- Borehole geophysical logging
- Borehole television surveys
- Slugs tests
- Isolated-zone constant-discharge tests
- Open-hole constant-discharge tests

These evaluations were completed to support a remedial investigation and feasibility study undertaken by USEPA contractors.

Low and others (2000) also cites single-well aquifer tests in diabase of wells on hilltops (7 wells), slopes (25 wells), and in valleys (11 wells).

3.3.1 General Hydrogeologic Conditions

Schreffler (1996) generally described diabase on page 3:
"Diabase has no primary porosity, and ground water moves through a network of interconnecting fractures. The ground-water flow paths are short, and ground water flows from areas of higher elevation to adjacent streams. Nearly all ground-water storage is in the weathered bedrock zone. Where the weathered bedrock is absent little ground-water storage is available."

3.3.2. Overburden and Weathered Bedrock Groundwater Storage

The Britton model ignored the overburden and weathered bedrock groundwater storage by grouping diabase with it in the top model layer (0-100 ft). The combined overburden and weathered bedrock thickness at the Boarhead Farms site was 6 to 29 feet (Schreffler, 1996). The study area has a thicker mantle where B&L estimated the combined overburden and weathered bedrock to be approximately 17 to 40 feet thick[2]. Ignoring this layer because it will be removed does not offer an analysis of the effect of its removal on local wells and water resources.

3.3.3. Fractures

The degree of diabase fracturing was not explored in the field or in the model. At the Boarhead Farms site (Schreffler, 1996) diabase fractures generally were not observed below 50 feet. The groundwater moves primarily through the upper portion of the diabase via the fractures. Isolated-zone drawdown testing of the diabase appeared to show that upper fractured zone and lower massive diabase zone had no vertical hydraulic connection, further affirming that diabase has no primary porosity.

3.3.4. Transmissivity and Hydraulic Conductivity

The use of a lower hydraulic conductivity (Kh) value in the model is less conservative than using a higher Kh value. Using a higher Kh value could produce deeper and farther-

[2] Data from hand dug wells (Table 1) and available PAGWIS wells that coincide with B&L-located private water supply wells (Table 2) or Britton model calibration wells (Britton, 2020) were the source for estimations.

reaching drawdown than otherwise predicted by the model. Low and others (2000) summarized diabase tested hydraulic conductivity values for wells on hilltops (2.4 ft/day), slopes (0.22 ft/day), and valleys (0.09 ft/day). The quarry is elevated and most like the hilltop wells, suggesting the 2.4 ft/day Kh value could be appropriate. Even the average of the Low and others (2000) median values (0.9 ft/day) or the Gerhart and Lazorchick (1988) 0.4 ft/day model value is significantly higher than the modeled value Britton used of 0.1 ft/day.

3.3.5. Recharge

Britton (2020) reported an average groundwater recharge condition for the diabase (2 in/year) and the Brunswick (8.5 in/year) but did not simulate conditions during a drought or above-average wet periods. Predicted drawdowns during these naturally occurring conditions are not known and well users are at risk of experiencing drawdown that is greater than otherwise predicted.

3.4 Model Domain Boundary Artificial

The preliminary model domain boundary was extended beyond the study area watershed boundary to, “account for drawdown across the watershed divide.” This may also have been performed to make the model “work.” Numerical models require the balance of water entering and exiting the model domain or else they cannot produce a modeled outcome. While the modeler’s decision was to expand the model domain beyond the watershed boundary to account for drawdown, it may also have been necessary to balance the model so that it could run without failure. In that circumstance the act may prove the model is indefensible. Furthermore, wells are at risk of impacts because imbalanced models likely underestimate drawdown.

The quarry is in the Upper Tohickon Creek watershed (Princeton Hydro, LLC and Boucher & James, Inc., 2005), but the model domain extends northwest and beyond the Tohickon watershed drainage divide and into the Tumble Brook watershed.

Numerical models have known limitations in boundary definition, water balance and porous media behavior. Properly parameterized numerical models evaluate groundwater conditions in watersheds bounded by natural groundwater divides. One cannot merely expand the model domain laterally to “get the model to work” without sacrificing the model’s defensibility.

3.5 The Overreliance on PAGWIS Data

The Britton model relied on PAGWIS for information, but PAGWIS is shown to have well locations far different from their actual GPS location. Likewise, PAGWIS is shown to have water levels also different from measurements taken during B&L site visits. Reliance on limited and perhaps inaccurate PAGWIS data for calibration calls into question the reliability of the modeled predictions. For this reason, the neighboring properties and water supplies are at risk of experiencing more drawdown than otherwise predicted by an indefensible model.

Figure 2 shows well points from improved lots with boundaries touching the 1000-foot radius, but PAGWIS records for these wells was limited. Improved properties shown on the H&K site plan not within the Coopersburg and Springfield public supply service areas likely have wells. Of the estimated 63 drilled wells identified (Figure 2), I visited 14 wells to GPS locate and measure water levels (Table 1). For these 14 wells, I searched PAGWIS for additional well data (Table 2) and relied on data provided by well owners (Table 1). Only 4 out of the 14 GPS-located wells or about 30% of the wells data were recovered in the PAGWIS database. Of those recovered, the PAGWIS locations compared to our GPS locations were off by approximately 60 to 260 feet. The water levels recorded also showed differences (Table 2). These data illustrate the limitations of relying on PAGWIS for modeling purposes. The locations may not be accurate, and data may not readily available for each well point.

The Britton model was calibrated using data from eight wells, where six of those wells were also in the PAGWIS database. The difference in locations and measured water levels between consultant-sourced and PAGWIS-sourced data are shown in Table 2 and Figure 2. For example, PAGWIS well 72840 consultant and PAGWIS locations are almost 2 miles apart. This is significant because a model that uses calibration points that rely on PAGWIS locations may have locations misrepresented spatially. These data also showed differences between PAGWIS water levels and consultant water levels. For example, PAGWIS well 73460 and 73397 consultant observed water level elevations 630 and 628 ft msl, compared to PAGWIS water levels estimated to be 620 and 640 ft msl, differ by 10 feet or more. Model predictions that are based on a calibration to one static condition may not reliably predict the future conditions. These examples illustrate the limitations of relying on PAGWIS for modeling purposes. Models that rely on PAGWIS data may have less defensible outcomes.

3.6 Model Calibration was Limited

3.6.1 Calibration Points

Most of the wells within the study area were not used in the calibration of the model, making the modeled results not very representative of the areas with domestic wells. The neighboring properties and water supplies are at risk of because the drawdown predictions are not based on many calibration points. Calibration wells represented 12% of the estimated 63 wells identified within 1,000 feet of the quarry. Again the Britton model was calibrated using data from only eight wells out of 63 potentially available (Figure 2).

3.6.2 Calibration Condition

The model uses a single reading of water level data for calibration. Groundwater wells are at risk of experiencing drawdowns that differ from the model because the model was not calibrated during different seasons and conditions. Groundwater conditions vary at the same location depending upon the time of year and weather conditions. Groundwater elevations can be higher or lower at any given time. Likewise, so can predicted drawdown.

3.6.3 Calibration Simulated Groundwater Contours

The preliminary groundwater model may not reliably predict conditions during below or above average scenarios, placing wells at risk or experiencing drawdown that differs from the modeled condition. Figure 2 illustrates the H&K preliminary model calibration simulated groundwater contours. Table 2 compares B&L-collected water levels to the model simulated levels. This demonstrates a poor correlation between the simulated condition and B&L-observed condition, representing a wet weather period. Drier weather observation may have a similar outcome.

3.7 Modeled Drawdown Underestimated and Indefensible

The wells are at risk of encountering a condition worse than what is otherwise predicted until facts prove otherwise for the following reasons:

3.7.1 Modeling Idealized Conditions

First and foremost, the modeled drawdown assumes that only one quarry pit will be dewatered at one time. However, the reclaimed and nearby "Point Lookout" diabase mine (Willard et al 1950) shows a backfilled and reclaimed mine like the finished construction of the proposed H&K mine. To reclaim a mine by filling, it will be necessary to continue dewatering during reclamation. This scenario with both pits dewatering at the same time will have the effect of increasing the depth and extent of drawdown.

3.7.2 Hydraulic Conductivity

Using a higher Kh value as suggested by the published data (0.4 to 2.4 ft/day) could have the effect of increasing the depth and extent of modeled drawdown. The model was found to be very sensitive to the hydraulic conductivity parameter. In this case this parameter has an unusually drastic effect on the model, yet it was not constrained. A very different outcome is likely if using a higher Kh value.

3.7.3 Recharge

Average conditions were modeled but drought or above-average conditions were not simulated. The model also was found to be very sensitive to recharge parameter. In this case this parameter has a significant effect on the model, yet it was not constrained. A very different outcome is likely under changed recharge conditions.

3.7.4 Primary Porosity

Though robust in their capabilities to discretize finely spaced flowfields to approximate heterogeneity and anisotropy in the aquifer, numerical models still (at the cell-by-cell scale) fundamentally assume idealized porous media behavior of an aquifer. Stated another way, within a given cell in the model, the program assumes that the aquifer behaves with homogenous and isotropic behavior based on the classical equivalent porous media equations (e.g., Theis 1935) that have underpinned the professional practice of quantitative hydrogeology for most of a century.

Numerical models, especially ones lacking in robust field-based parametrization of input criteria, cannot accurately and defensibly represent groundwater flow in a highly anisotropic, heterogeneous, and watering-influenced setting such as a (future) active pair of diabase quarries in fractured rock with no primary porosity. Careful calibration (comparison of observed and predicted groundwater levels in wells completed in differing positions and open to difference depths) could help define model parameters of existing conditions. However, these calibrations were completed based on a one-time measurement and are limited as described above.

4.0 IMPACTS TO HYDROLOGIC RESOURCES ARE NOT DEFINED

The preliminary model did not consider potential direct or indirect impacts to wetlands and streams.

1. H&K appears not to have sufficiently mapped the extent of wetlands on the quarry site. H&K wetland delineations have not been joint reviewed with the US Army Corps of Engineers. Hydric soil and MacFaden et al. (2019) mapping of potential wetlands shows additional potential wetlands on the quarry site that are not now delineated. Unmapped wetlands are at risk of a direct impact.

2. Wetlands off-site similarly are not well defined by the very limited NWI wetland mapping. Far more potential wetlands exist off-site compared to NWI mapping (Figure 3). These wetlands and streams with which they interact, or groundwater they recharge, are at risk of indirect impacts from proposed quarrying and dewatering.

3. The quarry did not characterize wetland function. The wetlands may be a key source of recharge to groundwater supply wells or provide baseflow to streams. Yet wetland function was ignored in the model.

As described above, the H&K consultant prepared the preliminary groundwater model report reliant upon published hydrologic information and limited field-collected data (Britton, 2020). Aspects of that numerical model are discussed herein in the context of local hydrology in greater detail.

4.1. Map Features

The quarry is in the Upper Tohickon Creek watershed (Princeton Hydro, LLC and Boucher & James, Inc., 2005). It is located just west of the headwaters of Hickon Creek, a tributary to Tohickon Creek. Figure 3 shows an abundance of mapped NWI, quarry-identified, and potential wetlands and water bodies (e.g. streams, ponds) on the USGS topographic basemap, including features observed in the site visit.

4.2. Hydrology

The model did not consider direct or indirect impacts to hydrology features that may manifest from dewatering or removing overburden and weathered bedrock. Though the H&K consultant delineated water bodies and wetlands on the quarry property, they did not assess whether wetlands were “recharge” or “discharge” functioning. H&K wetlands were categorized as “ephemeral” or “perennial” (H&K Engineering & Environmental, 2020).

4.2.1. Wetland Direct Impacts

The quarry NWI, quarry and potential wetlands mapped on Figure 3 (USDA, 2021, MacFaden et. al 2019) and their estimated sizes are compared in the table below.

Wetland Feature	Acres Inside Extraction Area	Acres Inside Quarry Property Boundary
H&K Delineated Wetlands	0	60.526
Potential Wetlands (Overlap of MacFaden and Hydric Soil)	3.357	97.371
NWI (PASDA)	0	29.374
USGS 1957 Bucks County Quadrangle Wetlands	N/A	10.462

The table suggests potential for direct impacts to wetlands in the quarry extraction area. Direct impacts cannot be fully explored or mitigated without first completing a jurisdictional determination with the USACE.

The table also suggests potential for indirect wetland impacts outside of the quarry extraction area, though they were not analyzed by the model. NWI mapping is incomplete and thus more wetlands likely exist than otherwise indicated outside of the quarry extraction area. The NWI mapped only 50% of the wetlands H&K identified within the quarry site and NWI mapped less than 30% of the potential wetlands (USDA 2021 and MacFaden et al 2019).

The extent of potential for indirect impacts to wetlands off-site cannot be known without field delineation and assessment of their function.

4.2.2. Discharge Wetlands Impacts

These wetland resources and the streams on which they rely for flow may be affected and are at risk of impacts. As little as 1 foot of drawdown (Oley Township v. DEP, EHB Docket No. 95-101-MG) could essentially cut off or limit the source of groundwater to the wetland. The model did not address the impact of drawdown on discharge functioning wetlands.

A discharge functioning wetland hydrology source is groundwater in direct connection with the intersecting streams and floodplains. Modeled drawdown less than 10 feet was not shared by the H&K consultants (Britton, 2020) and thus the degree to which quarry dewatering produces 1 foot of drawdown beneath “discharge” functioning wetlands was not analyzed. Furthermore, H&K and the model did not explore the function of the many wetlands on and off the quarry premises.

4.2.3. Recharge Wetlands Impacts

Removing overburden and weathered bedrock at the quarry pits could divert runoff and overland flow away from the “recharge” functioning wetland. This could essentially cut off or limit the supply of water to the wetland. The model did not address the impacts of overburden and weathered bedrock removal. These wetland resources and the groundwater which benefits from the recharge (e.g. wells) are at risk of adverse impact. Without an analysis of the effect of removing overburden and weathered bedrock, the risk remains unaddressed.

Recharge functioning wetlands’ primary hydrology is via overland flow from precipitation running off higher to lower elevation landscapes. The water collected in any recharge functioning wetland slowly infiltrates through the soils and provides recharge to groundwater, including private water supplies reliant on this resource. Precipitation that is neither evaporated nor taken up by plants or infiltrated will pond and run off to lower lying areas to support the function of a recharge wetland. B&L observed ponding and overland flow conditions during our site visits (Exhibit B). Quarry cross-sections in the application demonstrate the overburden and weathered bedrock removal areas are on hilltops and upgradient from surrounding wetlands. If wetlands downgradient are recharge functioning, then these resources are at risk of being cut off from their hydrology source.

5.0 SUMMARY OF PROFESSIONAL OPINION

Based on these observations and findings and to a reasonable degree of scientific certainty, it is my professional opinion the Britton report and testimony are not sufficient to conclude that drawdown from the quarry pumping will not have a material detrimental effect on neighboring water wells or hydrology features (e.g. wetlands).

5.1. Limited Scope of Analysis

The Britton diabase quarry preliminary groundwater model was limited in scope by:

- Preparing a numerical model supported by desktop data input parameters
- Not field characterizing the diabase through borehole logging and testing
- Not accounting for wetlands and fractures in the model
- Relying on PAGWIS data

5.2. Analysis Flaws

The Britton quarry analysis was flawed and model predictions indefensible because it:

- Artificially expanded the model domain to balance water in and out.
- Assumed porous media conditions in geology with no primary porosity. Modflow models assume porous media models and diabase has no primary porosity and is a fractured crystalline rock aquifer.
- Provided no fracture trace analysis and did not account for fractures as the primary flowpath for groundwater.
- Didn’t rely on geological studies specific to the geology in question.
- Assigned a less conservative hydraulic conductivity value when the model is particularly sensitive to this parameter.
- Explored only an average recharge condition when the model is particularly sensitive to this parameter. Recharge rate assumed an average versus a drought condition. In the past century there have been extended periods of drought most recently 1998 to 2002. They may have underestimated the drawdown as a result.
- Did not considering effects of pumping from two quarry pits at once, which would happen during reclamation.
- Did not considering pumping from onsite water wells.
- Did not performing field testing for site specific parameters.
- Calibrated the model with a single set of data points.
- Relied on PAGWIS data for model calibration.

- Deprecated the model's results of discontinuous ten-foot drawdown contours north of the northern pits' concentric drawdown contours.
- Provided no analysis of the diabase sheet depth and extent versus a vertical intrusion.

5.3. Necessary Analyses

The following in whole or part are necessary to do an analysis that may adequately explore the hydrogeology to determine whether the neighboring water wells or hydrology would be protected.

1. Compare modeled versus actual drawdowns from existing quarries to establish a zone of influence or impact. Assess if the quarry dewatering model predictions are realized in operation. Use empirical data to establish a zone of influence, such as from borings and geophysical and video logging boreholes of the study-area geology.

2. Establish an empirically or topographically-defined and/or geologically-defined area surrounding the quarry. In the area, establish a robust program for objective investigation by the approving authority, and funded mitigation by the quarry owner in the event of impact causation.

3. Employ an intensive hydrologic and hydrogeologic field characterization program before developing and running a model, whether numerical or analytical or both.

4. Use multiple kinds of models to compare predictions with more than one method. Repeat numerical modeling to address the limited scope of analysis and flaws. Some other types to consider: WHAEM, TDD, Construction Dewatering Analyses

5. Base decisions on the most conservative condition and modeled scenario.

6. Perform field analyses for model conceptualization and parameterization:
   - Fracture Trace Analysis and rock coring to assess degree of fracturing
   - Groundwater recharge and water balance analysis
   - Slug tests and open-hole and isolated-zone packer drawdown tests
   - Equip on-site and off-site monitoring well network with dedicated equipment to monitor baseline (four seasons worth)
   - Install on-site and off-site stream piezometers and stilling wells and dedicated equipment to monitor baseline conditions (four seasons)
   - Install rain stations and establish baseline conditions (four season)

- Install wetland piezometers and stilling wells and equip with dedicated equipment to monitor baseline (four season)
- Perform stream leakance testing
- During on-site drawdown testing monitor above-referenced networks
- For quarry operations monitor above-referenced networks

7. Perform a wetland function analysis and Army Corps Jurisdictional Delineation

8. Assess the recharging wetlands capture area and the effect of removing overburden and weathered rock from the capture area. Cutting off the recharging wetland hydrology could have a significant impact

9. Assess the position of 1 foot drawdown contours and extent to which measurable drawdown overlaps the "discharge" wetlands. One foot of drawdown could have a significant impact on a discharging wetland.

6.0 LIMITATIONS

My professional opinion was limited by:

6.1.1. No access to the quarry parcel.
6.1.2. No budget for more than one day of field work.
6.1.3. Lack of complete geological data for the private well supplies.

My professional opinion may differ should additional information become available.

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Table 1: Neighboring Well Information

Map ID[1]	Address[2]	Parcel No.[2]	Well Type[3/4]	Estimated Elevation (ft msl)[5]	Geology [6]	Pumping Rate (gpm)[3]	Well Depth (ft bgs)[3]	11/20/ 2020 SWL - BTN (ft ?)[3]	03/25/ 2021 SWL - B&L (ft bgs)[4]	03/25/ 2021 SWL - B&L (ft msl)[4]	PaGWIS Well ID
2	1574 Salem Road, Quakertown, PA	42-004-097-003	Drilled private well (Jd/Trb)	678	Diabase and/or Brunswick (Jd/Trb)	8	775	112.4	-	-	73499
3	311 Hilltop Road, Coopersburg, PA	42-004-014	Drilled private well (Jd)	659	Brunswick and/or Diabase (Jd/Trb)	-	200	-	-	-	-
6	1602 Salem Road, Coopersburg, PA	42-004-096	Drilled private well (Unknown)	657	Unknown	-	30	-	2.25	655	-
17	1876 Salem Road, Coopersburg, PA	42-004-088	Drilled private well (Jd/Trb)	626	Diabase and/or Brunswick (Jd/Trb)	-	244	48.8	62.56	563	-
			Drilled Well (wetland) (Jd)	608	Diabase (Jd)	-	73.11	-	1.24	607	-
			Hand Dug Well (wetland)	608	Overburden	-	3.3 - 4.0	-	at grade	608	-
			Hand Dug Well (other)	620	Overburden	-	10.8	-	1.10	619	-
22	669 Mine Road, Coopersburg, PA	42-004-105	Drilled private well (Jd/Trb)	669	Diabase and/or Brunswick (Jd/Trb)	-	500	103.1	-	-	-
28 & 29	635 Mine Road, Quakertown, PA	42-004-101	Drilled private well (Jd/Trb)	676	Diabase and/or Brunswick (Jd/Trb)	10	700	119.2	103.20	573	-
			Drilled private well (Unknown)	672	Unknown	-	-	22.7	15.55	656	-
			Hand Dug Well	660	Overburden		-	-	-	-	-
			Drilled private well	664	Overburden	-	-	-	-	-	-
30	608 Mine Road, Quakertown, PA	42-004-119	Drilled private well (Jd)	665	Diabase and/or Brunswick (Jd/Trb)	0.5	400	36	32.1	633	5878
33	1594 Salem Road, Coopersburg, PA	42-004-097-002	Drilled private well (Jd)	668	Diabase (Jd)	-	260	16.7	6.23	662	73397
35	1710 Salem Road, Quakertown, PA	42-004-093.001	Drilled private well (Jd)	660	Diabase (Jd)	3	127	9.4	-	-	-
			Hand Dug Well (side yard)	655	Overburden	-	19.0	-	5.45	650	-
			Hand Dug Well (woods)	608	Overburden	-	2.6 - 2.9	-	1.60	606	-
36	1810 Salem Road, Coopersburg, PA	42-004-091	Drilled private well (Jd)	652	Diabase (Jd)	-	218	34.8	-	-	73421
37	520 Springfield Road, Coopersburg, PA	42-004-077	Drilled private well (Jd/Trb)	608	Diabase and/or Brunswick (Jd/Trb)	-	500	-	7.75	600	-
			Hand Dug Well (old farm well)	616	Overburden		-	-	1.75	614	-
39	793 Mine Road Rear, Quakertown, PA	42-004-106-004	Drilled private well (Jd/Trb)	589	Diabase and/or Brunswick (Jd/Trb)	5	790	-	15.57 (AM)	573	-

Notes: ft = feet; bgs = below ground surface, ags= above ground surface, SWL = static water level, gpm = gallon per minute

[1] Map ID corresponds with map label on Figure 1 - Site Map.

[2] Data from GIS parcel shapefile provided by Springfield Township Government.

[3] Preliminary well information from BTN Groundwater Committee collected via sonic level reader AM on Nov. 22, 2020 or provided by a quarry neighbor.

[4] B&L observed well diameter and type during March 25, 2021 field visit.

[5] Elevation data from DEM digital download available through Bucks County GIS Data.

[6] Diabase geology assumed minimum base elevation 400 ft msl based on H&K quarry proposed depth. Wells completed deeper than this elevation assumed to yield from Diabase and/or Brunswick. Hand dug assumed to be completed in overburden. Unknown indicated for drilled wells without enough information to assign geology.

Table 2 Consultant and PaGWIS Sourced Well Information

	Consultant Developed Data [1]						PaGWIS Data [2]								
	Well	Description	Simulated GW Elevation (ft/msl)	Observed GW Elevation (ft/msl)	Longitude [3]	Latitude [3]	Well	Estimated Elevation (ft/msl) [4]	Static Water Level (ft bgs)	Total Well Depth (ft)	Casing Depth (ft)	Rock Type	Longitude [3]	Latitude [3]	
Val Britton Calibration Wells	Tatoo	Measured Residential Well	594	605	2658385.38	432620.74	-		-	-	-	-	-	-	PaGWIS Reports
	CM	Measured Residential Well	530	557	2657511.69	434822.56	-		-	-	-	-	-	-	
	HK-2	Measured Borehole	594	606	2658907.52	433780.90	-		-	-	-	-	-	-	
	HK-3	Measured Borehole	593	593	2659386.69	433718.40	-		-	-	-	-	-	-	
	CP-A	Surface Water Point	589	590	2659428.35	432968.40	-		-	-	-	-	-	-	
	CP-3	Surface Water Point	596	598	2652324.19	432385.06	-		-	-	-	-	-	-	
	CP-B	Surface Water Point	571	600	2660761.69	428926.73	-		-	-	-	-	-	-	
	72840	PAGWIS Well	637	646	2665470.02	435447.56	72840	545	20	300	20	Jd	2629570.98	426310.38	
	73460	PAGWIS Well	617	630	2663636.69	432885.06	73460	665	45	200	22	Jd	2631870.94	432750.02	
	73397	PAGWIS Well	621	628	2662553.35	432468.40	73397	665	25	260	20	Jd	2630794.98	432516.89	
	73443	PAGWIS Well	571	556	2659720.02	429093.40	73443	595	30	320	17	Trb	2628018.48	429406.41	
	474788	PAGWIS Well	603	586	2662386.69	429218.40	474788	660	16	40	38	Trb	2631689.92	429563.61	
	5862	PAGWIS Well	601	586	2658303.35	427822.56	5862	610	23	122	36	Trb	2626674.314	427650.22	
	Map ID	Description	Estimated Elevation (ft/msl) [4]	Observed GW Elevation (ft/msl)	Longitude [3]	Latitude [3]	Well	Estimated Elevation (ft/msl) [4]	Static Water Level (ft bgs)	Total Well Depth (ft)	Casing Depth (ft)	Rock Type	Longitude [3]	Latitude [3]	
Select B&L Private Supply Wells	2	Drilled private well (Jd/Trb)	678	-	2630872.72	431874.72	73499		50	400	40	-	-	-	PaGWIS Reports
	3	Drilled private well (Jd)	659	-	2625305.51	433495.73	-		-	-	-	-	-	-	
	6	Drilled private well (Unknown)	657	655	2630939.84	432493.44	-		-	-	-	-	-	-	
	17	Drilled private well (Jd/Trb)	626	563	2629718.22	435340.53	-		-	-	-	-	-	-	
		Drilled Well (wetland) (Jd)	608	607	2629914.62	435159.98	-		-	-	-	-	-	-	
		Hand Dug Well (wetland)	608	608	2629876.68	435396.84	-		-	-	-	-	-	-	
		Hand Dug Well (other)	620	619	2629944.44	435197.66	-		-	-	-	-	-	-	
	22	Drilled private well (Jd/Trb)	669	-	2630117.14	431201.88	-		-	-	-	-	-	-	
	28 & 29	Drilled private well (Jd/Trb)	676	573	2630353.53	431212.83	-		-	-	-	-	-	-	
		Drilled private well (Unknown)	672	656	2630469.63	431188.42	-		-	-	-	-	-	-	
		Hand Dug Well	660	-	2630332.04	431099.15	-		-	-	-	-	-	-	
		Drilled private well	664	-	2630378.27	431149.75	-		-	-	-	-	-	-	
	30	Drilled private well (Jd)	665	633	2630819.84	430830.43	5878	660	72.1	400	40	Jd	2630682.90	430895.77	
	33	Drilled private well (Jd)	668	662	2631015.32	432258.56	73397	665	25	260	20	Jd	2630794.98	432516.89	
	35	Drilled private well (Jd)	660	-	2631291.58	433516.62	-		-	-	-	-	-	-	
		Hand Dug Well (side yard)	655	650	2631332.40	433571.85	-		-	-	-	-	-	-	
		Hand Dug Well (woods)	608	606	2629861.25	433332.15	-		-	-	-	-	-	-	
	36	Drilled private well (Jd)	652	-	2630850.43	434803.32	73421	655	-	260	34	Jd	2628740.35	437016.98	
	37	Drilled private well (Jd/Trb)	608	600	2627291.21	434970.91	-		-	-	-	-	-	-	
		Hand Dug Well (old farm well)	616	614	2627080.06	434978.63	-		-	-	-	-	-	-	
	39	Drilled private well (Jd/Trb)	589	573	2627948.20	431196.19	-		-	-	-	-	-	-	

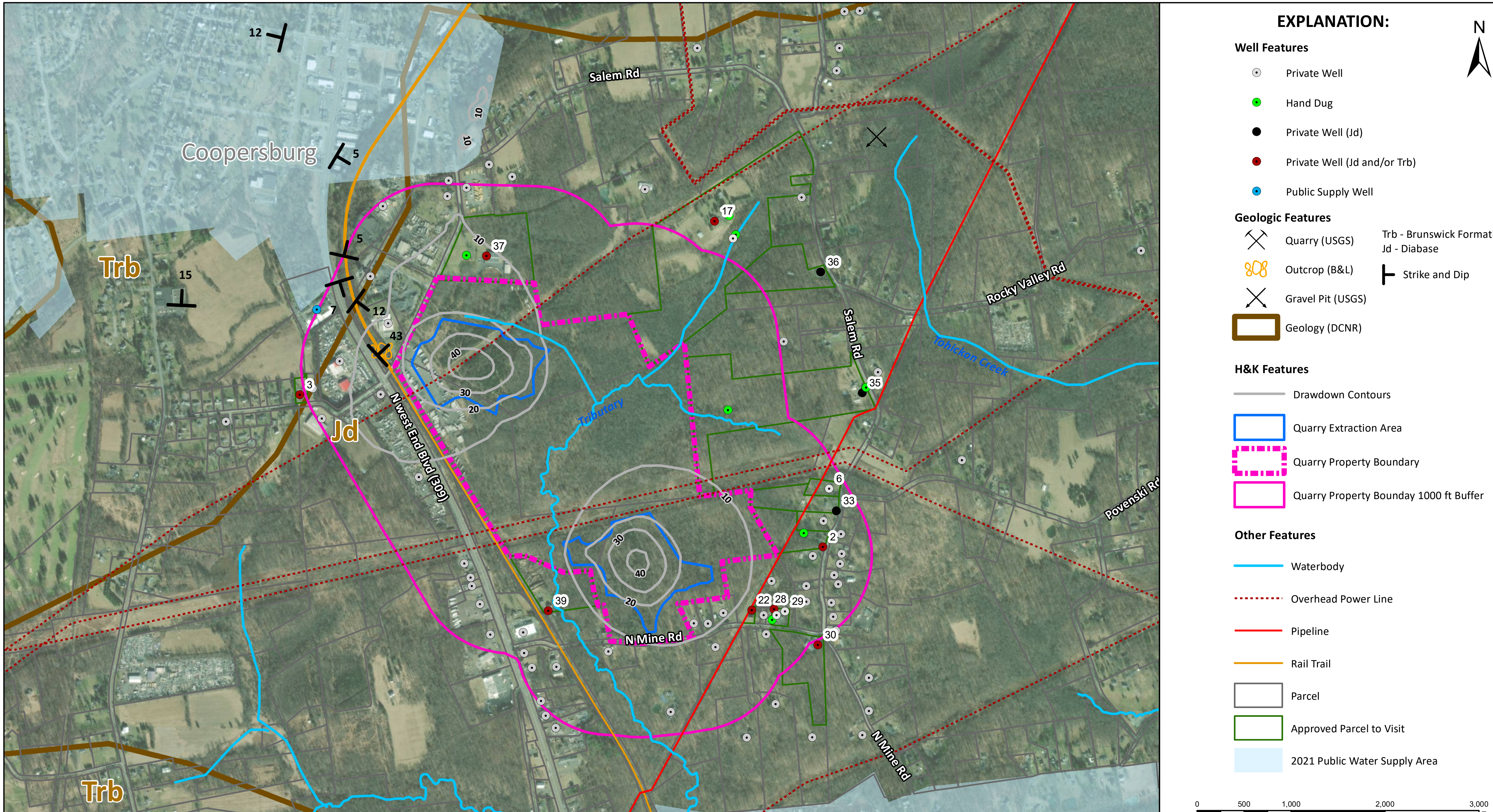
Notes: ft = feet; bgs = below ground surface; mean sea level

[1] Val Britton well data from Val Britton provided maps in H&K Quarry Application. B&L data from Figure 1 and Table 1.

[2] PaGWIS data downloaded from Pennsylvania Groundwater Information System (PaGWIS).

[3] Coordinates obtained through ArcGIS, PaGWIS database, Val Britton Map, and GPS data collected during site visit.

[4] Elevations estimated using 2-foot topographic contours from Bucks County GIS.



Notes:

1. Basemap from ESRI, others and the GIS user community.
2. Public water supply area, and rail trail from PASDA. Geologic features from USGS and PA DCNR. Pipeline data from PA DEP.
3. Wells and other features located by B&L using GPS on 3/25/21 or mapped from H&K Group Engineering and Environmental Services Division Continual Use Application Overall Site Plan. Outcrop point collected by B&L GPS on 3/25/21.
4. Parcels provided by Springfield Township (TWP).
5. Quarry features digitized from H&K Group Engineering and Environmental Services.
6. Overhead Power Line from Homeland Infrastructure Foundation-Level Data (HIFLD).
7. Waterbodies from PASDA, PAMAP, and H&K site plan.
8. This figure is integral to a written report and should only be used in that context. This figure is not intended to be used for boundary verification or survey control purposes.

Client:

CLEAN AIR COUNCIL

PROJECT NO. 2200.003.001

Project:

H&K Quarry Project

Springfield, Bucks County, PA

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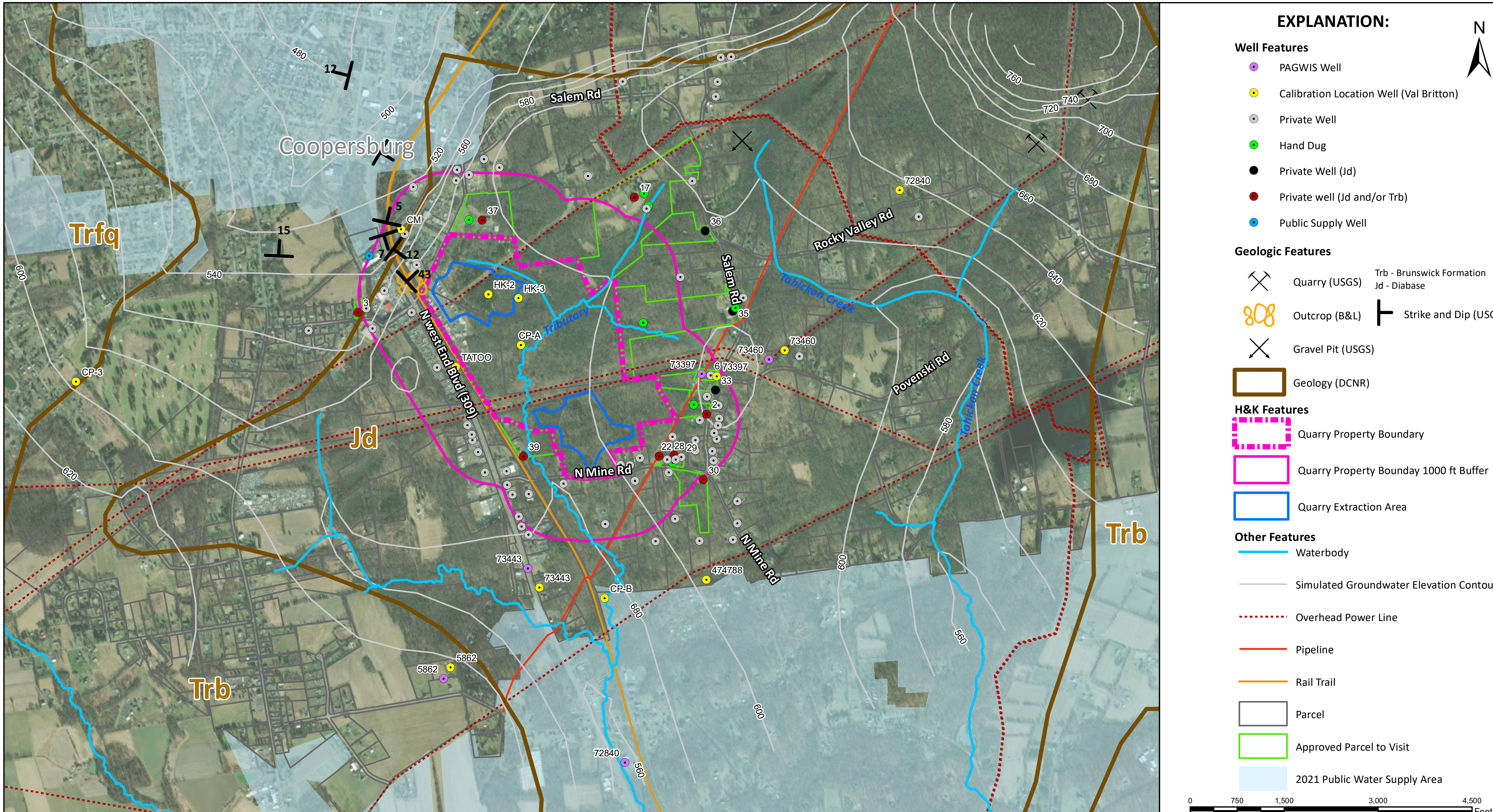
Figure 1:

Geologic Features Map

February 07, 2022



Notes:
1. Basemap from ESRI, others and the GIS user community.
2. Public water supply area, and rail trail from PASDA. Geologic features form United States Geological Survey (USGS) and PA DCNR. Pipeline data from PA DEP.
3. Wells and other features located by B&L using GPS on 3/25/21 or mapped from H&K Group Engineering and Environmental Services Division Continual Use Application Overall Site Plan. Outcrop point collected by B&L GPS on 3/25/21.
4. Parcels provided by Springfield Township (TWP).
5. Quarry features digitized from H&K Group Engineering and Environmental Services.
6. Overhead Power Line from Homeland Infrastructure Foundation-Level Data (HIFLD).
7. Waterbodies from PASDA, PAMAP, and H&K Site Plan.
8. Simulated groundwater elevation contours and calibration location wells from Val Britton map in H&K Quarry Application Report.
9. This figure is integral to a written report and should only be used in that context. This figure is not intended to be used for boundary verification or survey control purposes.

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Project:

H&K Quarry Project

Springfield, Bucks County, PA

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Figure 2:

Hydrogeologic Map

February 07, 2022

Diabase Quarry Report of Professional Opinion

Notes:

1. Basemap from ESRI, others and the GIS user community.
2. NWI wetlands, rail trail and public water supply area from PASDA. Pipeline data from PA DEP.
3. Wells and other features located by B&L using GPS on 3/25/21 or mapped from H&K Group Engineering and Environmental Services Division Continual Use Application Overall Site Plan.
4. Parcels provided by Springfield Township (TWP).
5. Quarry features digitized from H&K Group Engineering and Environmental Services Division Continual Use Application Overall Site Plan.
6. Overhead power line from Homeland Infrastructure Foundation-Level Data (HIFLD).
7. Schmid & Co. wetland points from 3/25/21 field visit. Schmid & Co. potential wetlands source is hydric soils from web soil survey and MacFaden et al. (2019) analysis.
8. Waterbodies from PASDA, PAMAP, and H&K site plan.
9. This figure is integral to a written report and should only be used in that context. This figure is not intended to be used for boundary verification or survey control purposes.

Client:

CLEAN AIR COUNCIL

PROJECT NO. 2200.003.001

Project:

H&K Quarry Project

Springfield, Bucks County, PA

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Figure 3:

Hydrologic Features Map

February 07, 2022

EXHIBIT A

Resume

Amy Martinez Parrish, P.G., EHS

Senior Managing Hydrogeologist
aparrish@bartonandloguidice.com

Years of Experience: 20

Education:
B.S. (with Honors), Geological and Environmental Science
Susquehanna University, 2002

Professional Registrations:
Professional Geologist, Pennsylvania 2009 and Delaware 2021, Environmental Health Specialist, Maryland 2007, On-site Sewage Disposal Systems Inspection, 2011, 40-Hr Basic Wetland Delineation, Maryland 2017,40-Hr OSHA Hazardous Waste Site Worker Training

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Summary

Expert Testimony and Litigation Support

As a Maryland Licensed Environmental Health Specialist (EHS) and a Pennsylvania Professional Geologist (P.G.), Ms. Parrish has provided expert consultation and support for cases of alleged environmental contamination and damages causation. Ms. Parrish has provided expertise in matters of horizontal directional drilling, groundwater withdrawal and groundwater discharge. Testimony has been offered in administrative hearings, legislative hearings and public informational hearings. Ms. Parrish also serves as an industry member on the MD Board of Environmental Health Specialists.

Relevant Project Experience

Expert Testimony and Litigation Support

Litigation Support: Clean Air Council, et. al. vs. PADEP and Sunoco Pipeline, L.P. Ms. Parrish was the Managing Hydrogeologist and provided expertise assessing the hydrogeological impacts from Horizontal Directional Drilling (HDD) projects for petroleum pipelines. She issued an affidavit on the shortfalls of third-party HDD hydrogeological reevaluations for pipeline installation projects completed in portions of Huntingdon and Lancaster Counties. She assessed off-site impacts from HDD construction in Chester and Delaware Counties. Her assessments identified deficiencies in the third-party hydrogeological reporting which included: the lack of geophysical surveys in Karst terrain, failure to consider groundwater movement via conduits and structural geologic contacts, fault and fracture trace features, and the failure to identify and monitor at-risk properties and neighboring water supplies. Her work helped uphold the injunctions halting drilling in areas at risk for continued water resources impacts. She suggested provisions of settlement agreement documents including the PADEP Inadvertent Return and Water Supply Assessment, Preparedness, Prevention and Contingency Plans. Ms. Parrish's expertise led to her appointment as stakeholder on the PADEP Trenchless Technology workgroup where she led subcommittees and contributed to the development of the PADEP Trenchless Technology (HDD) Technical Guidance Document.

Litigation Support: Representing Plaintiff in Confidential HDD Case, Pennsylvania
Ms. Parrish was the Managing Hydrogeologist and provided expertise assessing land subsidence impacts from HDD drilling at a confidential location in Pennsylvania. She led her team in completing a hydrogeological investigation, including providing geologic mapping of Karst conditions and features, and field identification and mapping of sinkholes and subsidence features. She provided expertise to the attorneys leading to a settlement agreement.

Litigation Support: Law Offices of Levin & Gann Representing Developer vs. Old York Manor – Pheasant Hill Estates Community Association, Baltimore County, MD Ms. Parrish was the Project Hydrogeologist supporting a proposed residential development to be served by well and septic systems and opining on potential impacts to new houses downgradient of the existing community. She provided well locating, drilling and water quality sampling recommendations intended to protect future supply wells to be located downgrade of existing septic systems. She prepared and delivered testimony, being sworn in by the Baltimore County Office of Administrative Hearings as a geological and environmental health expert. The project was disapproved not on the grounds of well and septic issues but only for failing to meet certain administrative grandfathering criteria.

Expert Consultation to Waive Code Requirements for Private Developer in Frederick County, MD
Ms. Parrish was the Project Hydrogeologist and led a team including the owner, land developer, driller, civil engineer, County environmental health agency and Maryland Department of the Environment to negotiate a waiver to the potable well setback code requirements. She provided alternate drilling locations downgradient from sewage disposal systems, but with tailored well construction specifications, adequate separation and aggressive water quality testing criteria and protections. Her work led to waiving of code requirements and successful well drilling and testing to support the development plans.

Litigation Support: Walden Golf Course vs. Baltimore Gas & Electric, Anne Arundel County, MD
Ms. Parrish was the Project Hydrogeologist providing geochemical and hydrogeological characterization of the surficial, unconfined Atlantic Coastal Plain aquifer underlying the golf course and surrounding area of Anne Arundel County, Maryland. She assessed changes in groundwater geochemistry following coal fly ash emplacement upgradient and within the groundwater capture zone of irrigation wells. She developed models and established groundwater flow velocities to map contaminant transport. She correlated changes in groundwater geochemistry to the fly ash emplacement, identifying aluminum heavy metals in irrigated groundwater as the probable cause of turf die off. Her work helped support an out-of-court settlement agreement.

Litigation Support: Representing Plaintiff in Confidential HDD Case, Pennsylvania
Ms. Parrish is the Senior Managing Hydrogeologist representing a client with alleged groundwater supply impacts from HDD drilling activity at a confidential location in Pennsylvania. She analyzed changes in site conditions as a consequence of HDD drilling and developed hydrogeological and geochemical evidence of time-correlative impacts. She issued a letter of professional opinion and began compiling discovery documents. Work is ongoing.

Litigation Support: Law Offices of Chaifetz & Coyle Representing Plaintiff vs. Jennifer Rivas, et. al., Carroll County, MD
Ms. Parrish was the Project Hydrogeologist and provided hydrogeological research, groundwater sampling, testing and interpretation of the cause of domestic supply well bacteriological contamination. Her work helped lead the case a successful judgement in the Carroll County District Court of Maryland against the seller who failed to disclose the contaminated well condition.

Litigation Support: Law Offices of Leslie Powell Representing Plaintiffs vs. Pheasant Ridge MHP, Frederick County, MD
Ms. Parrish was the Project Hydrogeologist representing homeowners with at risk groundwater supply wells against a mobile home park's plans to increase the permitted number of connections. Ms. Parrish researched and found evidence citing bacteriological contamination of the groundwater, wells at risk of groundwater under direct influence, total coliform rule violations, lead and copper rule violations, NPDES discharge permit monitoring violations, and groundwater recharge inadequacies for the mobile home park's private water & sewage facilities as reasons for denying the expansion. Ms. Parrish provided cross-examination questions to use against the opposing expert during the Board of Zoning Appeals hearing. A favorable judgement was delivered prior to her taking the stand.

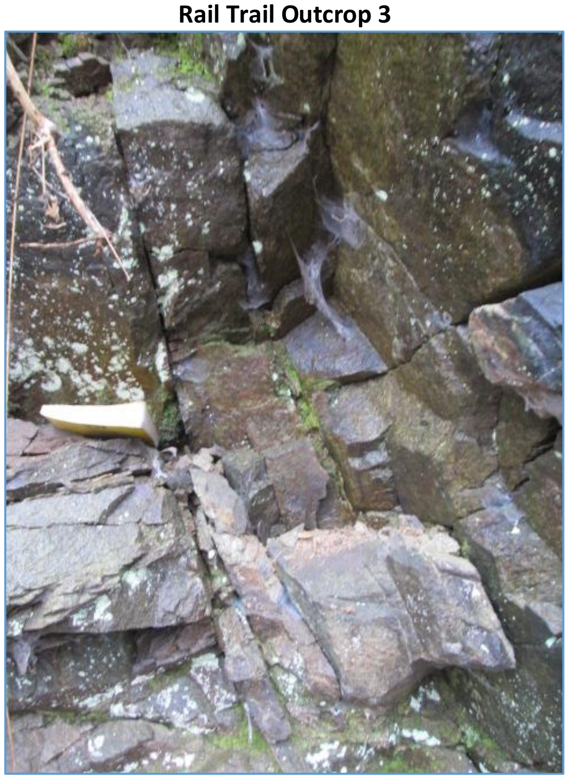
EXHIBIT B

Site Visit Photos

Photograph 1:
Rail Trail Outcrop 1

Photograph 2:
Rail Trail Outcrop 2

Photograph 3:
Rail Trail Outcrop 3



Photograph 4:
Rail Trail Outcrop 4

Photograph 5:
Name of Photo: Rail Trail Culvert 2

Photograph 6:

Name of Photo: Intermittent Stream

Photograph 7:
Name of Photo: Rail trail Low lying area

Photograph 8:
Name of Photo: Power Areas

Photograph 9:
Name of Photo: Rail Trail sign

Photograph 10:
Name of Photo: Rail trail Wetland

Photograph 11:
Name of Photo: Rail Trail Wetland 2

Photograph 12:
Name of Photo: Sheetz 3

Photograph 13:
Name of Photo: Sheetz 4

Photograph 14:
Name of Photo: Sheetz low lying area

Photograph 15:
Name of Photo: Sheetz low lying area 2

Photograph 16:
Name of Photo: Sheetz Supply Well cap

Photograph 17:
Name of Photo: Spears hand dug well house

Photograph 18:
Name of Photo: Spears hand dug well house 1

Photograph 19:
Name of Photo: Spears low lying areas

Photograph 20:
Name of Photo: Spears Supply Well

Photograph 21:
Name of Photo: Jones hand dug well

Photograph 22:
Name of Photo: Jones Supply lid

Photograph 23:
Name of Photo: Jones Wetland cased well no cap.

Photograph 24:
Name of Photo: Jones Wetland Hand dug well

Photograph 25:
Name of Photo: Hand dug well near power areas

Photograph 26:
Name of Photo: Hand dug old supply well

Photograph 27:
Name of Photo: Hand dug well west boundary

Photograph 28:
Name of Photo: Well marked Bird

Photograph 29:
Name of Photo: Premo supply lid

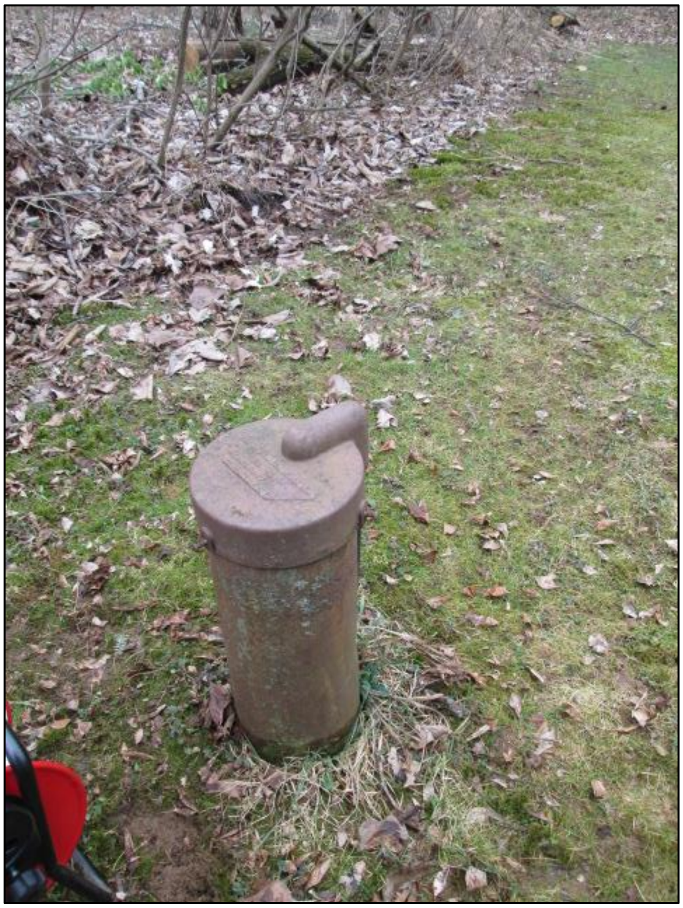
Photograph 30: Premo supply well

Name of Photograph:

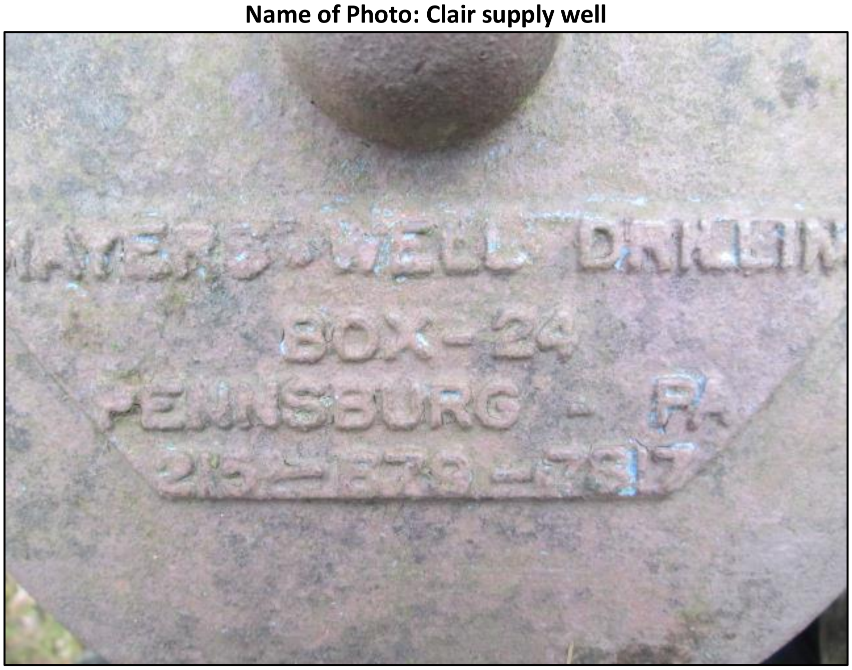
Photograph 31:
Name of Photo: Fliszar supply well

Photograph 32:
Name of Photo: Clair ponds

Photograph 33:
Name of Photo: Clair ponds 2



Photograph 34:
Name of Photo: Clair supply well



Photograph 35:
Name of photo: Clair supply well Lid

Photograph 36:
Name of Photo: Vorcheimer supply lid

Photograph 37:
Name of photo: Goad back up supply well

Photograph 38:
Name of Photo: Goad hand dug well

Photograph 39: Goad supply well

Name of Photo:

Photograph 40
Name of Photo: Goad supply well lid

Photograph 41:
Name of Photo: Goad well not used

Photograph 42:
Name of Photo: Pfeiffer supply well

Photograph 43: Pfeiffer supply well lid