QHS CONSULTING

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Pittsburgh PA 15237

April 7, 2025

Barbara Lynch
Chair, Salford Township Board of Supervisors
139 Ridge Road P.O. Box 54
Tylersport, PA 18971

Re: Evaluation of 2023 V.F. Britton Group Groundwater Modeling Report and September 2024 NPDES Permit Amendment for the Naceville Materials Quarry West, Rockhill Township, Bucks County, PA

1. INTRODUCTION

At the request of Salford Township (the Township), Quantitative Hydro Solutions, Inc. (QHS Consulting) has reviewed the September 2024 Application for Minor Permit Amendment for the Naceville Materials J.V. – Naceville Quarry (the Quarry), located in West Rockhill Township, Bucks County PA. Specifically, QHS Consulting was asked to review and evaluate the December 5, 2023 report entitled "*Groundwater Model Report – Current Conditions – Potential Groundwater Impacts – Naceville Materials, West Rockhill Township, Bucks County, PA*", prepared by V.F. Britton Group, LLC (i.e., the 2023 Britton Group Modeling Report) on behalf of H&K Group Inc. (H&K Group) and submitted as part of the September 2024 application. It is QHS Consulting's understanding that Township is concerned about the effect of groundwater withdrawals from the Quarry on nearby private water supply wells (several of which have and continue to go dry), and whether the 2023 Britton Group Model is a reliable decision-making tool for the purpose of determining whether the impacts to private water supply wells may be associated with quarry operations.

In addition to the review and evaluation of the 2023 Britton Group Modeling Report, the Township also asked QHS Consulting to review the June 2024 National Pollution Discharge Elimination System (NPDES) Permit Renewal Application submitted by H&K Group on behalf of Naceville Materials. The application requests an increase in permitted quarry discharge volume from 500,000 gallons per day (gpd) to 1,000,000 gpd.

As part of QHS Consulting's evaluation, several other documents and data were reviewed and analyzed to better understand the underlying data and information utilized to develop the 2023 Britton Group model, including the following:

- The April 9, 2015 report entitled "*Groundwater Model Report (Update) – Evaluation of Depth Expansion Impacts – Naceville Materials, West Rockhill Township, Bucks County, PA*", prepared by V.F. Britton Group, LLC (I.e., the 2015 Britton Group Modeling Report), which provides details on the Britton Group model that was updated and summarized in the 2023 Britton Group Modeling Report;

- A focused review of the 2005 report entitled "*Hydrogeological Investigation Report, Supplement to the Noncoal Surface Mining Permit Application, Naceville Materials, Joint Venture Naceville Materials Quarry, West Rockhill Township, Bucks County, Pennsylvania*", prepared by the H&K Group, which provides a characterization of site hydrogeologic characteristics that were considered by Britton Group in developing the 2015 and 2023 models;
- Data and information provided by the Township, including a summary table and map of private water supply wells that have gone dry; and
- Data and information obtained from a file review at the Pennsylvania Department of Envirornemntal Protection (PADEP), including information regarding site geologic conditions and water level elevation data for quarry monitoring wells.

As summary of comments associated with QHS Consulting's evaluation of the 2023 Britton Group Modeling Report is presented in Section 2 below. A brief summary of QHS Consulting's review of the June 2024 NPDES Permit Renewal Application is included in Section 3. Finally, conclusions based on documents, data, and information reviewed to date are summarized in Section 4.

2. EVALUATION OF 2023 BRITTON GROUP MODELING REPORT

Based on QHS Consulting's review of the 2023 Britton Group Modeling Report, a number of flaws and unsupported or inadequately explained assumptions were identified with regard to model construction, model boundary conditions, model input parameters, and model calibration. While QHS Consulting has not had the opportunity to review and analyze modeling files associated with the 2023 Britton Group Model, based on the examination of reports, data, and information to date, it appears likely that these deficiencies affect the utility and reliability of the model for use as a decision-making tool for the purpose of determining whether impacts to private water supply wells may be associated with quarry operations.

A summary of QHS Consulting's comments on the 2023 Britton Group Model based on our review and analysis of documents, data, and information to date are presented in the subsections below.

Model Purpose and Objectives

Comment 1 – Based on QHS Consulting's review of the September 2024 Application for a Minor Permit Amendment submitted by the H&K Group on behalf of Naceville Materials (which attaches the 2023 Britton Group Modeling Report), the submittal's cover letter does not provide any basis or rationale for the submittal of the 2023 Britton Group Model (and the modifications that were made to the model as part of the model update). Conversely, for the previous model update issued by H&K Group and the Britton Group in April of 2015, H&K Group noted in a cover letter that following PADEP's review of the existing groundwater flow model for the quarry, the updated model was developed based on PADEP's request that the model be re-calibrated based on more current data. Although the 2023 Britton Group model is in fact calibrated to more recent water level data, it is not clear as to whether this was the impetus for the current model update.

Comment 2 – In the "Purpose of Groundwater Flow Model Evaluation" Section of the 2023 Britton Group Modeling Report (Section 1.3, p. 8), it is noted that "*the purpose of the groundwater model* *discussed in this report is to* ***establish the current groundwater zone of influence*** *resulting from the current quarry configuration and dewatering rate*" [emphasis added]. The section does not, however, discuss the fact that several modifications were made to the model as part of the current update (including modification of model boundary conditions and hydraulic input parameters), nor does it provide a rationale for why those modifications were made. As discussed in subsequent comments, these modifications result in a significantly smaller groundwater zone of influence (ZOI) when compared with the ZOI generated by the 2015 Britton Group Model.

Comment 3 - Section 1.3 (p. 9) notes that "*it is not the intent of the groundwater model to solely define the hydrogeologic characteristics that exist at the site, but rather the* ***model is intended to be used as an additional evaluation tool in conjunction with the more conventional evaluation methods*** *that have been applied to the site*" [emphasis added]. It is unclear as to what the "*other more conventional methods*" of evaluation consist of, and how those methods are utilized to assess potential impacts to nearby residential wells in response to quarry operations.

<u>Model Conceptualization and Construction</u>

Comment 4 – The introductory paragraph of the Model Construction section of the 2023 Britton Group Modeling Report (Section 2.1, pg. 10) states the following: "*The collection and or evaluation of all data desired for a particular investigative purpose may not be possible due to economic and/or logistic limitations. For this reason, some assumptions and speculation relative to the site's geologic or hydro-geologic characteristics have been made during the development of this groundwater model*". It is unclear as to what "*assumptions and speculation relative to the site's geologic or hydrogeologic characteristics*" were made by the Britton Group in the 2023 model. Nonetheless, while modelers routinely deal with data and information gaps when developing and calibrating groundwater flow models, decisions regarding model construction, assignment of boundary conditions and hydraulic parameters, and model calibration should be estimated based on best available site data and information, and not on "speculation".

Comment 5 – The 2023 Britton Group Model's construction does not capture the complex geologic controls on groundwater flow as it relates to the stated model objectives. Specifically, the complex bedrock hydrogeologic conditions at, and in the vicinity of, the site are represented in the 2023 Britton Group Model as an Equivalent Porous Medium (EPM). As shown in **Figure 1**, the model does not properly incorporate the dipping bedrock strata (including the Brunswick and Lockatong Formations), nor does it take into account bedding plane partings associated with these formations (where many private water supply wells likely draw water from). Further, since the model is set up using a rectilinear grid, the area of grid refinement does not take into account important site characteristics, including the orientation of subsurface geology, or wells of interest located along Ridge Road.

<u>Model Boundary Conditions</u>

Comment 6 – Comparison of the 2023 Britton Group Model with the 2015 Britton Group Model indicates that the eastern model boundary was modified from a no-flow boundary in the 2015 Britton Group Model to a specified head boundary "*…to allow water to freely move past this boundary at specified head elevations since no natural or hydraulic groundwater divides exist in this* *direction."* (2023 Britton Group Modeling Report, Section 2.2, page 10) (**Figure 2**). This is incorrect. In fact, the original assignment of the eastern boundary as a no-flow boundary in the 2015 Britton Group Model is more appropriate, as this boundary is located along a natural groundwater divide. Instead, use of a specified head boundary would likely have been more appropriate along the southwestern model boundary, where no natural groundwater divide exists. Although QHS consulting has not had the opportunity to review and analyze modeling files for the 2015 and 2023 Britton Group Models to examine the effects associated with the assignment of a specified head along the eastern model boundary, the use of this boundary condition will maintain heads at the assigned elevations along this boundary. Coupled with the use of a no-flow boundary to the southwest, boundary assignments may artificially reduce the amount of drawdown in the model that is calculated due to quarry operations.

Comment 7 – In addition to the inappropriate assignment of a specified head boundary along the eastern boundary of the model domain (as well as assignment of a no-flow boundary along the southwestern model boundary), the quarry is represented in the model using a drain boundary condition. As discussed on page 13 of the 2023 Britton Group Modeling Report, "*The drain elevation was set at the appropriate simulated quarry bench elevation. During the calibration stage (existing site conditions), the drain conductance (rate at which water can pass through the floor of the quarry) is adjusted to generally match the observed average quarry discharge rate and maintain the observed general groundwater elevation contours from the quarry dewatering*." Although the conductance of the drain may have been adjusted to match the quarry dewatering rate of 347 gallons per minute (gpm) in the model, review of Figure 8 of the 2023 Britton Group Modeling report (which depicts simulated groundwater contours generated by the calibrated groundwater flow model) indicates that the lowest groundwater elevation contour in the Quarry area is at 400 ft msl, indicating that the quarry may have nearly 100 feet of water in the pit in certain areas of the model. Accordingly, the use of a drain boundary condition to represent quarry dewatering is not appropriate.

Comment 8 – Based on review of the 2023 Britton Group Model Report, the only pumping stress taken into account in the model appears to the quarry (which, as discussed in Comment 7 above, is inappropriately represented as a drain boundary condition). There are dozens of private wells located in proximity to the quarry, and it is unclear as to whether any other water supply wells (e.g., commercial water supply wells) are located within the model domain. Nonetheless, the 2023 Britton Group Modeling report includes no discussion or evaluation of potential effects of pumping of private water supply wells or other water supply wells that may be present within the model domain.

Model Input Parameters

Comment 9 – Review of the 2023 Britton Gorup Modeling Report indicates that relatively significant adjustments to model hydraulic conductivity values have been made when compared to the 2015 Britton Group Model. Two issues with these modifications have been identified: 1) the average hydraulic conductivity values considered during model calibration are too high based on the aquifer pump testing conducted by H&K in the early 2000s (as presented in the 2005 H&K report), and 2) the final calibrated hydraulic conductivity values used in the model were higher still than the already-too-high average values that were considered as part of model calibration.

The hydraulic conductivity values derived from aquifer pump tests that were summarized in the 2005 H&K Report were used to estimate average values for hydraulic conductivity to aid in the calibration of the 2023 Britton Group Model (which are included in Table 4 of the 2023 Britton Group Report). Review of the 2005 H&K Report indicates that several of the values reported in Table 4 of the Britton Group Modeling Report for the Upper and Lower Argillite were determined to be anomalous. Specifically:

- Pumping Test #1 – The estimated hydraulic conductivity values of 21.9 ft/day for the Keller Hand Dug Well (NMR-1B) and 60.2 ft/day for the NW-MW-2 were determined by H&K to be anomalous, as H&K reported that the limited drawdowns observed in these wells were likely the result of changes barometric pressure and evapotranspiration processes rather than influences from pumping well NM-MW-10 (H&K Group 2005, pg. 21)
- Pumping Test #3 - The estimated hydraulic conductivity value of 126 ft/day for the Keller Hand Dug Well (NMR-1B) was determined by H&K to be anomalous, as the shallow water bearing for this shallow well (which was completed to 20 feet below ground surface (bgs)) is isolated and not hydraulically connected to the underlying water-bearing Argillite formation. (H&K Group 2005, pg. 37)

Nonetheless, the Britton Group utilized these anomalously high hydraulic conductivity values (along with others reported in Table 4 of their report) to calculate average hydraulic conductivity values for the Lower and Upper Argillite, which were in turn used as targets during model calibration. Leaving aside the fact that these anomalously high hydraulic conductivity values should not have been considered in developing average hydraulic conductivity values for the purpose of model calibration, the use of average hydraulic conductivity as a central (i.e., representative) value is only appropriate if the pump test dataset abides by a normal (i.e., Gaussian) distribution (whereby the average and the median are approximately equal and therefore both representative of the dataset). In non-normally distributed data, the average is not representative of the dataset, and a median or geometric mean is a more appropriate choice for a central value. In the case of the H&K pump test data, averages are overestimates of the central representative value because of the influence of high values from a small number of pump tests. Because these datasets are not normally distributed, average values <u>should not</u> be used as representative values for hydraulic conductivity assignments. Instead, a geometric mean or median would be better than averages for calibration, which both of which result in lower hydraulic conductivity values that are more consistent with values used in the 2015 Britton Group Model (see **Table 1** below).

Table 1. Hydraulic conductivity (K) estimates from pump tests performed by H&K for the Lower Argillite and Upper Argillite units

Lower Argillite K (ft/d)	Upper Argillite K (ft/d)
60.2	1.45
9.79	3.95
9.17	1.7
10.5	2.82
1.32	2.88
1.51	2.7
2.82	21.9
1.45	126
7.11	0.765
5.98	3.47
4.49	10.5
1.7	2.88
6.76	1.52
3.81	0.711
9.13	1.81
2.96	0.711
Average = 8.7	Average = 11.6
Median = 5.24	Median = 2.76
Geom. mean = 4.88	Geom. mean = 3.08

Note: Yellow highlighted values were identified by H&K as being anomalous

For the purposes of model calibration, the Britton Group utilized the average values in **Table 1** as representative values obtained from field testing (both of which are higher than the median and geometric mean values for the Upper and Lower Argillite datasets). The 2023 Britton Group Modeling Report states that the calibrated hydraulic conductivity in the model was "*generally within the ranges obtained from the site-specific aquifer testing*" (pg. 12). Review of the final hydraulic conductivity values assigned to the majority of the model zones in the calibrated model, however, indicate that they are generally approximately two times greater than the averages from the Upper and Lower Argillite pump tests (**Table 2**).

Table 2. Hydraulic conductivity (K) values used in model zones

Model Zone	K (ft/d)
102	8
103	22
104	10
202	25
203	10
204	20
302	25
303	20

The use of hydraulic conductivity values that are consistently higher than the averages from pump tests, as well as the use of average hydraulic conductivity values as target values when a median or geometric mean would be more appropriate, results in the model likely overestimating hydraulic conductivity by a factor of ~4 to ~9. Further, the higher hydraulic conductivity values utilized in the 2023 Britton Group Model, coupled with the use of specified heads along the eastern model boundary, likely reduce the amount of drawdown predicted by the 2023 Britton Group Model.

Comment 10 – In addition to use of higher hydraulic conductivity values in the 2023 Britton Group Model, horizontal anisotropy values were also modified in the 2023 model compared to the 2015 model. As noted in the 2023 Britton Group Modeling Report, site-specific aquifer pump tests performed by H&K indicated a horizontal anisotropy ratio (Ky/Kx) of 0.3. This field measured anisotropy value was utilized in 2015 Britton Group model. Although the 2023 Britton Group Modeling Report states that "*This ratio was assigned to the Brunswick Group and the Lockatong Formation material within the model during the calibration process*" (pg. 12), Figure 7 of the 2023 Britton Group Modeling Report (which includes a table with hydraulic conductivity and anisotropy values utilized in the calibrated groundwater flow model) indicates that horizontal anisotropy values utilized in the 2023 Britton Group Model were 0.5 for the thin uppermost layers (model zones 102, 103, 104), but was adjusted to 0.01 for the other argillite model zones. Justification for significantly lowering the anisotropy ratio for these model layers was not provided, and as noted above, is not consistent with the field measured horizontal anisotropy value of 0.3. Importantly, the use of these significantly lower horizontal anisotropy values likely results in the reduction in quarry drawdown in the Y direction (i.e., to the north-northwest and to the south-southeast) when compared to the 2015 model, which is evident when comparing the Zones of Influence (ZOIs) generated by the 2015 and 2023 Britton Group Models (**Figure 3**).

Model Calibration

Comment 11 – Review of the dataset utilized for calibration of the 2023 Britton Group Model indicates that the dataset included average groundwater elevations (measured between January and August of 2023) for Quarry monitoring wells; static groundwater levels for private water supply wells (measured in August 2023); and static groundwater levels for wells obtained from the

Pennsylvania Groundwater Information System (PAWGIS) for areas located in the outer portions of the model domain. Review of groundwater level data for Quarry monitoring wells indicated that between January and December of 2023 (see Table 1 of the 2023 Britton Group Modeling Report), groundwater levels in certain monitoring wells varied by more than 20 feet (e.g., NM-MW-5, which ranged from 386.83 ft msl in March of 2023 to 362.23 ft msl in August of 2023), whereas others had very little variation (e.g., the same groundwater elevation value (495.00 ft amsl) was reported for each month for well NMR-146, which is likely erroneous). In addition to the variability of the monitoring well groundwater elevation data used for the calibration of the 2023 Britton Group Model, the report notes on page 15 that the static groundwater elevations in residential wells used for model calibration may also fluctuate (as they are active water supply wells). The report notes that groundwater elevation data for wells obtained from PAWGIS are based on records provided by well drillers at the time of well installation are also uncertain, as groundwater levels collected at the time of well installation may not have had a chance to stabilize before being measured. Accordingly, there is a great deal of uncertainty with regard to the accuracy of the observed groundwater elevation dataset used by the Britton Group for calibrating the 2023 model, which in turn affects the reliability of the model calibration and accuracy of the final model output.

Comment 12 - Based on the comparison of observed and simulated groundwater elevations in the 2023 Britton Group Model, the normalized root mean square error (NRMSE) was reported to be 10.89%. As the Britton Group model report points out, a reasonably calibrated model should have a NRMSE of less than 10%. A review of calibration results for the 2023 Britton Group Model indicates that the two wells (475739 and 505291) with the highest and lowest observed head values greatly impact the NRMSE (**Figure 4**). While the model reasonably matches the observed groundwater elevation in well 475739 (which has an observed groundwater elevation of 583 feet), this well is located in the northeast extreme of the model domain (**Figure 5**), and the groundwater elevation in this well is <u>103 feet higher</u> than the next highest observed groundwater elevation. This well exerts strong statistical leverage in the model calibration, meaning it strongly influences the NRMSE.

The influence of well 475739 on the NMRSE is largely mathematical. NMRSE is calculated using Equation 1:

$$NRMSE = \frac{\sqrt{\sum_{i=1}^{n} \frac{(h_i^{sim} - h_i^{obs})^2}{n}}}{h_{max}^{obs} - h_{min}^{obs}} \; x \; 100\% \qquad \text{Eq. 1}$$

where h_i^{sim} and h_i^{obs} are the simulated and observed heads for well *i*, respectively, and h_{max}^{obs} and h_{min}^{obs} are the maximum and minimum observed heads, respectively. Because the simulated head for 475739 is near the perfect-fit calibration line (see **Figure 4**), it adds minimally to the residuals (the numerator of Eq. 1). However, because its observed head (583 ft) is 103 ft greater than the next highest head (well 419847, head = 480 ft), the denominator increases markedly, making the NRMSE much smaller, resulting in a calibration fit that appears better simply by the inclusion of well 475739. For example, if well 475739 is removed from the calibration dataset, the calibration is much poorer, with a recalculated NRMSE from the remaining 44 wells of 15.14%. As noted previously, well 505291 also influences the NRMSE, because it is the lowest observed head. When this well is removed from the calibration dataset, the recalculated NRMSE from the remaining 44 wells is 11.9%. The removal of any other single well results in a recalculated NRMSE of 11.02% or less, causing little deviation from the 10.89% NRMSE in the 2023 Britton Group model calibration dataset. Ultimately, as demonstrated above, the inclusion of wells 475739 and 505291in the evaluation of model calibration has a significant effect on the calculated NMRSE. Removal of one or both of these wells from the dataset results in a relatively poor model calibration when only wells located in closer proximity to the Quarry are considered.

Comment 13 – A review of the calibration results for the 2023 Britton Group Model indicates that observed head observation points at lower elevations are generally much lower than computed modeled heads (see **Figure 4**). The locations of these wells are primarily located in proximity to west of the Quarry (**Figure 5**). Further, evaluation of observed and modeled heads for several wells in this area indicates that the model overpredicts heads by more than <u>70 feet</u> in some instances (see **Table 3** below).

Well ID	Observed (ft msl)	Modeled (ft msl)	Residual (ft)
NMR--4B	390.72	421.4456	-30.7256
NMR-8	356.54	419.8574	-63.3174
NMR-72	341.11	412.9334	-71.8234
NMR-MW-11	430.23	454.6421	-24.4121
11	343	411.2797	-68.2797
5	382	400.5172	-18.5172

The model is greatly overpredicting heads in this area (where several private water supply wells have been reported to have gone dry). Based on information reviewed to date, it appears likely that the 2023 Britton Group model cannot be reliably used as a tool to assist in evaluating potential impacts to nearby residential wells associated with quarry dewatering operations.

<u>Other Uncertainties</u>

Comment 14 – There are several additional uncertainties regarding the development and the calibration of the 2023 Britton Group Model that are either not adequately explained or appear to be based on assumptions that have not been adequately evaluated and/or reported. These uncertainties and inadequately supported assumptions include:

- the use of nearly identical hydraulic conductivity values for Lockatong and Brunswick formations;
- the assumption that groundwater elevations collected from both shallow and deep water bearing zones form a common water bearing zone;
- the assumption that this common water bearing zone is unconfined;
- the assumption of 1:1 vertical anisotropy for all modeled hydraulic conductivity zones;
- whether pumping from any residential, commercial/industrial, or other water supply wells were considered in the evaluation;
- the lack of a full explanation and discussion of model sensitivity analyses;
- the rationale for the zones assigned in the model for the purpose of model calibration; and

- the range and sensitivity of PEST parameters used for automated calibration, and the uncertainty that PEST reports for each of its calculated calibration parameters.

3. EVALUATION OF NPDES PERMIT RENEWAL APPLICATION

In addition to reviewing and evaluating the 2023 Britton Group Modeling Report, the Township also requested that QHS Consulting review the June 2024 NPDES Permit Renewal Application submitted by HK Group on behalf of Naceville Materials. The public notice included in the application states that Naceville Materials seeks to renew the existing NPDES permit (No. PA0594466) for an additional five-year period and to increase the permitted quarry discharge volume from 500,000 gpd to 1,000,000 gpd.

Based on QHS Consulting's review of the June 2024 NPDES Permit Renewal Application, it does not appear that any justification is provided for the requested increase in permitted discharge volume, nor does the application include supporting documentation or analysis (e.g., engineering design calculations). Additionally, it is unclear whether the requested increase is due to increased groundwater withdrawal, increased surface water runoff into the quarry pit, or a combination of both.

Accordingly, additional information—such as design calculations demonstrating the need for increased discharge—is required to properly evaluate the requested modification to the permitted quarry discharge volume.

4. CONCLUSIONS

Based on QHS Consulting's review of the 2023 Britton Group Modeling Report (along with related documents, including the 2015 Britton Group Modeling Report and the 2005 H&K Report), several flaws and unsupported or inadequately explained assumptions were identified regarding model construction, boundary conditions, input parameters, and calibration.

First, as noted in the comments above, the model uses an Equivalent Porous Media (EPM) approach, which does not adequately account for the complex bedrock hydrogeologic conditions at and near the site that influence groundwater flow—specifically, dipping bedrock geology and bedding plane partings, which are likely sources for private water supply wells.

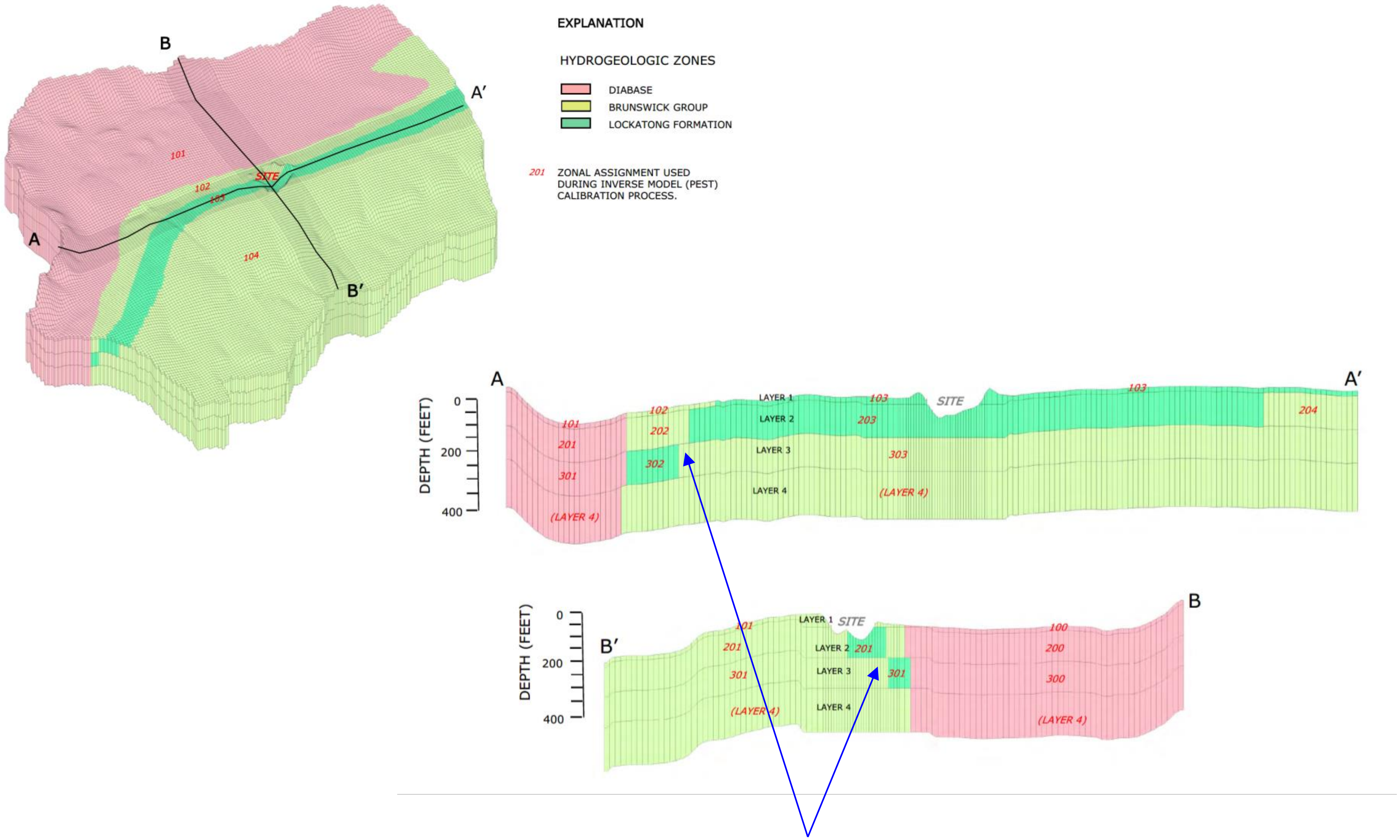
Second, the model incorporates several problematic inputs and assumptions: the incorrect use of specified heads along the eastern boundary; the use of hydraulic conductivity values that exceed those measured during H&K's pumping tests (and those used in the 2015 Britton Group model); and horizontal anisotropy values that differ by an order of magnitude from those derived from aquifer pump tests. These issues likely affect the extent of the Zone of Influence (ZOI) predicted by the 2023 model, which is smaller than that produced by the 2015 model and is likely not representative of the actual ZOI associated with quarry dewatering.

Third, the 2023 Britton Group model is poorly calibrated—particularly in the area immediately surrounding and to the west of the quarry—where it overpredicts groundwater heads by more than 70 feet in some locations.

Taken together with other flaws and uncertainties noted above, these issues indicate that, based on the review of available documents and data to date, the 2023 Britton Group model likely cannot be relied upon to evaluate potential impacts to nearby residential wells from quarry dewatering operations.

Finally, it should be noted that the comments and conclusions provided herein are based solely on the review of reports, data, and other currently available information. QHS Consulting has not had the opportunity to review or analyze the modeling files associated with either the 2023 or 2015 Britton Group models, as these files were not made available. A more detailed evaluation—which could provide additional insight into the flaws and uncertainties identified as part of this current evaluation — could be conducted if the modeling files are obtained from the Britton Group and if requested by the Township.

Modified from 2023 Britton Group Modeling Report, Figure 7



Lockatong Formation is not connected vertically

![QHS CONSULTING logo]
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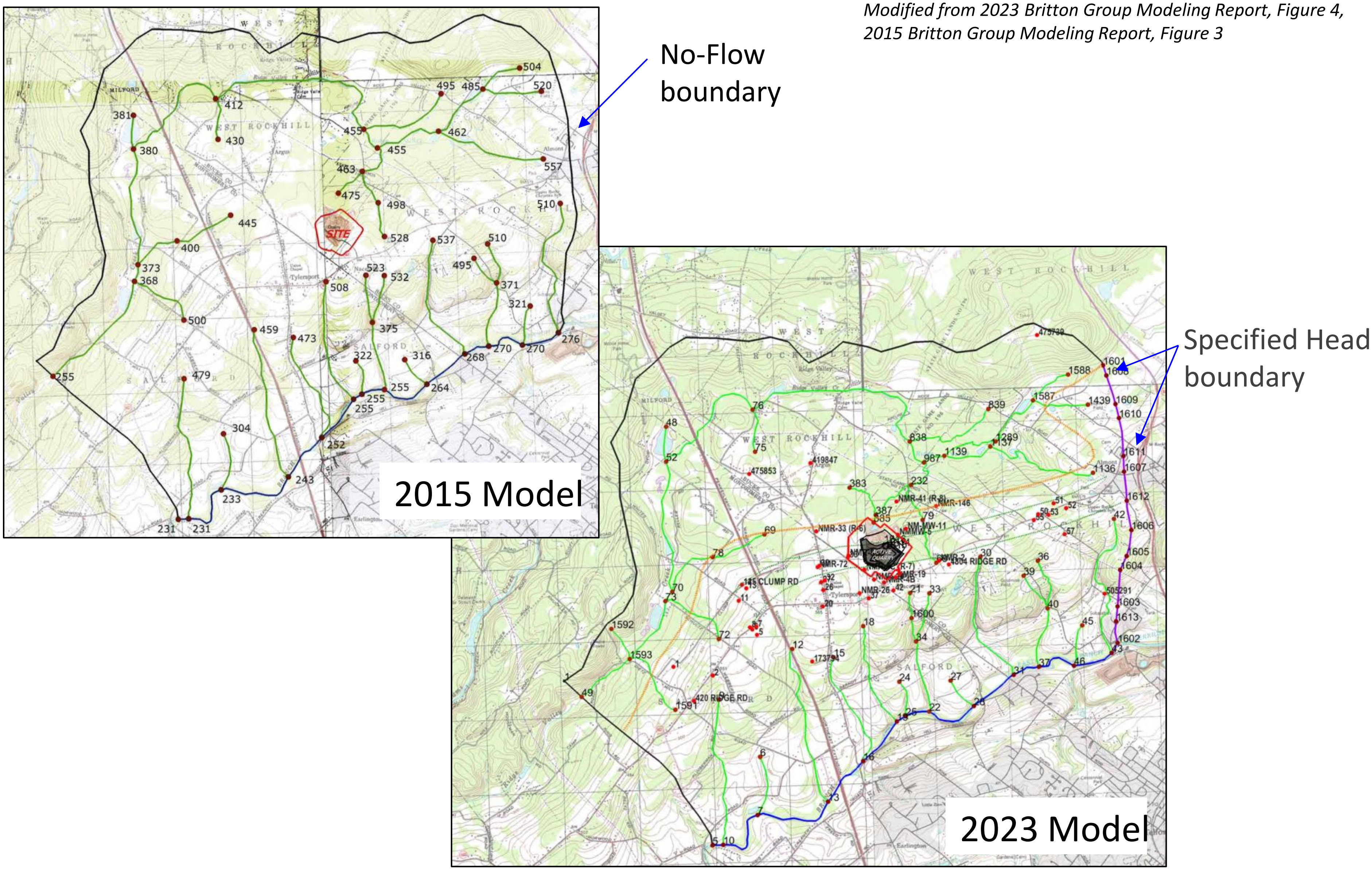
2023 Britton Group Model
General Construction and Layering

Figure 1

Modified from 2023 Britton Group Modeling Report, Figure 4,
2015 Britton Group Modeling Report, Figure 3



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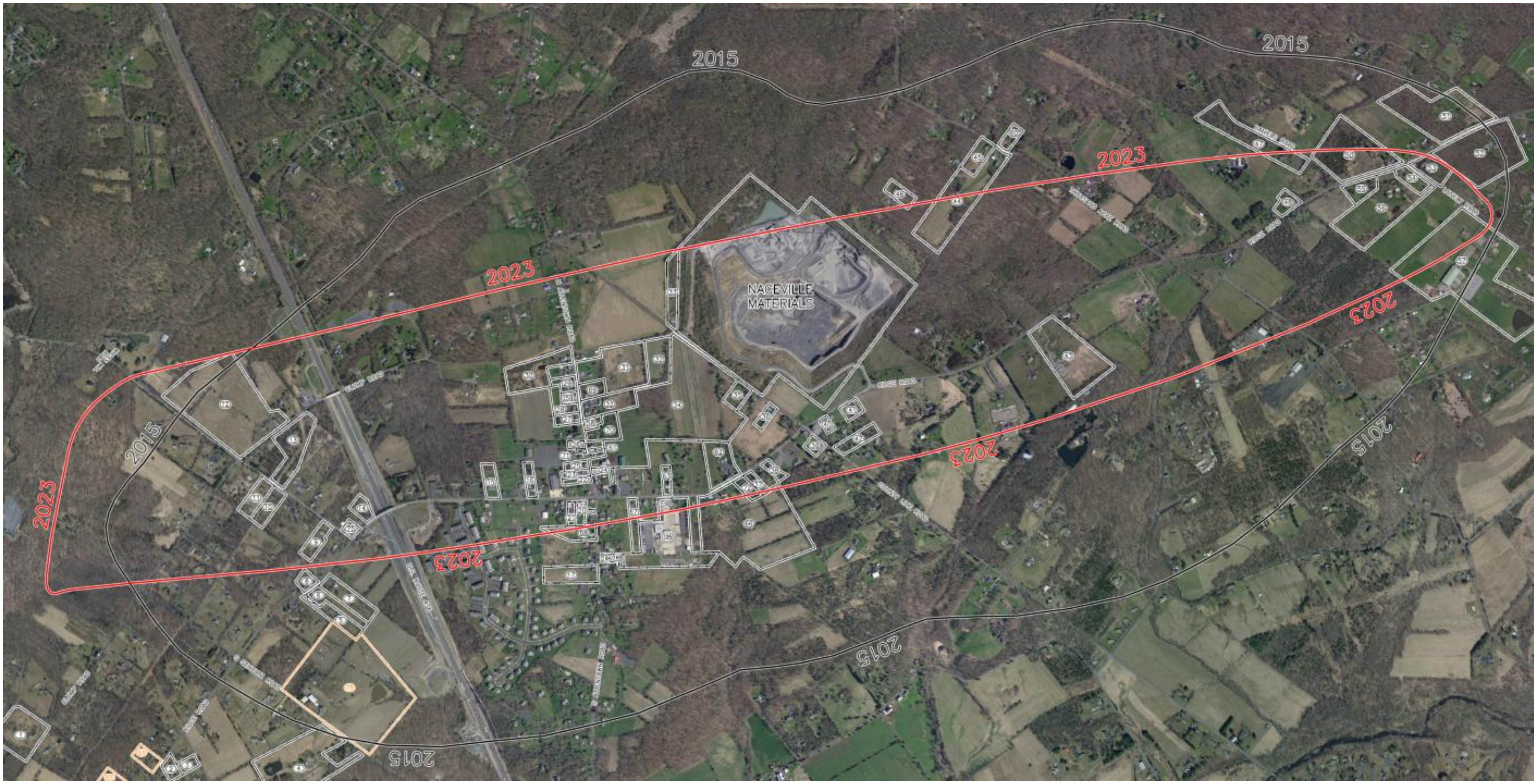
Comparison of Eastern Model Boundary Conditions – 2015 and 2023 Britton Group Models

Figure 2



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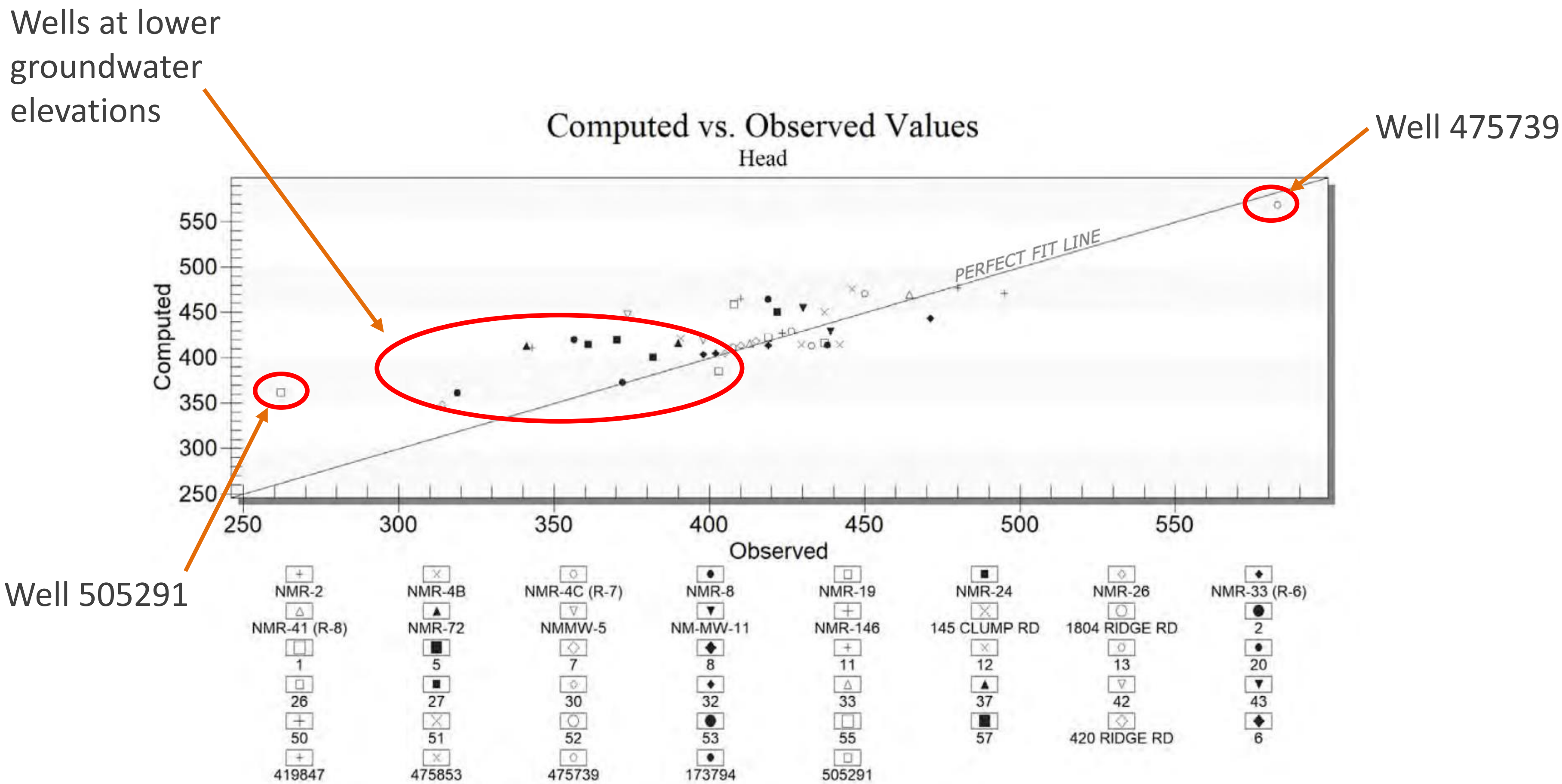
Comparison of Modeled Zones of Influence
2015 and 2023 Britton Group Models

Figure 3

Modified from 2023 Britton Group Modeling Report, Figure 9



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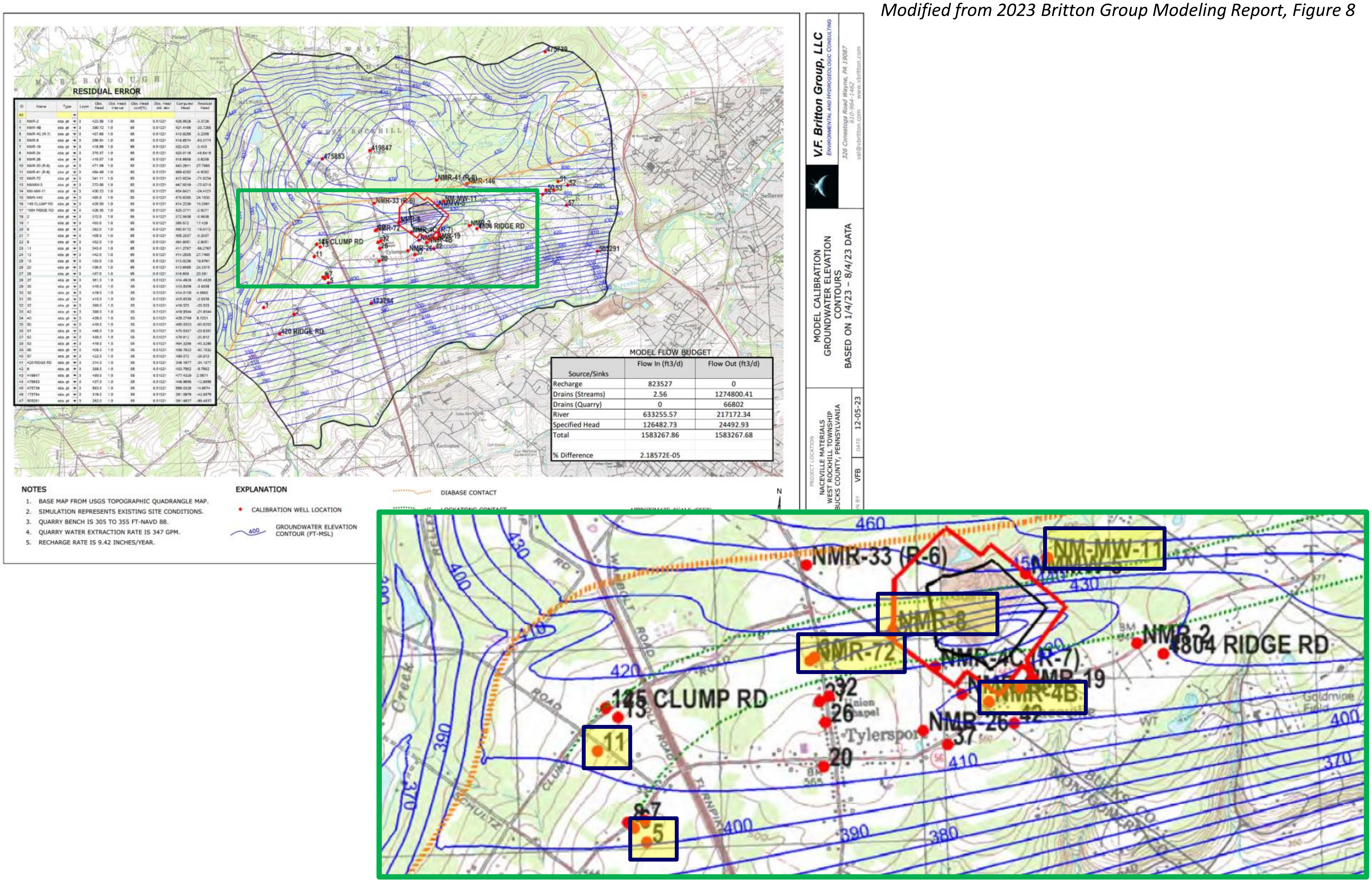
Observed vs, Simulated Head Values
2023 Britton Group Model

Figure 4

Modified from 2023 Britton Group Modeling Report, Figure 8



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Calibrated Groundwater Elevation Contours
2023 Britton Group Model
Locations of Select Calibration Wells

Figure 5