Environmental Study Change in use of New Britain Water Company Land

Proposed Quarry Expansion and Future Water Storage Reservoir

Prepared for:
City of New Britain, Connecticut

- *February 2018*

Lenard Engineering, Inc.
Civil, Environmental & Hydrogeological Consultants

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Introduction

Chapter 1 – Introduction

The City of New Britain (New Britain) wishes to determine the feasibility and the environmental impacts of creating a new drinking storage water reservoir on City owned property located at 0 Biddle Pass in Plainville, Connecticut. This reservoir would fill the current and future footprint of a Quarry expansion conducted by Tilcon, Inc. (Tilcon), both on a portion of the Tilcon property to the north, as well as on a portion of New Britain's 131 acre property.

The first step in this process was creation of Substitute Senate Bill No. 300, Public Act No. 16-61, "An Act Concerning An Environmental Study On A Change In Use Of New Britain Water Company Land", which was approved by the Connecticut legislature on May 26, 2016. A complete copy of this Public Act is provided in **Appendix 1-A**.

New Britain retained a project team of independent consultants led by Lenard Engineering, Inc. (LEI) of Glastonbury, Connecticut to complete this study. This team consists of the following experts:

- Lenard Engineering, Inc. – Overall Project Planning and Management, Water Supply Engineering, Water Demand Projections and Safe Yield Analyses
- Legette, Brashears and Graham (LBG), Farmington, CT – Hydrologic and Hydrogeologic Impact Evaluations
- Tighe and Bond, Inc., Shelton, CT and Westfield, MA – New Reservoir Water Treatment Feasibility and Air Quality and Noise Impact Study.
- Davison Environmental, Chester, CT – Wetland and Biological Inventory and Assessment

Key requirements from PA 16-61 are summarized below:

- The Environmental Study...shall examine the potential impact of...New Britain changing the use of said city's water company-owned class I and class II land to allow for the lease of approximately 131.4 acres owned by said city and located in the town of Plainville, more specifically described as 0 Biddle Pass, for the purpose of allowing the extraction of stone and other minerals on such property.
- Such study shall include, but need not be limited to, an analysis of the:
    1. Likely environmental impacts of such change on local hydrology, forest ecology, natural land resources and formations, and wetland systems;

2. Long-term water supply needs of the City of New Britain as well as interconnected, and reasonably feasible interconnected, water companies in the general geographic region surrounding the areas supplied by the City of New Britain's water reservoir system;

3. Likely safe yield increase of the City of New Britain water reservoir system that could be supplied by such change of use:

4. Impact on raw reservoir quality that is likely to occur from such change of use;

5. Procedures and steps that are available to minimize environmental impacts of such change of use: and

6. Permits required for such change of use.

A detailed Scope of Services was submitted to the City of New Britain, as well as forwarded to both the State Water Planning Council and State Council on Environmental Quality for review and comment. Scope modifications were made based upon comments received, and a copy of the final approved Scope of Services, with a revision date of February 7, 2017 is provided in **Appendix 1-B**.

APPENDIX 1 – A

Substitute Senate Bill No. 300, Public Act No. 16-61, "An Act Concerning An Environmental Study On A Change In Use Of New Britain Water Company Land"

Substitute Senate Bill No. 300

Public Act No. 16-61

AN ACT CONCERNING AN ENVIRONMENTAL STUDY ON A CHANGE IN USE OF NEW BRITAIN WATER COMPANY LAND.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

Section 1. (*Effective from passage*) (a) Not later than one hundred eighty days after the effective date of this section, the city of New Britain shall commission an environmental study, to be conducted by an independent third party acceptable to the Water Planning Council, established pursuant to section 25-33o of the general statutes, in consultation with the Council on Environmental Quality, established pursuant to section 22a-11 of the general statutes. Such study shall examine the potential impact of the city of New Britain changing the use of said city's water company-owned class I and class II land to allow for the lease of approximately 131. 4 acres owned by said city and located in the town of Plainville, more specifically described as 0 Biddle Pass, for the purpose of allowing the extraction of stone and other minerals on such property.

(b) Such study shall include, but need not be limited to, an analysis of the (1) likely environmental impacts of such change of use on local hydrology, forest ecology, natural land resources and formations, and wetlands systems; (2) long-term water supply needs for the city of New Britain as well as interconnected, and reasonably feasible interconnected, water companies in the general geographic region surrounding the areas supplied by the city of New Britain's water reservoir system; (3) likely safe yield increase to the city of New Britain's water reservoir system that could be supplied by such change of use; (4) impact on raw reservoir water quality that is likely to occur from such change of use; (5) procedures and steps that are available to minimize environmental impacts from such change of use; and (6) permits required for such change of use. At the conclusion of such study, the independent third party that conducted the environmental study shall submit a written report on the results of such study to the Water Planning Council, the Council on Environmental Quality and the city of New Britain's conservation commission.

(c) Not later than ninety days after receipt of the report on the environmental study, the Water Planning Council and the Council on Environmental Quality shall review such report to determine the potential impact on the environment and the purity and adequacy of the existing and future public water supply and to provide guidance to the New Britain Water

Department concerning the suitability of the best management practices identified in such report for the protection of the environment, public water supply and public health and make written comments concerning such review. Said councils shall submit their written comments to the city of New Britain.

(d) Not later than fifteen days after receipt of said councils' comments on the report of the environmental study, the city of New Britain shall post such report and said councils' comments on said city's Internet web site. The city of New Britain shall hold a public hearing within the city of New Britain not later than thirty days after receipt of said councils' comments on such report and shall publish notice concerning such report and public hearing in a newspaper of general circulation in the city of New Britain. Such notice shall include: (1) Directions on how members of the public may obtain a copy of such report and comments; (2) a statement informing members of the public of the opportunity to submit comments to the Water Planning Council for a period of thirty days regarding such report; and (3) the date, time and location where said city shall hold the public hearing on such report.

(e) Not later than sixty days after the public hearing required pursuant to subsection (d) of this section, the Water Planning Council, in consultation with the Council on Environmental Quality, shall submit: (1) The report on the results of the environmental study; (2) said councils' comments on review of such report; (3) a summary of the public comments received concerning such report and comments; and (4) said councils' recommendations to the joint standing committees of the General Assembly having cognizance of matters relating to environment and public health, in accordance with the provisions of section 11-4a of the general statutes.

Sec. 2. Section 25-37i of the general statutes is repealed. (*Effective from passage*)

Sec. 3. Section 64 of public act 07-5 of the June special session is repealed. (*Effective from passage*)

Approved May 26, 2016

APPENDIX 1 – B

Proposal for Environmental Study and Water Supply Planning for Proposed Quarry Reservoir

Lenard Engineering, Inc., Glastonbury, Connecticut

Original Date: June 17, 2016
Revised Date: September 7, 2016
Revision # 2 Date: February 7, 2017

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Original Date: June 17, 2016
Revised Date: September 7, 2016
Revision # 2 Date: February 7, 2017

Mr. Gilbert Bligh, Director
New Britain Water Department
1000 Shuttle Meadow Avenue
New Britain, CT 06051

Subject: Proposal for Environmental Study and Water Supply Planning for Proposed Quarry Reservoir

Dear Mr. Bligh:

Lenard Engineering, Inc. (LEI) is pleased to present this proposal to perform an environmental study and water supply planning for a reservoir proposed to be constructed within a quarry excavated by Tilcon Connecticut Inc., including excavation on City-owned watershed lands. The study will be conducted under the auspices of Public Act 16-61, "An Act Concerning an Environmental Study on a Change in Use of New Britain Water Company Land". This act was previously known as Substitute Senate Bill No. 300.

The act calls for an environmental study of "the potential impact of the city of New Britain changing the use of said city's water company-owned class I and class II land to by said city and located in the town of Plainville … for the purpose of allowing the extraction of stone and other minerals on such property." The end result of this extraction will be the creation of a new water storage reservoir for the City.

As shown in the figure to the right, the City parcel is immediately south of the quarry, very close to the southeast corner of Plainville. Due to the presence of a natural gas transmission main, a 7.4-acre area in the southeast corner of the parcel is excluded from the project. The remaining area of 124 acres is being addressed herein.

Base map from Town of Plainville GIS

Our proposal is based on our meetings and discussions with you, past meetings between New Britain and Tilcon, and our review of prior documents about the proposed project. In the sections that follow, we present our proposed scope of services, staffing, schedule, and budget. Project Scope Revision # 2 incorporates items requested by the State Council on Environmental Quality, as recorded in their meeting minutes dated October 19, 2016, and summarized in a new Task # 10 item.

Proposed Scope of Services

We have organized the work of this project into nine tasks, as shown in the box at right. Each is itemized below.

Project Tasks
1. Project Startup and Management
2. Review Quarry Operations, Expansion, and Reservoir
3. Safe Yield Review
4. Environmental Review of Existing Conditions
5. Environmental Effects and Mitigation Measures
6. Water System Planning
7. Report Preparation
8. Public Hearing
9. Post-Submittal Services

Task 1 - Project Startup and Management

1.1 Coordinate a kickoff meeting in New Britain, to be attended by Lenard Engineering (LEI) and select sub-contractors. Review the work plan, schedule, and information needs.

1.2 Coordinate a field visit to the Tilcon quarry for key project personnel, to tour the quarry and meet with Tilcon staff. Review the upcoming field investigations, and discuss the Tilcon data needed for the study. It is assumed the kickoff meeting and field visit will occur on the same day.

1.3 LEI's licensed surveyor will prepare the necessary base mapping for the project. He will conduct land record research, utilize best available information to show approximate property lines, merge available DEEP LIDAR topography for the site, obtain GPS located wetland and other habitat areas from our ecological consultant, and create an accurate map suitable for the evaluations in this study.

1.4 Provide project management services throughout the project. Project management will include progress meetings, quality management, schedule management and administrative functions. Prepare monthly project reports and invoices, and submit to the City for review and approval. Two progress meetings are assumed, in addition to specific meetings identified elsewhere in the scope of services.

1.5 If separately authorized by the City, furnish the services of an external specialist, to provide peer review of the draft report (see Task 9). An allowance is included in the budget for this purpose.

Task 2 - Review Proposed Quarry Operations, Quarry Expansion and Reservoir Development

2.1 Summarize current operating procedures at the existing quarry, based on the Task 1 field visit, information provided by Tilcon, and subsequent discussions. Procedures will include, but not be limited to: water usage, wastewater discharges, stormwater discharges, air emissions, on-site hazardous material storage and use, hazardous waste generation, and blasting/processing/storage of rock materials on-site.

2.2 List the permits and approvals that are in place for current operations. Summarize Tilcon's regulatory history with respect to these permits and approvals.

2.3 Summarize information furnished by Tilcon to describe (1) the proposed expansion of quarrying operations onto the City-owned watershed parcel, (2) any changes in operations for the expanded area as compared to current practices, and (3) any increases expected in the parameters listed in 2.1 above.

2.4 Based on information provided by Tilcon, describe the physical features of the proposed reservoir (such as area, depth, volume) and how those features will change during the proposed 50-year excavation term.

Task 3 - Safe Yield Review

Lenard Engineering, Inc. (LEI) will update our 2007 safe yield review of the proposed quarry reservoir, to include the potential for flood skimming to fill the new reservoir:

3.1 Conduct field inspections of the White Bridge wellfield and pumping station, and the White Bridge Pond pumping station, to discuss their current and potential modified operation schemes. Review the capacity of the existing 30" and 36" transmission main that currently connects both Whigville Reservoir and the White Bridge pumping facilities to Shuttle Meadow Reservoir, and determine if this would need to be modified to maximize the water captured during flood skimming. Inspect the future Tilcon quarry reservoir site, West Canal, and Shuttle Meadow Reservoir areas, to review potential discharge locations for water from a future Tilcon quarry reservoir.

3.2 The original safe yield model focused only on drought periods, and operated the reservoir and wellfield network to maximize yield under those conditions. Review those rules, and develop modified rules to take advantage of flood skimming at Copper Mine Brook

3.3 Review available stream gauging data to find appropriate periods of record to evaluate safe yields, taking into account drought periods as well as periods of normal or excess precipitation, to accurately model the impacts of flood skimming.

3.4 Develop two or three combinations of stream gauging data and operating scenarios which would simulate capturing flood skimming waters in Copper Mine Brook. Review these scenarios in person with the City to obtain input.

3.5 Run the new safe yield model with the agreed-upon streamflow data sets and operating rules, and develop summaries of the output data. Make minor modifications to each run in an attempt to maximize system safe yield. Review this summary data with the City to solicit comments.

3.6 Based on comments received from the modeling completed above, make final safe yield model runs for the project, and print out complete results as well as summaries of all runs completed during the study.

3.7 Prepare a draft summary Technical Memorandum of the safe yield modeling efforts, review with the City, and incorporate comments into a final Technical Memorandum.

Task 4 - Environmental Review of Existing Conditions — City Watershed Parcel and Lands Proposed for Donation

Based upon provided by the Council on Environmental Quality in their July 29, 2016 letter, and a follow-up meeting with the CEQ Executive Director and DEEP staff, LEI and our project team members have significantly enhanced the ecological studies provided in our project. Section 4.1 below replaces past sections which dealt with ecological evaluations, and now is better classified as "Natural Resource Inventory and Evaluations".

4.1 Natural Resource Inventory and Evaluations

The natural resource inventory will be conducted by Environmental Planning Services team of specialists including a wildlife biologist, wetland scientist, botanist, soil scientist and forester. The site will be surveyed in its entirety, including the southeast corner (east of the gas line right-of-way) previously noted as excluded from the study area.

Detailed multi-season field surveys of the site's natural resources will be conducted. Surveys will identify and map terrestrial and aquatic habitat types, flora and fauna. All field data will be plotted and analyzed using GIS software (ArcMap 10.4). To aid in resource mapping, a Trimble GPS-unit capable of sub-meter accuracy will be used in the field to locate notable resources with a level of accuracy not typically employed for environmental planning purposes.

Initial study of the site will include a "desktop analysis" to identify existing known biotic and abiotic natural resources present. This will be a GIS-based analysis and will include review of USGS topographic maps, orthophotography, hydrography, USDA NRCS soils mapping, FEMA floodplain data, National Wetland Inventory (NWI) Maps, and Town of Plainville Assessor's data. The desktop analysis will provide the data necessary to initiate field-based surveys of the site's natural resources.

This scope of work is intended to comply with the language and intent of Public Act No. 16-61 *An Act Concerning an Environmental Study on a Change in Use of New Britain Water Company Land*, as discussed during our team's September 1, 2016 meeting with Karl Wagener and Peter Hearn from the State of Connecticut's Council of Environmental Quality.

Flora and Fauna Inventory

1. <u>Wildlife Surveys</u>
   Wildlife surveys will focus on three groups of species: reptiles, amphibians and birds. These species groups were chosen as the focus of work because many of these species are highly susceptible to impacts associated with significant land alteration and development. Therefore, we believe they represent an appropriate "barometer" for measuring the ecological effects of a change

in land use of this type. This is particularly true for amphibians which use multiple habitat types in a given season, both aquatic and terrestrial.

While all species observed on the site will be recorded, special attention will be paid to rare species, including state-listed species as well as "Species of Greatest Conservation Need" as identified by the CT Wildlife Action Plan (2015).

Amphibian and reptile surveys will be focused during the peak spring migration and breeding period (i.e., March through June). Surveys will also be conducted in September and October, in order to capture the period of increased terrestrial movement which occurs in the fall. Survey techniques will include visual/call surveys, cover searching and dip-netting.

By spring of 2017, a full growing season (i.e., spring, summer and fall) of biological data will have been collected.

Detailed vernal pool surveys will be conducted in the spring of 2017 using techniques including visual observations (to observe egg masses, adults and larvae), dip-net surveys, minnow trapping surveys and call surveys, in order to identify the full suite of amphibians and reptiles breeding in any potential vernal pools identified on the siteduring the initial summer-fall of 2016 field surveys.

Breeding birds will be surveyed within May and June of 2017, during the optimal period for identification of migratory and resident birds in the State. Birds will be identified visually and via song. The survey will inventory birds using a randomized habitat/activity based route as opposed to point-count method, to maximize the number of observable species.

2. Habitat/Vegetation Mapping
   Describe and map the plant communities, habitat types and forest cover types on the site. Habitat descriptions and mapping will include total acreage, dominant plant species, general characteristics and location/extent. In addition, a detailed survey of the two known CT DEEP NDDB Critical Habitats (*sub-acid rocky summit outcrop*) present along the western site boundary will be conducted by a qualified botanist.

3. Forest Ecology Assessment
   Due to the fact that the site is primarily forested, the overall ecological assessment will focus on effects to forest-dwelling flora and fauna, including effects on forest-interior species such as area-sensitive songbird species. The loss of forest habitat will be considered at a local as well as landscape scale. In addition, a CT Certified Forester will map and describe forest stand characteristics, including but not limited to size-class distribution, tree species composition and forest structure.

Wetland and Watercourse Inventory and Evaluation

4. Wetland and Watercourse Delineation – Connecticut Jurisdictional Wetlands

Field delineation of inland wetlands and watercourses on the site by a qualified soil scientist. Onsite state wetland and watercourse boundaries will be delineated in accordance with Section 22a 38 (15) of the Connecticut General Statutes (CGS). Allwetland flags will be GPS-located and incorporated into the GIS mapping for natural resource planning.

Produce a Wetland and Watercourses & Soils Report (Connecticut State Wetlands Delineation Report). Wetlands and watercourses in the state are regulated by the Connecticut General Statutes, Chapter 440, Sections 22a-28 to 22a-45. The Wetland and Watercourses & Soils Report will include a narrative description of the delineated state wetlands and watercourses and soils mapping, based on field investigations.

5. Wetland and Watercourse Delineation – Federal Jurisdictional Wetlands
Field delineation of federal wetlands in accordance with the Corps of Engineers Wetlands Delineation Manual (1987) utilizing the Northcentral and Northeast Regional Supplement (Version 2.0, January 2012). ACOE delineation data sheets will be completed for representative transects.

Produce a Federal Wetland Delineation Report and Field Completion Memorandum. The report will include the extent of wetlands on site, upland and wetland soil types, and the character of existing wetlands. Wetland descriptions will include a description of their position in the landscape, dominant plant species, and cover types present on the site, notable invasive species present and an assessment of the overall ecological condition of the wetlands. Wetland habitat classification will be in accordance with Cowardin et al., 1979.

6. Wetland Evaluation
Wetland functions and values will be assessed using the widely acceptedThe Highway Methodology Workbook (supplement): wetland functions and values, a descriptive approach developed by the U.S. Army Corp of Engineers.

State and Federal Listed Species – Screening and Assessment

7. State-listed Species Assessment
The Connecticut Department of Energy and Environmental Protection (CT DEEP) maintains a database that documents the known locations of CT-listed endangered, threatened, and special concern plant and animal species known as the Natural Diversity Database (NDDB). A Natural Diversity Database application will be submitted to determine what documented flora, fauna or natural communities are known to occur on the site. While this information is not typically based on comprehensive surveys, it will be used to guide our assessment of potential state-listed species.

8. Federally Listed Threatened and Endangered Species
Pursuant to Section 7 of the federal Endangered Species Act (ESA), initiate and continue as needed informal consultation and coordination with the USFWS to determine the presence of Federal threatened or endangered flora and fauna on the City parcel. The U.S. Fish & Wildlife Service (USFWS) IPaC Trust Resource Report for the study area reveals one listed federal species in the

study area, namely the Northern Long Eared Bat (*Myotis septentrionalis*) (NLEB).

Based on the results of Tasks 7 & 8, additional habitat assessment and/or targeted surveys may be required to evaluate potential impacts to State- and federally- listed species in the event that our existing survey methods/effort do not adequately assess the site for these species.

Recreational Resources

9. Trails and Public Use

   There is an existing trail network present within the western portions of the site. Trails will be GPS-located (Trimble GPS-unit capable of sub-meter accuracy), mapped and described, and their context and significance within the local/regional trail system will be assessed. Observed and potential public use of the site will be considered.

Regulatory Compliance – Ecological Impacts and Permitting Requirements

10. Evaluation of Ecological Impacts

    Based on the results of this study, we will analyze the extent of impacts of the proposed reservoir creation on the project site on all of the abiotic and biotic natural resources identified on the site. This evaluation will include, but not be limited to: effects on forest ecology, impacts to wildlife and plant species and impacts to onsite as well as downstream wetlands and watercourses.

11. Preliminary Permitting Analysis

    From the preliminary impact analysis, provide an overview of federal, state and local environmental permitting requirements based on current environmental laws and regulations at the time of the impact analysis. The overview will include both the existing quarry site and the 131 acre City of New Britain parcel. No permit applications will be completed or filed. The regulatory implications will be summarized and an initial analysis of potential mitigation measures will be developed to comply with current environmental laws and regulations at the time of the impact analysis. General areas for replication/restoration/mitigation will be identified on the donated land based on the preliminary characterization of existing conditions.

4.2 Groundwater Hydrology and Quality

4.2.1 Information Collection

Conduct a literature search to obtain available publications and data regarding the geology and hydrogeology of the study area from federal, state and local sources. Information of interest includes watershed delineations, surficial geology maps, bedrock geology maps, bedrock elevation contours, fracture-trace studies, well and boring logs, pumping test records, groundwater data and elevations, groundwater quality data, groundwater protection areas, and surface-water and wetland information developed under Task 4.1, etc.

Complete an independent lineament analysis of the study area using stereoscopic analysis of aerial photographs, topographic interpretation and review of LiDAR (light detection and ranging) data.

Tour the quarry with a Tilcon representative. Visit the adjoining City parcel. Observe local geologic features, bedrock outcrops, hydrologic features, monitoring wells, etc. Obtain from Tilcon any information they may have on geology or hydrogeology for the area of their present and potential future operations.

Preliminary information indicates the only private wells in the vicinity are along Ledge Road in Plainville. Complete a well-inventory survey to confirm the general locations of private wells, for noting on the project study area maps. It is not intended to collect well records or perform detailed mapping of well locations.

4.2.2 Conceptual Hydrogeologic Model

Develop a conceptual hydrogeologic model of the site. Such a model will provide a description and understanding of the existing bedrock and surficial geology, groundwater and surface-water/wetland hydrology, and hydrogeologic characteristics of the study area. The end product will include an inventory of groundwater resources within the study area.

Prepare mapping showing the limits of the study area for the hydrogeologic review, the approximate location of hydrogeologic data points critical to the review (wells, borings, gauging stations, etc.), and the general location of private wells. Overlay any existing aquifer delineations, Level A areas, and watershed areas, to provide an understanding of the area resources and the current protections.

Summarize and present surficial and bedrock geology using excerpts from available mapping. No independent geologic field mapping is anticipated.

Using existing data, prepare two geologic cross-sections extending in an east-west and north-south direction through the New Britain parcel.

There is unlikely to be sufficient data to develop groundwater-elevation contours. A map will be prepared showing general groundwater flow directions within the parcel.

Identify groundwater resources in the study area – aquifers, private wells, groundwater protection areas etc. Identify any data gaps in the conceptual model which might require future study.

4.3 Cultural Resources

4.3.1 Archaeological Resources

Lenard Engineering will conduct a records check with the Connecticut State Historic Preservation

Office (SHPO) to identify any known archaeological sites that fall within the proposed quarry site and donated land. A brief summary of results of the records check will be provided detailing any known sites.

4.3.2 Historic Structures

Lenard Engineering will conduct a records check with the Connecticut State Historic Preservation Office (SHPO) and the National Register of Historic Places to identify any known historic resources that fall within the proposed quarry site and donated land. A brief summary of results of the records check will be provided detailing any known resources.

4.3.3 Follow-up Work

If the results of the Cultural Resources review conducted in items 4.3.1 and 4.3.2 above indicate past history of archeological resources or historic structures, LEI will prepare a supplemental scope of work for the City to conduct additional field investigations and studies.

Task 5 - Environmental Effects and Mitigation Measures for Proposed Project

5.1 Wetlands and Terrestrial Resources

5.2 Preliminary Permitting Analysis

Refer to Scope Section 4.1, Items 10 and 11 for this evaluation.

5.3 Groundwater Hydrology and Quality

5.3.1 Based on the conceptual model developed in Task 4 and on the understanding of present and future Tilcon operations, perform a qualitative assessment of potential impacts of the change in watershed land use upon groundwater and surface-water resources. Include discussion on potential impacts to private wells, known groundwater resources, and how impacts on groundwater may affect nearby surface-water bodies.

5.3.2 Once the groundwater impacts are understood to area resources, identify and assess potential mitigation measures. The types of mitigation measures that might, for example, be considered could be recommendations regarding Tilcon quarrying operations, methods of dewatering and associated discharge locations, and/or monitoring networks.

Task 6 - Water System Planning

6.1 Water Quality and Treatment

6.1.1 Review one year of data provided by the City on the source water quality of the Shuttle Meadow Reservoir, and of the individual reservoirs that supply raw water to Shuttle Meadow.

6.1.2 Review data provided by Tilcon on the quality of the quarry water that is currently discharged to the Quinnipiac River. Identify other water quality parameters that would be of interest when considering the impact of the quarry water on the Shuttle Meadow Reservoir and WTP. Conduct 1-2 rounds of water quality samples for the selected parameters. Furnish the services of a State- certified analytical laboratory for the water quality analysis.

6.1.3 Meet with WTP operators to discuss their operational experience in treating waters of varying quality. Identify any potential issues with the ability of the WTP to treat water delivered to Shuttle Meadow from the quarry. Describe any modifications to treatment facilities or plant operations that may be needed.

6.2 Regional Water Supply and Demand

LEI will examine the water supply and demand status of the City of New Britain and its "interconnected and reasonably-feasible interconnected" water systems. These include the Town of Berlin Water Control Commission, Kensington Fire District, City of Bristol, and Valley Water (Plainville). In addition, the Worthington Fire District purchases all its water from Berlin, and thus must be included as well. It is assumed that each utility will cooperate to provide their past and current demands, most recent Water Supply Plan update, source safe yields, and future water demand projections for the 5-, 20-, and 50-year planning periods.

6.2.1 For each utility, perform the following work:

a) Attend up to two meetings to discuss safe yields, available supplies and water demands.

b) Update the existing water supply plan production and consumption data from the date of the last plan to current (through 2015), using data provided by the utility.

c) Instead of revisiting and potentially updating land use studies, population projections, service area expansions, etc., utilize the published 5-, 20-, and 50-year water demand projections within the existing plans.

d) Utilize published source safe yield and available supply data for the current, 5-, 20- and 50-year periods, provided by the utility. For systems with surface water supplies, we will not include any potential safe yield reductions for the recent CTDEEP minimum streamflow regulations, unless provided by the utility.

e) Compare projected demands vs. available supply to determine surpluses or deficits, and summarize these in spreadsheets and graphs.

6.3 For the cumulative region including New Britain and the adjacent interconnected utilities, perform the following work:

a) Document the findings for each system in a comprehensive Technical Memorandum, with a summary spreadsheet and graph showing the water needs of New Britain and the other systems over a 50-year period.

b) For the region, sum the available supplies vs. water demands for each public water system, and develop a final water demand spreadsheet and graph for the region. Project how much water New Britain may have to export to meet regional demands.

c) Prepare a description of the findings for each water utility in the region, as well as a final section which summarizes the findings, sums up region-wide available supplies vs. projected water demand for the present (2015) and the 5-, 20- and 50-year planning periods. Review with the City, and incorporate comments into a final Technical Memorandum.

6.4 Water Supply Facilities

Develop a concept plan of facilities that would be needed to (1) fill the quarry reservoir from the existing raw water transmission system during flood skimming, (2) convey water from the quarry reservoir to Shuttle Meadow, and (3) refresh the water in the new reservoir periodically.

Task 7 - Report Preparation

7.1 Prepare a draft report presenting the results of the work of Tasks 1 through 6. Include field data, maps, and tables as needed to describe the work.

7.2 Meet with New Britain Water Department officials and with the Board of Water Commissioners, to discuss the draft study.

7.3 Respond to City comments, and prepare a final version of the report. Furnish 20 copies for distribution to local or state entities, and submit an electronic copy to the City.

Task 8 - Public Hearing

8.1 Assist the City in preparing for the Public Hearing mandated in paragraph (d) of this project's enabling act, Public Act 16-61.

8.2 Attend the Public Hearing, and assist the City in presenting the results of the study.

Task 9 -Post-Submittal Services (NO LONGER INCLUDED IN SCOPE)

An allowance is included in the budget to cover services that the City may wish to authorize after submittal of the report (excepting the Public Hearing which has its own Task above). It is not possible at this time to know the scope and cost of any such efforts.

Pursuant to prior discussions, there are a number of potential work tasks which were not included in the scope work but which could be pursued at a later date if needed. Among them are the following:

- Additional ecological reviews, as noted in the scope of services
- Consideration of noise, traffic or air quality impacts
- Field investigations to further characterize subsurface conditions
- Coordination with local or state agencies (if desired, this could be performed as part of the Task 9 services)

Task 10 –Additional Tasks Requested by the State Council on Environmental Quality (CEQ)

As noted in the State Council on Environmental Quality (CEQ) October 19, 2016 meeting minutes, the following additional tasks will be added to the project scope:

- With regard to the cultural analysis, the study will meet the archeological requirements of the State's stormwater general permit, and will do more extensive field analysis subsequently only if the preliminary analysis indicates a need to do so.
- With regard to water quantity, LEI and our hydrogeologic specialist Leggette, Brashears and Graham (LBG) will provide an analysis of surface and groundwater at the site now, during construction and upon conclusion of the project (50 years out) and will include neighboring properties in all three stages.
- LEI will define how much of New Britain's current water produced is consumed, used for purposes other than consumption and how much is lost. We will compare this value to industry standards.
- During the water quality and treatment analysis, LEI and our water treatment specialist Tighe & Bond will analyze the impacts of chemicals typically found in mining operations.
- Applicable data used in generating conclusions to the study will be included in the study.

- Impacts on the water table due to the project, including consideration of possible effects of climate change will be analyzed.
- The possible impacts of blasting on the rock structure's ability to hold water and on Wassel Reservoir will be conducted by LEI and our geologic consultant LBG.
- The projects impact on drinking water in New Britain's West Canal and other reservoirs will be examined.

We have assumed the City would be responsible for the following:

1. Providing to Lenard Engineering, Inc. and its sub-contractors documents and data in its files which are needed for the project.
2. Providing legal and physical access to public and private properties as needed for the project.

Proposed Project Schedule

Based upon the need for enhanced environmental and ecological studies, which require four season evaluations of critical items, our report to the City of New Britain is tentatively scheduled for Summer of 2017.

Thank you for this opportunity to serve the City of New Britain on this exciting project.

Respectfully Submitted
Lenard Engineering, Inc.

James E. Ericson, P.E.
Vice President

▪ Executive Summary

Chapter 2 - Executive Summary

1) Public Act 16-61, "An Act Concerning an Environmental Study on a Change in Use of New Britain Water Company Land", was approved by the Connecticut legislature on May 26, 2016. This act states, "The Environmental Study…shall examine the potential impact of…New Britain changing the use of said city's water company-owned class I and class II land to allow for the lease of approximately 131.4 acres owned by said city and located in the town of Plainville, more specifically described as 0 Biddle Pass, for the purpose of allowing the extraction of stone and other minerals on such property".

2) Key aspects of the study were to include:

   - The likely environmental impacts of such change on local hydrology, forest ecology, natural land resources and formations, and wetland systems;
   - The long-term water supply needs of the City of New Britain as well as interconnected, and reasonably feasible interconnected, water companies in the general geographic region surrounding the areas supplied by the City of New Britain's water reservoir system;
   - The likely safe yield increase of the City of New Britain water reservoir system that could be supplied by such change of use;
   - The impact on raw reservoir quality that is likely to occur from such change of use;
   - The procedures and steps that are available to minimize environmental impacts of such change of use; and
   - The permits required for such change of use.

3) Tilcon, Inc. operates an active quarry operation on a 352 acre +/- parcel, located in Plainville, Connecticut. The City of New Britain owns an abutting 131 acre +/- wooded parcel located immediately to the south. **Figure 3-1** shows the location of both parcels.

4) **Figure 3-5** is a Watershed Map and Water Company Land Classification Map for New Britain's parcel. The vast majority of the property is located within the Willow Brook Sub-Regional Basin, part of the Mattabesset Regional Basin. The two intermittent streams on the parcel flow to the east, towards New Britain's West Canal, and ultimately into Shuttle Meadow Reservoir. There are 13.6 acres of Class I and 112 acres of Class II water company land on New Britain's 131 acre parcel.

5) LEI worked with North American Reserve LLC, a mining and geologic consultant to develop a footprint and concept plan for the future Quarry expansion. The proposed Quarry expansion limits preserved **44 acres** on the western portion, and **17 acres** on the southeast portion of the New Britain parcel, to minimize impacts on neighboring properties as well as to critical environmental receptors, both on and off the property.

6) **Figure 3-6** shows the limits of the proposed Quarry expansion. It maintains a minimum 300 foot setback from the Tennessee Gas Transmission main easement, as well as a minimum 1000 foot wooded buffer between the proposed Quarry expansion limits and all residential structures. Quarrying would proceed from west to east for work on the New Britain parcel, to further delay impacts to residential New Britain neighborhoods. Due to the reduced footprint, the estimated time to complete quarrying activities has been reduced to 35-40 years, down from previous estimates of 40 – 50 years.

7) Consistent with previous presentations, if the proposed Quarry expansion and Storage Reservoir is approved for construction, Tilcon will donate approximately **291 acres** of open space land to the Towns of Plainville, New Britain and Southington, with **132 acres** of this land within the Shuttle Meadow Reservoir watershed.

8) Once the Quarry expansion is completed, the volume created will available for a new water Storage Reservoir for the City of New Britain. **Figure 3-8** shows the proposed Storage Reservoir for the City of New Britain. This reservoir will have the following characteristics:

   - a surface area of **109 acres**
   - a maximum depth of **130 feet** +/-, and
   - a total capacity of **2.31 billion gallons**

   Note that the current sum of the total storage from all of New Britain's six reservoirs is approximately **2.85 billion gallons**; thus, this reservoir will increase the total storage capacity in New Britain's reservoir network by approximately **45 %, to over 5 billion gallons**.

9) Chapter 4 describes existing water uses within the Coppermine Brook watershed, and discusses the feasibility of "flood skimming" as a means to help fill the proposed 2.31 billion gallon Storage Reservoir. Based on discussions with the DEEP, modifications to New Britain's system to add the proposed Storage Reservoir should also include providing DEEP minimum streamflow requirements on Coppermine Brook at the White Bridge Surface Supply pumping station.

10) A review of 84 years of historic USGS streamflow gauging records on Bunnell Brook in Burlington, the nearest continuous streamflow gauge to Coppermine Brook, indicate that adequate streamflows would be present for flood skimming, especially during average or above-average years. Projected times to completely refill the proposed Storage Reservoir range between 6 to 28 months.

11) LEI modified the operating rules from our two previous Safe Yield Models for New Britain, to optimize Safe Yield from this new Storage Reservoir. Only after the Storage Reservoir is in place, New Britain can then modify the operation of the White Bridge Surface Pump Station to only pump when DEEP minimum streamflows exist on Coppermine Brook. This by itself would provide significantly increased streamflows in Coppermine Brook over and above current regulatory conditions, especially during critical dry periods.

12) Through the addition of a 2.31 billion gallon Storage Reservoir, New Britain can increase system safe yield by **approximately 2 MGD** over current estimates, up to approximately **20.20 MGD**.

13) Chapter 5 discusses the long term water supply needs for the city of New Britain as well as interconnected, and reasonably feasible interconnected water companies in the general geographic region surrounding New Britain. New Britain has agreements with several surrounding utilities to provide water supplies through interconnections, including:

- Kensington Fire District, Berlin, CT
- Berlin Water Control Commission, Berlin, CT
- Bristol Water Department, Bristol, CT and
- Valley Water Systems, Plainville, CT

14) New Britain also maintains two treated water emergency interconnections with the Metropolitan District Commission (MDC). As noted in Chapter 3, New Britain has a contract with the MDC to purchase raw water from Nepaug Reservoir, which has historically occurred only during severe drought conditions. This contract allows for a purchase of 5 MGD average daily demand on a yearly basis, or up to 10 MGD demand over a six month period.

15) The table below provides average daily demand projections for the City of New Britain, as well as the four interconnected customers listed in Item 13 above. As shown, average daily demands are projected to increase from **9.39 MGD in 2015**, to **10.94 MGD in 2060**, an increase of **1.55 MGD**, approximately **14 %**.

EXISTING AND PREDICTED FUTURE WATER DEMANDS
NEW BRITAIN AND INTERCONNECTED UTILITIES

Year	2015	2020	2030	2060
Ave. Daily Demand (mgd)	9.39	9.90	10.31	10.94

16) Leggette, Brashears and Graham (LBG) of Farmington, Connecticut conducted a comprehensive Hydrogeologic Assessment of the proposed Quarry Expansion and New Storage Reservoir creation, contained in Chapter 6. LBG conducted a detailed private well inventory and assessment for properties within 1500 feet of the existing and proposed Quarry expansion and Storage Reservoir creation. LBG identified 661 properties within this area, with the vast majority connected to public water. For those served by private bedrock wells, LBG projects no impact from this project.

17) LBG installed and monitored piezometers within select streambeds, wetlands and vernal pools at key areas across the 131 acre New Britain parcel. The piezometer indicates the hydrology of the surface-water features is derived principally from direct precipitation and stormwater runoff with negligible to minor contribution by groundwater discharge.

18) There should be no significant direct impacts to the hydrology supporting Shuttle Meadow Reservoir, the East Canal or the two largest wetland bodies /vernal pools located to the west of the proposed Storage Reservoir, Wetlands #1 and 2. Any reductions in flows to the West Canal can be easily mitigated by regular pumping from the proposed Storage Reservoir to the West Canal.

19) Davison Environmental of Chester, CT conducted a Wetland and Biological Inventory and Assessment in Chapter 7 for the proposed Quarry Expansion and Storage Reservoir project. This study included detailed multi-year surveys for plants (including rare plant species), habitat characterizations, unique ecological communities (e.g. vernal pools), and surveys to determine habitat use and diversity of amphibians, reptiles and birds.

20) Mapped wetlands on the New Britain parcel total approximately 13.5 aces, or about 10% of the total property. Eight vernal pools were identified both on the property, and also immediately south of the property. A total of 4.7 acres of wetlands will be lost as a result of Quarry expansion and Storage Reservoir creation, as they fall within the footprint of the excavation. Two of the largest wetland areas will be preserved – Wetlands 1 and 2 (including Vernal Pools PVP 1 and PVP 2), but will be impacted to a lesser degree by a reduction of Critical Terrestrial Habitat within a 750 foot radius of these vernal pools.

21) Four State listed species of concern were identified on the site: a) Spotted Turtle, b) Jefferson Salamander Complex, c) Eastern Box Turtle and d) Fir Clubmoss. Refer to Chapter 7 for details.

22) A breeding bird survey was conducted between March and August, 2017. A total of 43 bird species were identified, including a total of 17 in the Greatest Conservation Need Species, six very important species and three most important species. Overall bird diversity is relatively low due primarily to the fact that habitat diversity is limited at the site. The site is essentially a single habitat (mixed hardwood forest) with minimal amounts of sub-optimal early-successional (non-forested) habitats present.

23) Tighe & Bond Consulting Engineers of Westfield, MA conducted a Water Quality and Treatment Review for the proposed Storage Reservoir. The study characterized the water quality in the proposed reservoir and identified any characteristics that would negatively impact New Britain's water treatment process. The report concluded that the majority of the water filling the Storage Reservoir will come from flood skimming operations on Coppermine Brook, with lesser contributions from surface water runoff on adjacent land.

24) Tighe & Bond reviewed past on-site surface water sample results collected at the site in 2011, as well as collected an additional sample in 2017. The representative surface water runoff samples both in 2011 and 2017 showed concentrations below the detection limits for most constituents measured.

25) Tighe & Bond concluded that their evaluation did not identify and significant differences between the existing reservoirs and samples assumed to be representative of the proposed reservoir. Modifications to the Shuttle Meadow Water Treatment Plant are not anticipated to be needed. Tighe & Bond further recommended the reservoir be equipped with a multi-level intake structure and a release structure capable of both routine and emergency releases.

26) Tighe & Bond also conducted an evaluation of potential Air Quality and Noise Impacts from the proposed Quarry expansion. Although the footprint of the quarry area would expand south of the existing boundary, operations and processing rates of production equipment at the plant would not be altered in any way by the expansion. A portable rock crusher may be relocated further south as the quarry expands, but will remain on Tilcon property. No impacts to the existing air quality permits or potential emissions are anticipated as a result of the quarry expansion.

27) Similarly, Tighe & Bond determined that changes in noise generation as a result of the quarry footprint expansion is expected to be insignificant, as processing operations will not be altered in any way. Furthermore, as the quarry footprint moves south, a no-blast zone along the northwest portion of the existing facility adjacent to a residential neighborhood would reduce noise impacts in this direction.

28) The Connecticut Council on Environmental Quality (CEQ) requested that additional topics be addressed as part of this environmental study, which is presented in Chapter 10. The most significant item requested was an analysis of potential climate change impacts on the project. Utilizing the January 2018 State Water Plan final report, LEI extracted key points from this document which impact rainfall, streamflow and water availability.

29) According to the State Water Plan, the impacts of climate change to existing water utilities that rely primarily on surface water will be significant; redistribution of rainfall, more extreme floods especially in the winter and spring months, followed by periods of more frequent, longer and more severe droughts. The impact of increased precipitation in winter and spring will not greatly benefit surface water system such as New Britain, which presently do not have the capability to store large excesses of water during these seasons, which routinely flow over reservoir spillways when reservoirs are full. The likelihood of more frequent, longer and more severe droughts, especially during the summer and autumn seasons, will likely exceed the current 1: 100 year return frequency drought; thus, overall system safe yields could decrease.

30) Also, general increases in winter and spring precipitation will increase streamflows, and dovetail nicely into proposed flood skimming on Coppermine Brook described in Chapter 4. Increased duration withdrawals from New Britain's White Bridge Surface Water Pumping Station, based on these higher predicted flows, will help reduce the documented downstream flooding on Coppermine Brook, as well as fill the proposed 2.31 billion gallon Storage Reservoir in shorter time.

31) Chapter 11 provides a list of anticipated local, state and federal permits required for the project.

32) Chapter 12 reviews current and future available supply versus projected water demands for the present (2015), five year (2020), twenty year (2030, and fifty year (2060) planning periods. Available supply will increase by approximately 2 MGD, from current values of 18.23 MGD, to **20.20 MGD** with the proposed Storage Reservoir in place.

33) Estimated average daily water demands for New Britain and the four interconnected public water systems (Kensington Fire District, Berlin Water Control, Bristol Water Department and Valley Water Systems) are estimated to increase from 9.39 MGD in 2015, to 10.94 MGD in 2060, an increase of **1.55 MGD**. With the addition of the proposed Storage Reservoir to New Britain's sources of supply, estimated in 2060 +/-, this will allow New Britain to maintain their current margins of safety over the next 50 years.

34) Chapter 12 also reduces potential future reductions in available supply and safe yield, due to DEEP Minimum Streamflow Regulations, and potential impacts of climate change, changes to DEEP Water Diversion regulations, and New Britain's purchased water contract with the MDC. The impacts on available supply of potential safe yield reductions ranging from 2.0 to 6.6 mgd are discussed.

35) Although it is impossible to predict future events, it is reasonable to expect that a) the impacts of climate change will negatively impact safe yields and available supplies of water, especially from surface water supplied systems, and b) environmental regulations may likely continue to become stricter, and more restrictive pertaining to the withdrawal of water in Connecticut. Making reasonable allowances for these likely impacts, New Britain's current adequate margin of safety could drop below state regulatory requirements, without a new source of supply. The addition of the 2.31 billion gallon Storage Reservoir, combined with flood skimming from Coppermine Brook, will provide an additional 2 MGD of available supply, to guarantee an adequate margin of safety for both New Britain and the surrounding communities it supplies.

36) Chapter 13 presents a summary of Project Benefits versus Environmental Costs of the project. Please refer to this chapter for a detailed discussion.

37) In conclusion, if the State Legislature, after receiving comments from the Water Planning Council, Council on Environmental Quality, State Agencies, Municipalities, and the public, decide that this project is beneficial to both New Britain and the entire Central Connecticut region, a significant permitting effort will be required. This is not the one and only study that will be done on the site, and that any questions or concerns received can be incorporated into future permitting efforts.

38) LEI and our project team (Leggette, Brashears and Graham, Davison Environmental, and Tighe & Bond) would like to thank the numerous parties that provided data, input and comments which contributed to this environmental study.

SOURCES:
PROPERTY LINES COMPILED FROM
RESPECTIVE TOWN ASSESSORS RECORDS.

PROJECT LOCATION MAP
PREPARED FOR
PROPOSED STORAGE RESERVOIR
CITY OF NEW BRITAIN
0 BIDDLE PASS, PLAINVILLE, CONNECTICUT

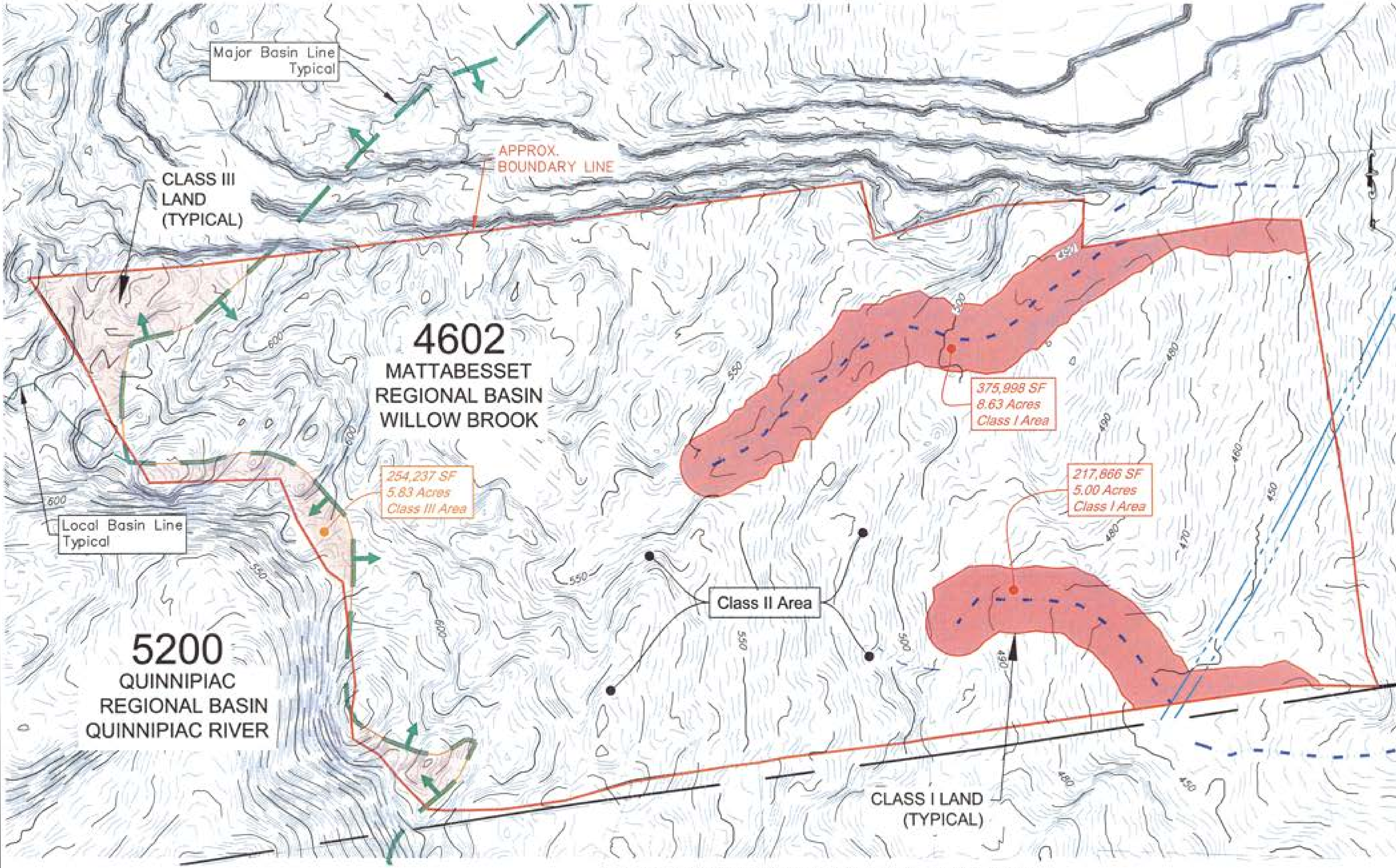
Drawing date: DEC. 8, 2017
Drawing Scale: 1"=300'

Rev.	Date	Revision	By

Designed By: KLD
Drawn By: KLD
Checked By: JE
CAD File: Comp Sheet

Lenard Engineering, Inc.
Civil, Environmental and Hydrogeological Consultants

Figure #: 3-1
Job #: 16-370



TOTAL PROPERTY AREA = 5,721,773 SF 131.35± ACRES

Class I Area = 593,864 SF 13.63± Acres

Class II Area = 4,873,672 SF 111.88± Acres

Class III Area = 254,237 SF 5.83± Acres

GRAPHIC SCALE

0 150 300 600

(IN FEET)

DRAINAGE BASINS AND WATER COMPANY LAND CLASSIFICATION

PREPARED FOR

PROPOSED STORAGE RESERVOIR

NEW BRITAIN WATER COMPANY

0 BIDDLE PASS, NEW BRITAIN, CONNECTICUT

Lenard Engineering, Inc.

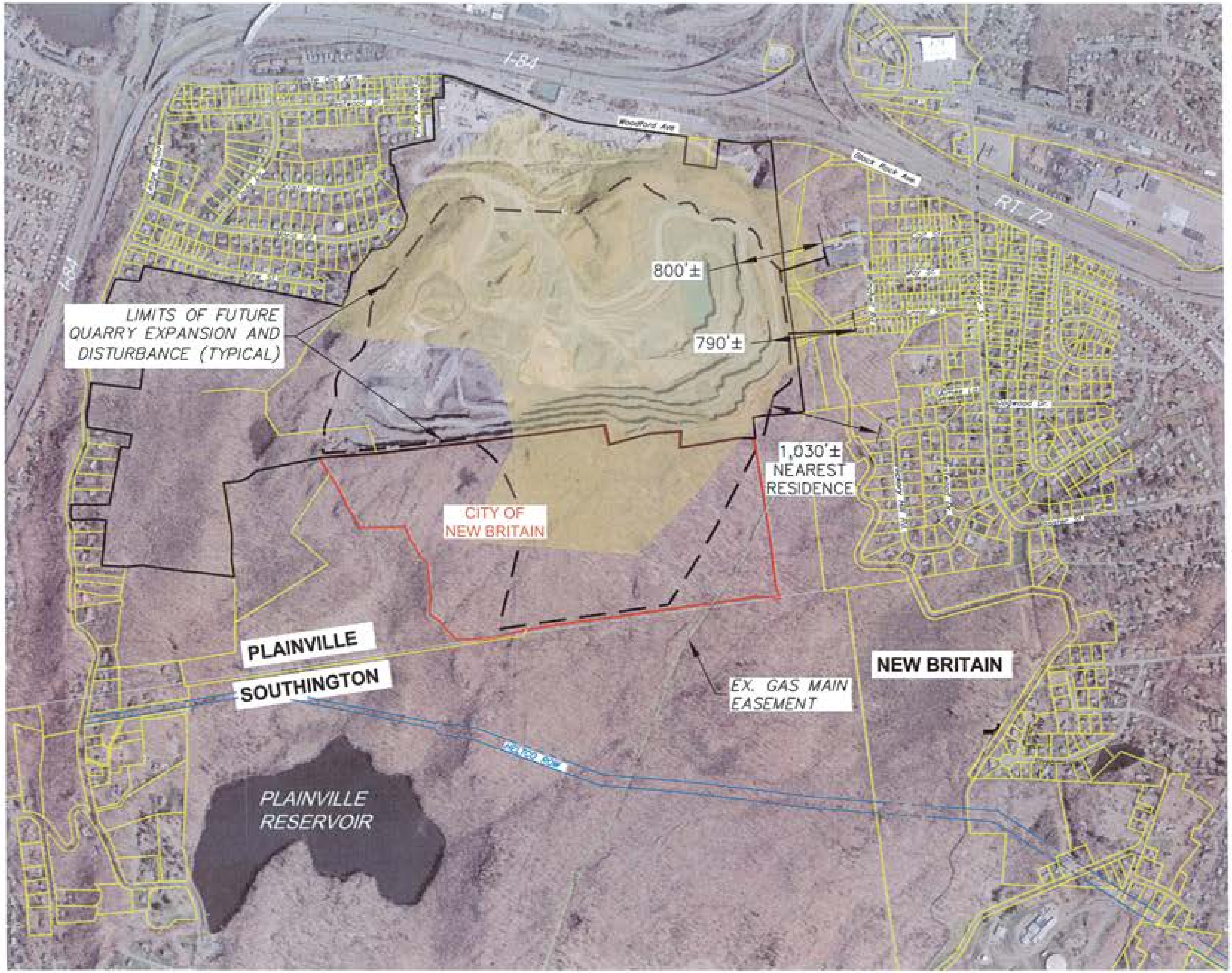
Civil, Environmental and Hydrogeological Consultants

Drawing date: DEC. 8, 2017

Designed By: JEE | Drawn By: KLD | Checked By: JEE | CAD File: Watershed

Figure # 3-5

Job # 16-370



GRAPHIC SCALE

0 500 1000 2000

(IN FEET)

LIMITS OF DISTURBANCE-PROPOSED QUARRY EXPANSION

PREPARED FOR

PROPOSED STORAGE RESERVOIR

CITY OF NEW BRITAIN

0 BIDDLE PASS, PLAINVILLE, CONNECTICUT

Drawing date: DEC. 8, 2017

Drawing Scale: 1"=1000'

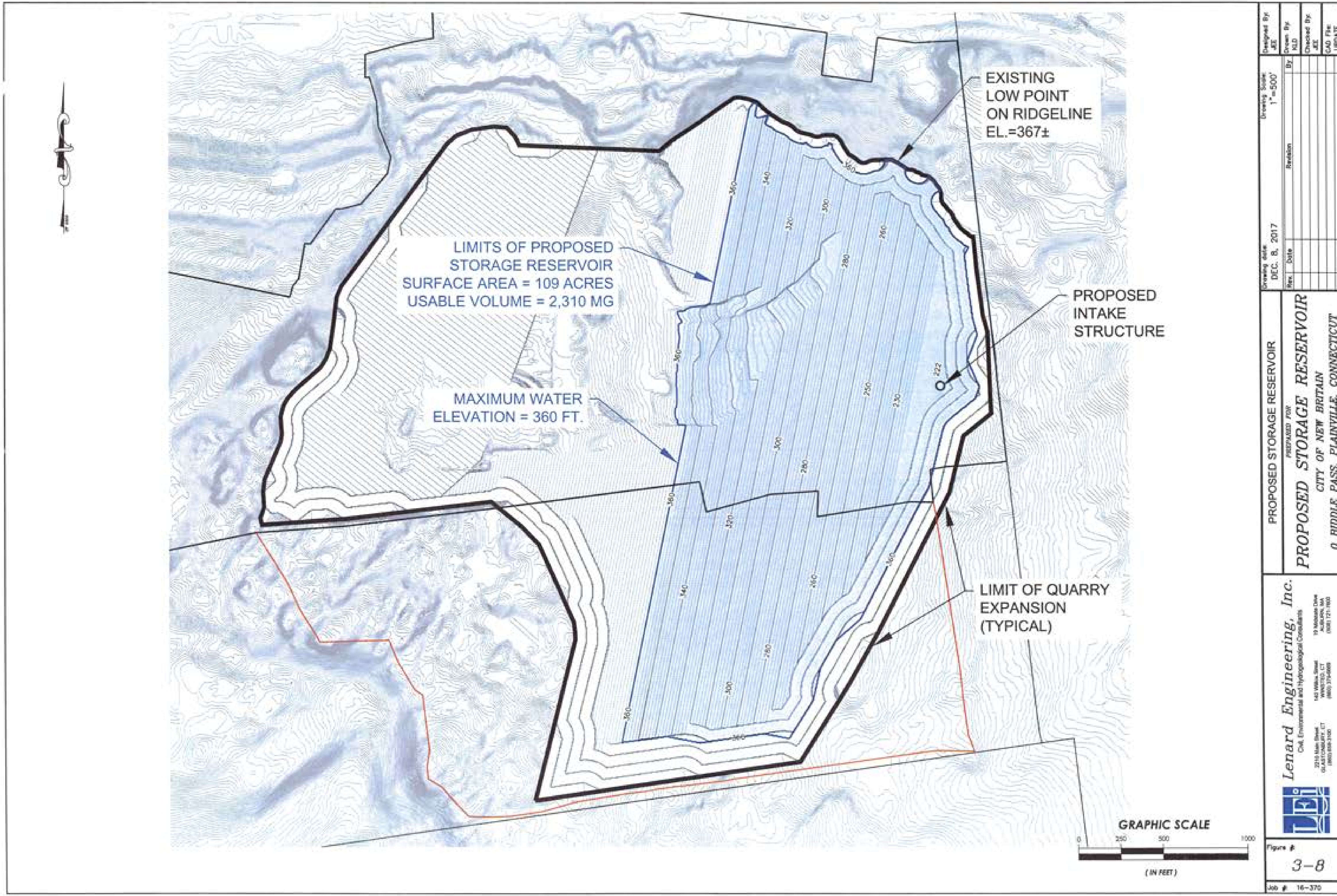
Rev.	Date	Revision	By

Designed By: JEE
Drawn By: KLD
Checked By: JEE
CAD File: CTECO

Lenard Engineering, Inc.
Civil, Environmental and Hydrogeological Consultants

Figure #: 3-6

Job #: 16-370



EXISTING
LOW POINT
ON RIDGELINE
EL.=367±
LIMITS OF PROPOSED
STORAGE RESERVOIR
SURFACE AREA = 109 ACRES
USABLE VOLUME = 2,310 MG
PROPOSED
INTAKE
STRUCTURE
MAXIMUM WATER
ELEVATION = 360 FT.
LIMIT OF QUARRY
EXPANSION
(TYPICAL)
GRAPHIC SCALE
0
250
500
1000
(IN FEET)
PROPOSED STORAGE RESERVOIR
PROPOSED STORAGE RESERVOIR
CITY OF NEW BRITAIN
0 BIDDLE PASS, PLAINVILLE, CONNECTICUT
Lenard Engineering, Inc.
Civil, Environmental and Hydrogeological Consultants
Drawing date:
DEC. 8, 2017
Drawing Scale:
1"=500'
Figure #
3-8
Job # 16-370

Existing Quarry Operations, Proposed Quarry Expansion and Proposed Drinking Water Reservoir Creation

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Chapter 3 - Existing Quarry Operations, Proposed Quarry Expansion and Proposed Drinking Water Reservoir Creation

Task 2 from LEI's approved Scope of Services includes a discussion of current Quarry operations, the proposed Quarry expansion, how a future drinking storage water reservoir would be created, and the anticipated permits required for the Quarry Expansion and Storage Reservoir creation. This chapter provides a detailed discussion of these items.

A) Review of Quarry Operations- Tilcon operates an active trap rock quarry operation on a 352 acre +/- parcel, located at 300 Woodford Avenue in Plainville, Connecticut. Current activities at this facility consist of the production of bituminous concrete (asphalt), paving materials, stone quarrying, aggregate processing and ready-mix concrete. The materials produced at the site by Tilcon (asphalt, concrete and crushed stone aggregate materials) are sold to independent contractors or used by Tilcon for off-site projects.

   The City of New Britain owns an abutting 131 acre +/- wooded parcel located immediately south of the Tilcon parcel, located at 0 Biddle Pass in Plainville, Connecticut. The majority of this parcel is within the public water supply watershed area for New Britain's Shuttle Meadow Reservoir.

B) Project Mapping- A basic understanding of both the Tilcon and New Britain subject properties, as well as the surrounding properties and their environments, is crucial to understanding both the existing conditions and potential impacts of a proposed Quarry expansion and Storage Reservoir creation.

   Figure 3-1 is a project location map showing both Tilcon and New Britain parcels. Although both are located in Plainville, **Figure 3-1** also shows the approximate Town lines for the adjacent towns of New Britain and Southington.

   Figure 3-2 is a USGS Area Map for an enlarged area around these parcels, and includes State Highways and local streets, the locations of Bradley Mountain, Plainville Reservoir (aka Crescent Lake) and Shuttle Meadow Reservoir, along with 10 foot contour intervals.

   Figure 3-3 is a Property Map, showing approximate property lines for the active Tilcon Quarry parcel, the City of New Britain parcel, and neighboring properties. In addition to Tilcon's 352 acre Quarry parcel, it also owns multiple additional parcels in the area. Note the 30 foot wide Gas Transmission Right-of-Way owned now or formerly by the Tennessee Gas Transmission Company crosses portions of both the Tilcon and New Britain parcels.

   Figure 3-4 is a Topographic Map for the 131 acre New Britain parcel. The parcel generally slopes from west to east, with the highest elevation of 660 feet +/- along the western border, and the lowest elevation of 430 feet +/- on the eastern property line. As noted above a 30 foot gas main easement cuts across the southeastern portion of the site. Two seasonal intermittent streams are present, and flow from the center of the property eastward. When flowing, each of these streams discharge into New Britain's West Canal, and eventually discharge into Shuttle Meadow Reservoir.

Figure 3-5 provides a Watershed Map and Water Company Land Classification Map for the New Britain parcel. As shown, a major drainage basin divide exists on this parcel, near the western boundary. DEEP Basin 4602 exists on the eastern side of this drainage divide, and is the Willow Brook Sub-Regional Basin, part of the Mattabesset Regional Basin. DEEP Basin 5200 exists on the western side of this drainage divide, which is the Quinnipiac River Regional Basin.

Figure 3-5 also shows the approximate limits of Class I, II and III lands on New Britain's 131 acre parcel. The Connecticut Department of Public Health (DPH) regulations characterize Water Company owned land into three general categories:

- Class I- Class I land includes all land owned by a water company or acquired from a water company through foreclosure or other involuntary transfer of ownership or control which is either: (1) Within two hundred and fifty feet of high water of a reservoir or **one hundred feet of all watercourses as defined in agency regulations** adopted pursuant to this section; (2) within the areas along watercourses which are covered by any of the critical components of a stream belt; (3) land with slopes fifteen per cent or greater without significant interception by wetlands, swales and natural depressions between the slopes and the watercourses; (4) within two hundred feet of groundwater wells; (5) an identified direct recharge area or outcrop of aquifer now in use or available for future use, or (6) an area with shallow depth to bedrock, twenty inches or less, or poorly drained or very poorly drained soils as defined by the United States Soil Conservation Service that are contiguous to land described in subdivision (3) or (4) of this subsection and that extend to the top of the slope above the receiving watercourse bodies,

- Class II- Class II land includes all land owned by a water company or acquired from a water company through foreclosure or other involuntary transfer of ownership or control which is either (1) **on a public drinking supply watershed which is not included in class I** or (2) completely off a public drinking supply watershed and which is within one hundred and fifty feet of a distribution reservoir or a first-order stream tributary to a distribution reservoir.

- Class III- Class III land includes all land owned by a water company or acquired from a water company through foreclosure or other involuntary transfer of ownership or control which is unimproved land **off public drinking supply watersheds and beyond one hundred and fifty feet from a distribution reservoir or first-order stream tributary to a distribution reservoir**.

Class I land on the New Britain parcel includes the two intermittent streams that flow from the center portion of the parcel eastward, including a 100 foot setback from these streams. **Class I** land totals approximately **13.63 acres +/-, or 10.4 %** of the total land area.

Class II land is the remaining land on the parcel within the Basin 4602, Willow Brook Sub-regional basin, part of the Mattabesset Regional basin, which flows towards the east, and ultimately flows into New Britain's West Canal. **Class II** land totals approximately **111.88 acres +/-, or 85.2 %** of the total land area.

Class III land is the land located to the west of the major basin drainage divide, part of Basin 5200, the Quinnipiac River Regional Basin, and off the public drinking water supply watershed area. Runoff on this portion of the site flows to the west, and does not enter either the West Canal or Shuttle Meadow Reservoir. Class III land totals approximately **5.83 acres +/-, or 4.4 %** of the total land area.

GRAPHIC SCALE

(IN FEET)
1 inch = 300 ft.

SOURCES:
PROPERTY LINES COMPILED FROM
RESPECTIVE TOWN ASSESSORS RECORDS.

Designed By: KLD
Drawn By: KLD
Checked By: JE
CAD File: Comp. Sheet

Drawing date: DEC. 8, 2017
Drawing Scale: 1"=300'

Rev.	Date	Revision	By

PROJECT LOCATION MAP

PREPARED FOR

PROPOSED STORAGE RESERVOIR
CITY OF NEW BRITAIN
0 BIDDLE PASS, PLAINVILLE, CONNECTICUT

Lenard Engineering, Inc.
Civil, Environmental and Hydrogeological Consultants

Figure #: 3-1

Job #: 16-370

SOURCE: USGS NEW BRITAIN, CT. QUADRANGLE 2012

GRAPHIC SCALE

0 750 1500 3000

(IN FEET)

USGS AREA MAP

PREPARED FOR

PROPOSED STORAGE RESERVOIR

CITY OF NEW BRITAIN

0 BIDDLE PASS, PLAINVILLE, CONNECTICUT

Lenard Engineering, Inc.

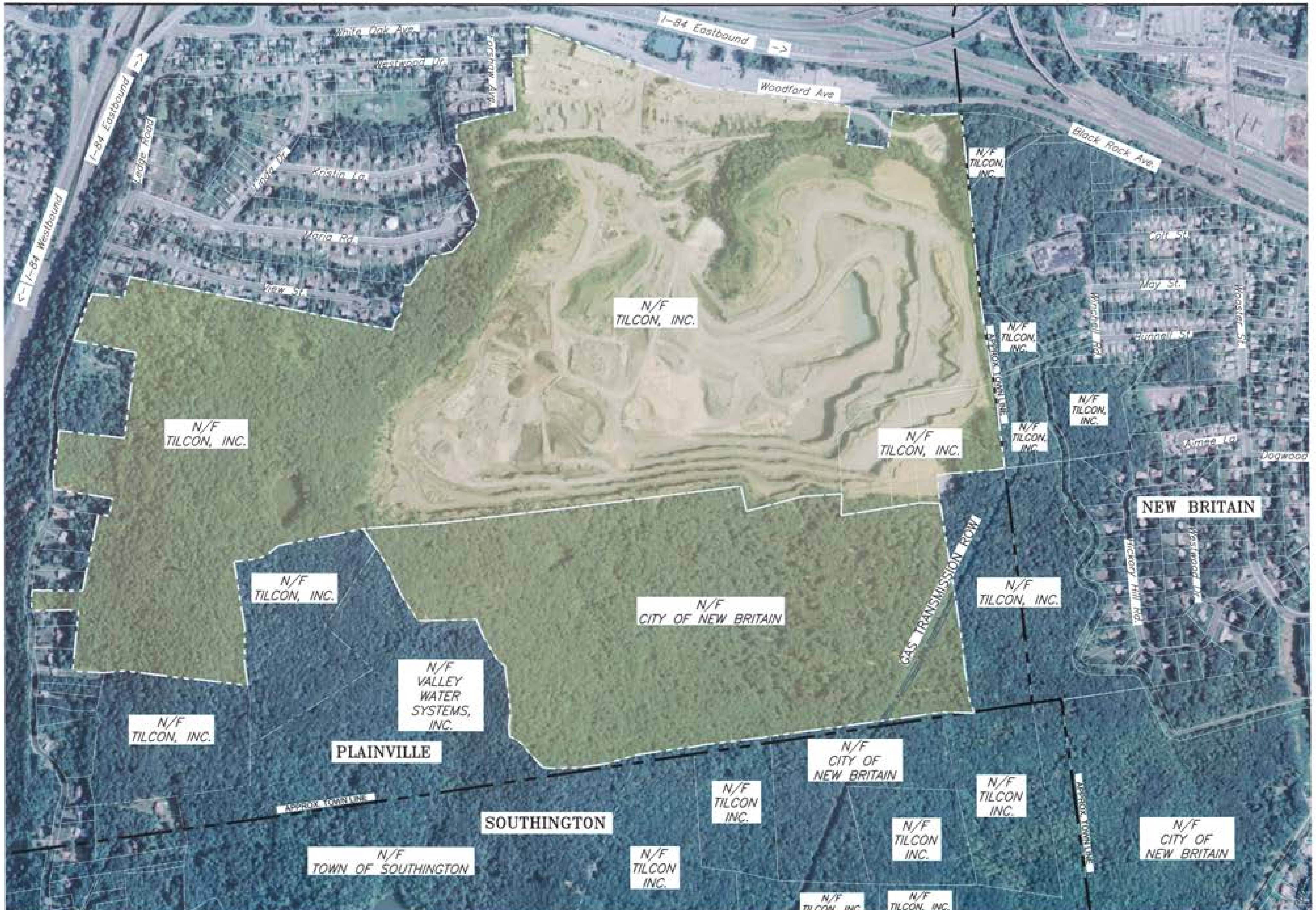
Civil, Environmental and Hydrogeological Consultants

Drawing date: DEC. 8, 2017

Drawing Scale: 1"=1500'

Figure #: 3-2

Job #: 16-370



GRAPHIC SCALE

(IN FEET)
1 inch = 300 ft.

SOUCES:
PROPERTY LINES AND OWNERSHIPS TAKEN
FROM RESPECTIVE TOWN ASSESSORS RECORDS.

Designed By KLD | Drawn By KLD | Checked By JEE | CAD File: Comp Sheet

Drawing date: DEC. 8, 2017 | Drawing Scale: 1"=300'

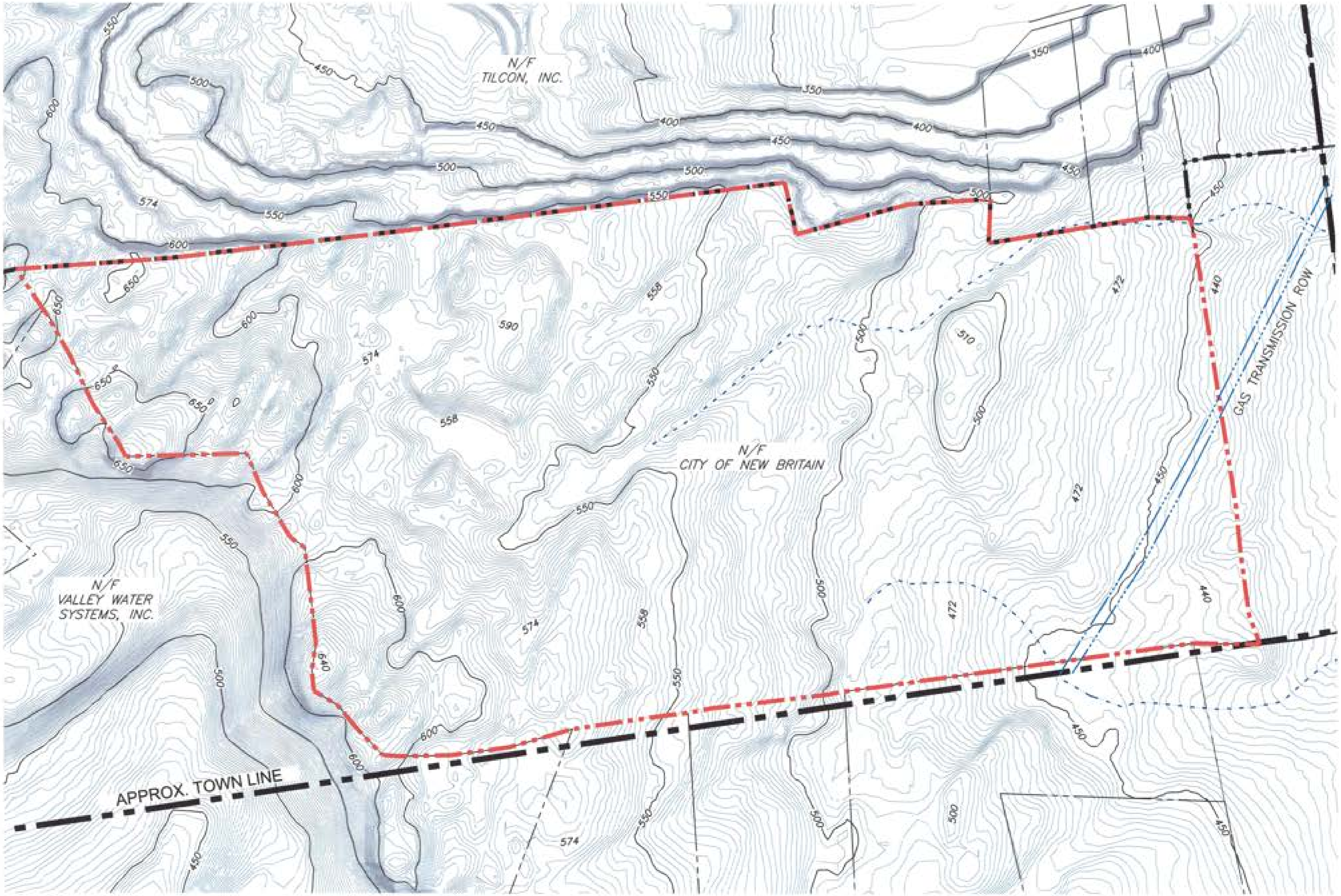
Rev.	Date	Revision	By

PROPERTY MAP
PREPARED FOR
PROPOSED STORAGE RESERVOIR
CITY OF NEW BRITAIN
0 BIDDLE PASS, PLAINVILLE, CONNECTICUT

Lenard Engineering, Inc.
Civil, Environmental and Hydrogeological Consultants

Figure # 3-3

Job # 16-370



GRAPHIC SCALE

(IN FEET)
1 inch = 150 ft.

SOURCE:
CONTOURS DEVELOPED FROM LIDAR AVAILABLE ON CONNECTICUT ENVIRONMENTAL CONDITIONS ONLINE (CTECO)
CONTOUR INTERVAL IS 2' WITH 50 INTERVALS HIGHLIGHTED.

Designed By: KLD
Drawn By: KLD
Checked By: JE
CAD File: Comp Sheet

Drawing date: DEC. 8, 2017
Drawing Scale: 1"=150'

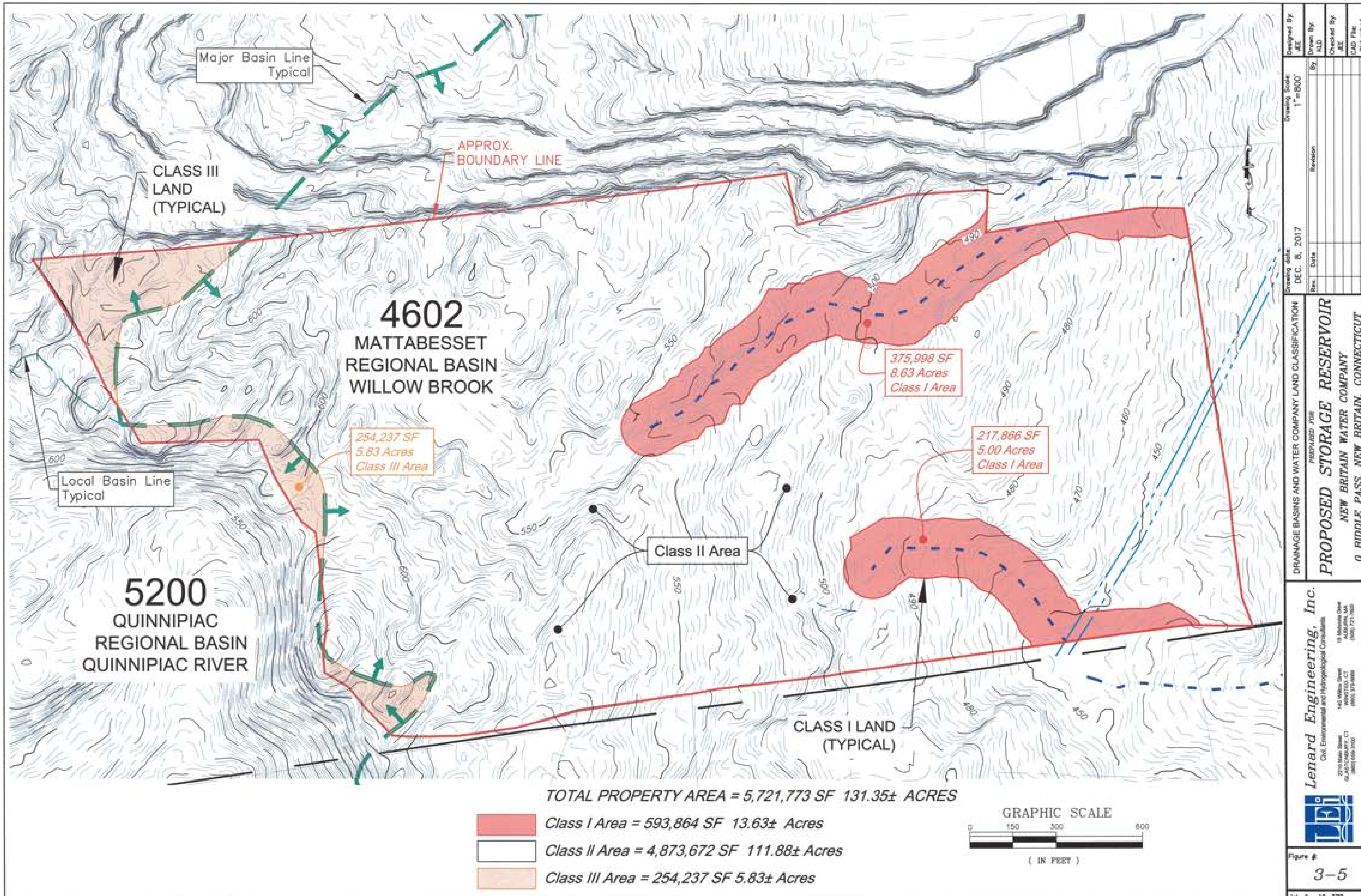
Rev.	Date	Revision	By

TOPOGRAPHIC MAP
PREPARED FOR
PROPOSED STORAGE RESERVOIR
CITY OF NEW BRITAIN
0 BIDDLE PASS, PLAINVILLE, CONNECTICUT

Lenard Engineering, Inc.
Civil, Environmental and Hydrogeological Consultants

Figure #: 3–4

Job #: 16–370



Major Basin Line
Typical
APPROX.
BOUNDARY LINE
CLASS III
LAND
(TYPICAL)
4602
MATTABESSET
REGIONAL BASIN
WILLOW BROOK
375,998 SF
8.63 Acres
Class I Area
254,237 SF
5.83 Acres
Class III Area
217,866 SF
5.00 Acres
Class I Area
Local Basin Line
Typical
Class II Area
5200
QUINNIPIAC
REGIONAL BASIN
QUINNIPIAC RIVER
CLASS I LAND
(TYPICAL)
TOTAL PROPERTY AREA = 5,721,773 SF 131.35± ACRES
Class I Area = 593,864 SF 13.63± Acres
Class II Area = 4,873,672 SF 111.88± Acres
Class III Area = 254,237 SF 5.83± Acres
GRAPHIC SCALE
0 150 300 600
(IN FEET)
Designed By: JEE
Drawn By: KLD
Checked By: JEE
CAD File: Watershed
Drawing Scale: 1"=600'
Drawing date: DEC. 8, 2017
Rev. Date Revision By
DRAINAGE BASINS AND WATER COMPANY LAND CLASSIFICATION
PREPARED FOR
PROPOSED STORAGE RESERVOIR
NEW BRITAIN WATER COMPANY
0 BIDDLE PASS, NEW BRITAIN, CONNECTICUT
Lenard Engineering, Inc.
Civil, Environmental and Hydrogeological Consultants
Figure # 3-5
Job # 16-370

C) Proposed Quarry Expansion- LEI worked in conjunction with North American Reserve LLC (North American) from Laconia, New Hampshire to develop a footprint and concept plan for the future Quarry expansion. North American is Tilcon's mining and geologic consultant, and is presently assisting them in Quarry related mapping and designs. LEI and North American worked closely to locate a Quarry Expansion on the New Britain parcel to minimize impacts on neighboring properties as well as to critical environmental receptors, both on and off the property. These potential impacts will be discussed in detail in future chapters.

Figure 3-6 shows the limits of disturbance for the proposed Quarry expansion. The proposed expansion maintains a minimum 300 foot setback from the Tennessee Gas Transmission main easement, and approximately 1,030 feet from the nearest residential property on Westwood Drive in New Britain. A minimum 1000 foot wooded buffer will be maintained between all future Quarry expansion limits and all residential structures.

One key determination in determining how broad a Quarry expansion, and the subsequent Storage Reservoir would be created, are the existing Quarry contours. The current lowest top of Quarry elevation exists on the northern rim of the Quarry, which has an approximate elevation of 367 feet +/-. If the existing Quarry footprint were filled with water, it would fill to this elevation, and then overflow to the north and east towards Woodford Avenue.

According to North American, the vast majority of the existing quarry equipment and operations will not be relocated from their current locations; thus minimizing new impacts to abutting land owners. A screening device may be relocated closer to the working face of the expanded Quarry, but in no case would leave existing Tilcon property.

The preliminary sequence of quarrying would proceed from west to east for work on the New Britain parcel, to further delay and reduce impacts to residential neighborhoods in New Britain located to the east.

Please refer to Chapter 9 – Tilcon Quarry Expansion Air Quality and Noise Considerations, prepared by Tighe & Bond Consulting Engineers, for a detailed discussion of potential air quality and noise impacts from the Quarry expansion.

D) Additional Open Space Parcels - Consistent with previous presentations by Tilcon, if the proposed Quarry expansion and Storage Reservoir is approved for construction, Tilcon will be donating large parcels of land surrounding the existing Quarry and the proposed Quarry expansion to the City of New Britain, and the Towns of Plainville and Southington, to be maintained as open space in the future. These parcels, along with the outline of the proposed Quarry expansion, are shown in **Figure 3-7**.

Table 3-1 below summarizes the areas of land proposed to be donated by Tilcon for open space, along with the portions of this acreage within the existing Shuttle Meadow Reservoir watershed area.

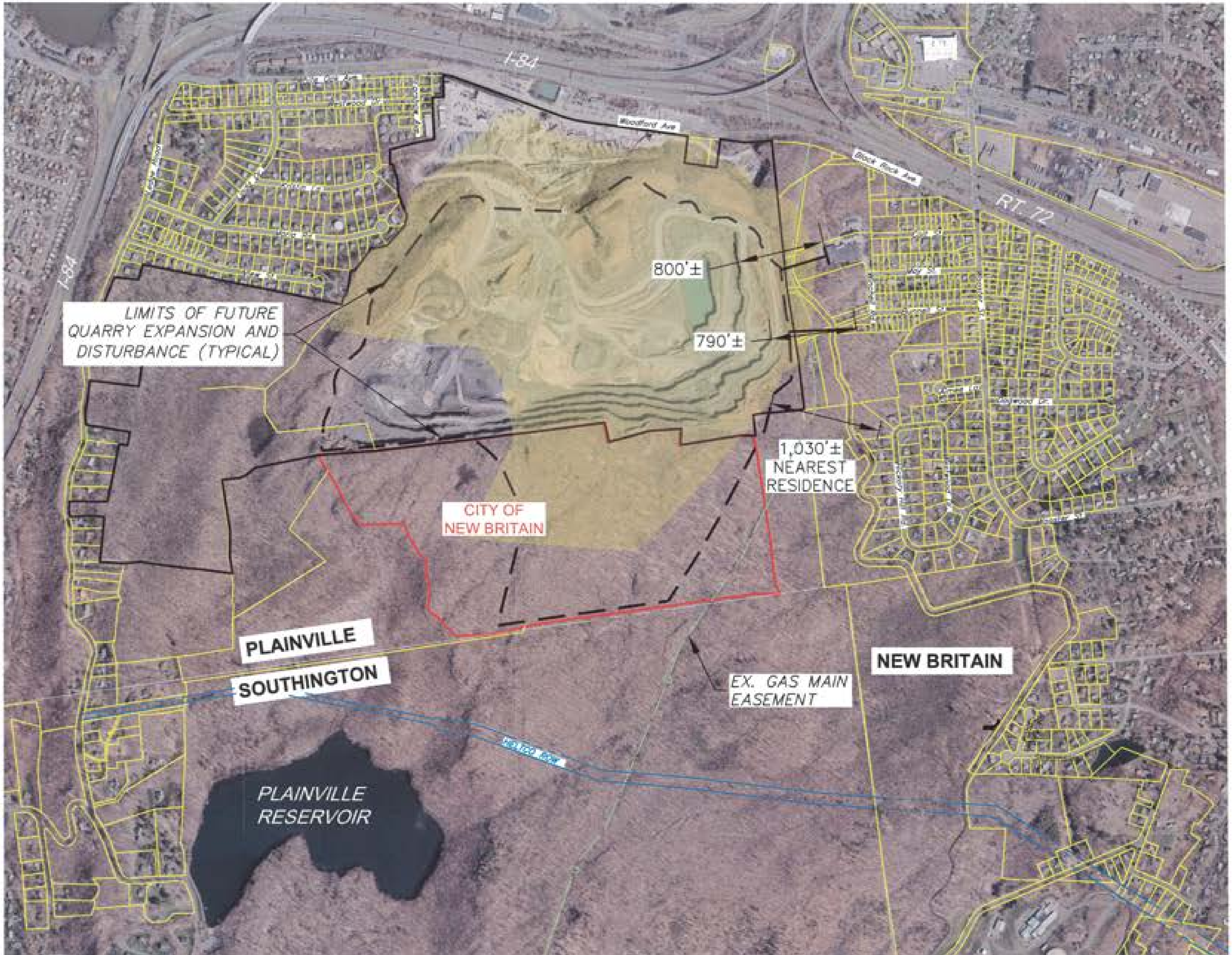
TABLE 3-1
PROPOSED OPEN SPACE PARCEL AREAS

TOWN	TOTAL OPEN SPACE PARCEL AREAS TO BE DONATED	AREA OF OPEN SPACE PARCELS WITHIN SHUTTLE MEADOW RES. WATERSHED
Plainville	171 acres	19 acres
New Britain	41 acres	34 acres
Southington	79 acres	79 acres
TOTALS	**291 acres**	**132 acres**

Also shown on **Figure 3-7** is the DEEP regional drainage basin divide. Tilcon properties to the east and south of this divide are within the New Britain's Shuttle Meadow Reservoir watershed area, and would be maintained as open space to preserve drinking water quality in the watershed.

Not included in these calculated areas are a) the current open space area on the Valley Water Systems parcel (49 acres), and b) the portion of the existing Tilcon Quarry parcel that will be converted to a drinking water reservoir, plus at a minimum the 250 foot area upgradient of the reservoir's high water mark that would be Class 1 water company land.

E) Estimated Timeline- Because the footprint of the proposed Quarry expansion has been reduced to minimize impacts on environmental receptors and neighboring properties, the overall volume of rock to be removed and the associated life of the Quarry expansion, has also been reduced. North American now estimates the smaller footprint Quarry expansion will be completed within 35 - 40 years, which is reduced from 40-50 years using previous estimates. This will allow the City of New Britain to utilize a future Quarry Reservoir much earlier, as well as limit the duration of Quarry activities.



GRAPHIC SCALE

0 500 1000 2000

(IN FEET)

LIMITS OF DISTURBANCE-PROPOSED QUARRY EXPANSION

PREPARED FOR

PROPOSED STORAGE RESERVOIR

CITY OF NEW BRITAIN

0 BIDDLE PASS, PLAINVILLE, CONNECTICUT

Drawing date: DEC. 8, 2017

Drawing Scale: 1"=1000'

Designed By: JEE

Drawn By: KLD

Checked By: JEE

CAD File: CTECO

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Figure # 3-6

Job #: 16-370

GRAPHIC SCALE

(IN FEET)
1 inch = 300 ft.

SOUCES:
PROPERTY LINES AND OWNERSHIPS TAKEN FROM RESPECTIVE TOWN ASSESSORS RECORDS.
DRAINAGE BASIN LINES FROM CT. DEEP GIS WEBSITE.

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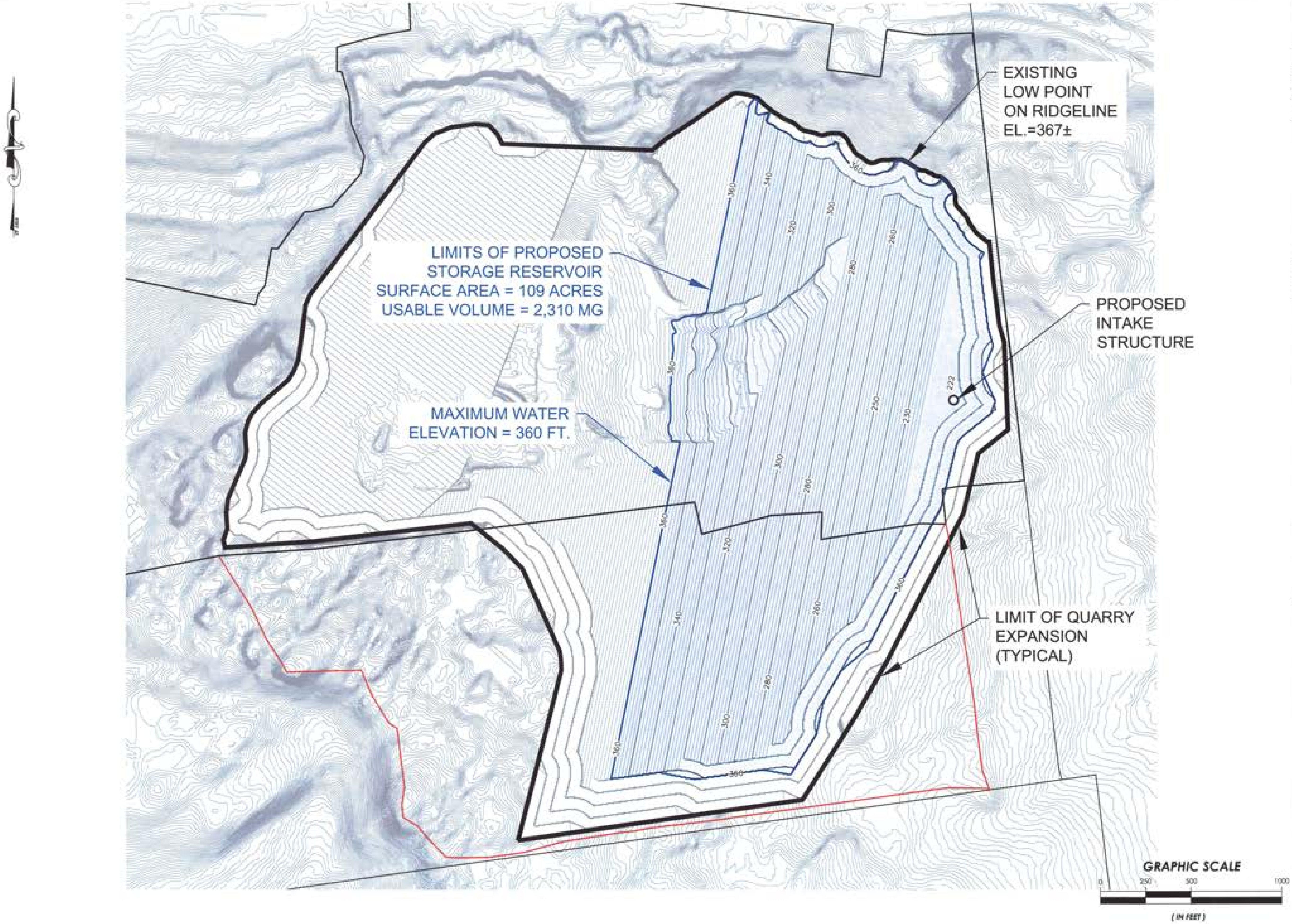
PROPOSED OPEN SPACE PARCELS
PREPARED FOR
PROPOSED STORAGE RESERVOIR
CITY OF NEW BRITAIN
0 BIDDLE PASS, PLAINVILLE, CONNECTICUT

Drawing date: DEC. 8, 2017
Drawing Scale: 1"=300'

Designed By: RLD
Drawn By: RLD
Checked By: JEE

Figure #: 3-7
Job #: 16-370



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Drawn By: KLD
Checked By: JEE
CAD File: UPDATE

Rev.	Date	Revision	By

PROPOSED STORAGE RESERVOIR

PREPARED FOR

PROPOSED STORAGE RESERVOIR

CITY OF NEW BRITAIN

0 BIDDLE PASS, PLAINVILLE, CONNECTICUT

Lenard Engineering, Inc.
Civil, Environmental and Hydrogeological Consultants

2210 Main Street GLASTONBURY, CT (860) 659-3100 · 140 Willow Street WINSTED, CT (860) 379-6669 · 19 Midstate Drive AUBURN, MA (508) 721-7600

Figure # 3-8

Job # 16-370

F) <u>Proposed Storage Reservoir Creation</u> – Once the Quarry expansion is completed, the volume created within both the existing Quarry limits, as well as the Quarry Expansion will available as a new water storage reservoir for the City of New Britain. As previously discussed, the current lowest rim elevation on the northeast corner of the existing Quarry is at elevation 367 feet +/-. In order to avoid the construction of dam structures, as well as to avoid potential reservoir overflows onto Woodford Avenue, the proposed maximum water surface elevation for the Storage Reservoir is 360 feet.

Figure 3-8 shows the proposed limits of a full future Storage Reservoir, with a maximum water surface elevation of 360 feet. This reservoir will have the following characteristics:

1) It has a surface area of **109 acres** +/-, with slightly more than half of the reservoir located on the existing Tilcon property.

2) It has a maximum depth of **130 feet** +/-, located on the eastern side of the reservoir.

3) It has a total capacity of **2.31 billion gallons**. Note that the current sum of the total storage from all of New Britain's six reservoirs is approximately **2.85 billion gallons**; thus, the proposed Storage Reservoir will increase New Britain's storage capacity by approximately **45 %**.

4) A new intake structure will be constructed near the deepest portion of the reservoir, and have intakes at multiple levels, to allow New Britain to draw water from the depth with optimum water quality. **Figure 3-9** provides a schematic of the intake structure.

5) The intake structure will have an overflow at elevation 360, which will allow water during storm events to overflow into the West Canal, and not onto Woodford Avenue or adjacent properties. Due to the minimum natural watershed area contributing to the Storage Reservoir, flooding event are thought to be minimal.

6) The intake structure will house multiple pumps, with a combined maximum withdrawal capacity of 20 million gallons per day (mgd), which will allow New Britain to utilize anywhere between 0 to 20 mgd to discharge to either the West Canal, or directly to the Shuttle Meadow Water Filtration plant.

7) The areas of the Quarry between the shelved ledges and elevation 360 feet will be re-vegetated, to provide a forested ground cover to help by improving water quality through natural soil absorption.

8) As discussed in detail in Chapter 4- Potential Safe Yield Increases, through a combination of providing 2.31 billion gallons of usable storage, and flood skimming utilizing New Britain's existing White Bridge Surface Water Pumping Station located on Coppermine Brook in Bristol, New Britain will increase its overall system safe yield by approximately 2 MGD.

G) Additional Infrastructure Improvements - In addition to construction of an intake structure, the following improvements will be required for this project:

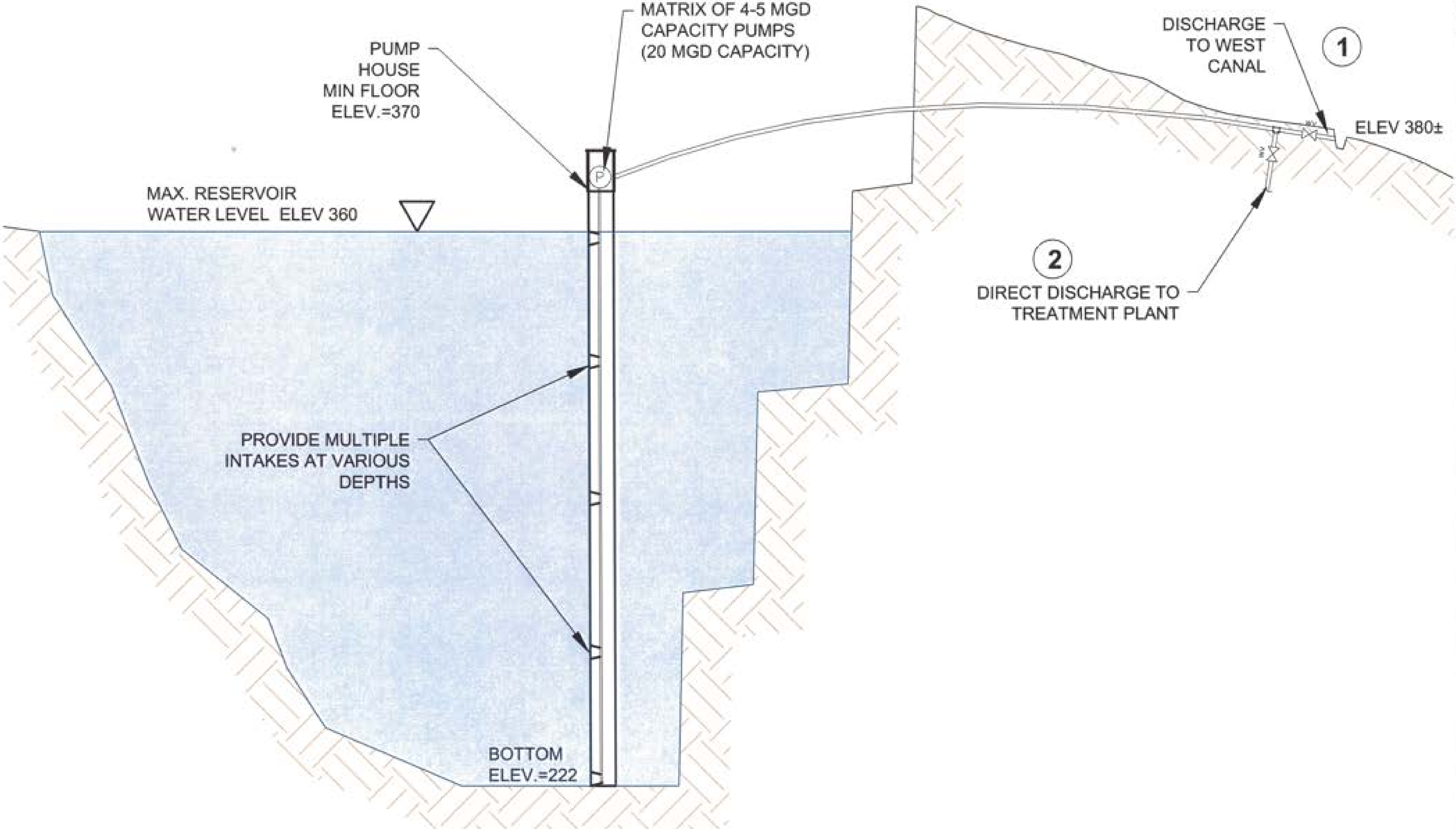
1) Inspect and Upgrade Raw Water Transmission Mains (as required) Between White Bridge Pumping Station, West Canal and Proposed Storage Reservoir – Water from the White Bridge Surface and Groundwater Pumping Stations flow through approximately 35,000 linear feet of transmission main to the current discharge location on the West Canal. This transmission main is reported to be constructed on or around 1910, and is over 100 years old, but still functions well to meet current New Britain water needs.

   While the estimated 35 – 40 years of quarrying activities are taking place, and prior to Storage Reservoir creation, this pipeline should be inspected, to determine if repairs or replacement in sections or in its entirety will be required. Improvements could consist of cleaning and cement lining, pipe-bursting and in-place replacement, or new pipe installation adjacent to the existing transmission mains.

2) Inspect and Upgrade West Canal (as required) to Handle Additional Discharge Rates- The existing West Canal receives discharges from the Whites Bridge Surface and Groundwater Pumping Stations, up to an estimated maximum rate of 16 mgd, as well as runoff from its own watershed area. With the proposed Storage Reservoir in place, the Intake Structure Pumping Station will have a maximum pumping capacity of 20 MGD.

   While the estimated quarrying activities are taking place, and assessment of channel condition and capacity should be conducted, and any necessary upgrades provided to accommodate future increases in flows.

H) Anticipated Permitting Requirements – A detail discussion and list of anticipated permitting requirements, both for the proposed Quarry expansion as well as for the future Drinking Water Supply Reservoir, is provided in Chapter 11.



STORAGE RESERVOIR INTAKE STRUCTURE
SCHEMATIC DESIGN

Designed By: JEE
Drawn By: KLD
Checked By: JEE
CAD File: SCHEMATIC
Drawing Scale: NO SCALE
Drawing date: DEC. 8, 2017

Rev.	Date	Revision	By

SCHEMATIC INTAKE DESIGN
PREPARED FOR
PROPOSED STORAGE RESERVOIR
CITY OF NEW BRITAIN
0 BIDDLE PASS, PLAINVILLE, CONNECTICUT

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Figure #: 3-9
Job #: 16-370

▪ Updated Surface Water Safe Yield Study with New Storage Reservoir

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Chapter 4 - Updated System Safe Yield Study with New Storage Reservoir

A) INTRODUCTION

Public Act (PA) 16-61 (see Chapter 1) mandates the requirements for this study, which includes Item 3: "(the) likely safe yield increase to the City of New Britain's water reservoir system."

This chapter addresses this item of PA 16-61, as well as provides a summary of past estimates of System Safe Yield Studies, and discusses the feasibility of flood skimming on Coppermine Brook as a source of supply to fill the proposed 2.31 billion gallon Storage Reservoir.

B) REVIEW OF PAST SAFE YIELD STUDIES

1) 2002 Safe Yield Study (LEI) – As part of the approved 2002 State of Connecticut Department of Public Health (DPH) Water Supply Plan, LEI conducted a Safe Yield Study for the City of New Britain, in accordance with DPH Water Supply Planning regulation 25-32d. A copy of the Executive Summary from that report is provided below in italics.

I.EXECUTIVE SUMMARY

The City of New Britain Water Department (NBWD) retained Lenard Engineering, Inc. (LEI) to conduct a safe yield evaluation for its surface and ground water systems. The water supply system consists of six reservoirs (Shuttle Meadow, Wasel, Whigville, Wolcott, North Hart and South Hart) and three pumped sources (White Bridge Wells, White Bridge Surface Water Pond, and Nepaug).

The Safe Yield Analysis was conducted in accordance with the document "Reservoir Yield Analysis – Mass Balance Methodology for Surface Water Supplies, Connecticut Department of Public Health (formerly Department of Health Services) Water Supplies Section, January 1989".

The characteristics and interconnections of these sources are described in the 2002 Water Supply Plan. The safe yield is calculated using an analytical model to obtain a water mass balance for each individual reservoir and for the total system. The system was analyzed for the five year drought period from January 1964 to December 1968. The analysis began with all the reservoirs full on January 1964. System demand was then gradually increased until all the reservoirs run nearly dry only once during the five year period. This demand is the model or system safe yield. The model safe yield was then compared to the 1:100 drought recurrence interval to determine whether stream flow inputs during that critical drought period were *less than or equal to a calculated 1:100 year drought. Because stream flow inputs utilized in the model were less than those for a calculated 1:100 year drought, the model safe yield in this case is also serves as the 1:100 year drought safe yield.*

Using all the currently connected water sources, the results of the analysis indicate a system safe yield of ***17.64 MGD****.*

It should be noted that this system safe yield was calculated using regulations and methodologies in place as of October 2002. Any changes to water supply or water resource related regulations presently being discussed by the State Water Planning Council, may impact the system safe yield calculation.

Figure 4 - 1 - Overall Plan of Sources, New Britain Water Department shows the location of New Britain's Sources of Supply, including the proposed Storage Reservoir.

It should be noted that the following assumptions were made in the 2002 report:

1) The Patton Brook well was not included as part of the evaluation, as at the time is was being leased to the Town of Southington.

2) The model operating rules were set up to maximize the amount of water taken from gravity sources (Shuttle Meadow, Wasel, Whigville and Wolcott), and once these sources were reduced to only then take water from pumped sources (North and South Harts Ponds, Whites Bridge Wells, Whites Bridge Pond Station and Nepaug (MDC)). These rules were created not necessarily to maximize safe yield but to also minimize system pumping costs.

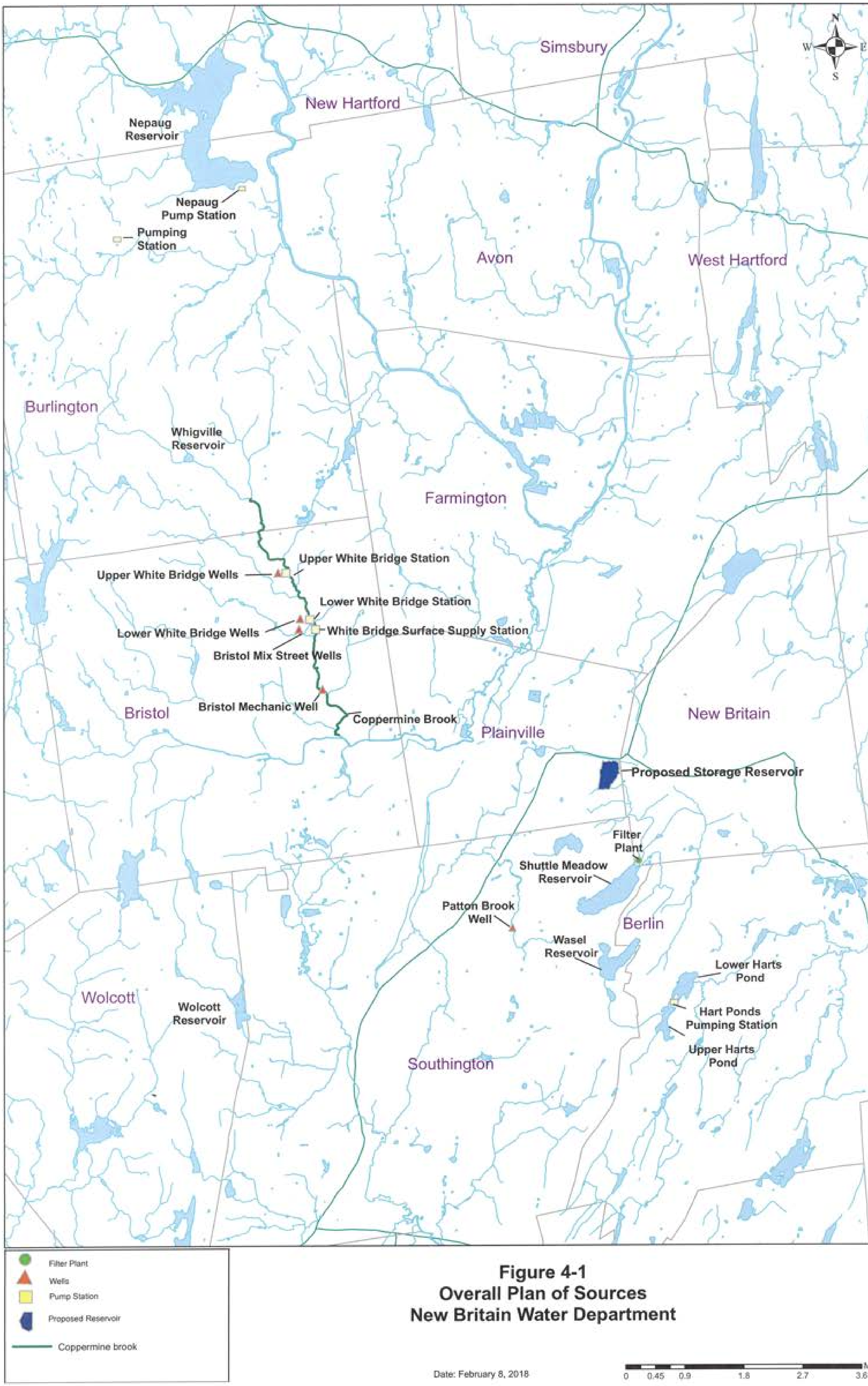

Figure 4-1
Overall Plan of Sources
New Britain Water Department

Date: February 8, 2018

2) 2007 Updated Safe Yield Study- including Proposed Tilcon Quarry Reservoir (LEI)

As part of the 2007 Update to New Britain's Water Supply Plan, LEI evaluated the potential of adding a future "Quarry Reservoir" within its Shuttle Meadow Reservoir watershed. The proposal at the time was to allow the neighboring property owner, Tilcon, to conduct quarrying activities on a 131 acre New Britain parcel over an estimated 40 to 50 year duration, after which a drinking water reservoir would be created in the excavation left by the quarry. Below is the summary and conclusions from that 2007 report, in italics:

LEI was retained by the City of New Britain Water Department (NBWD) to update the system safe yield model, to determine the impact on safe yield for a proposed future reservoir at the Tilcon quarry site.

LEI obtained significant data for model input from Tilcon's engineering consultant, Loureiro Engineering Associates (Loureiro) of Plainville, CT. Loureiro provided LEI with copies of watershed area maps, stage vs. storage, and stage vs. area calculations for the various quarry reservoir configurations.

LEI created a new quarry reservoir with these characteristics, and input this new reservoir into our existing NBWD safe yield model. LEI conducted ten additional safe yield model runs, the results of which are described below.

SUMMARY AND CONCLUSIONS

*These additional model runs estimate the creation of a new reservoir at the Tilcon quarry site would increase system safe yield, from **17.64 MGD** presently to at least **17.80 MGD**. The benefit of storage volumes greater than 100 MG is marginal, as the small watershed areas available to refill the reservoirs are the limiting factor, and the Quarry reservoir would not be able to refill back to full pond conditions within a reasonable period of time. As shown in Run # 7, if we allow a 398 MG reservoir to refill back to only 50 %, then the safe yield would increase significantly, up to **18.30 MGD**.*

*The other impact of incorporating this proposed Quarry Reservoir into the NBWD system is to avoid the potential loss of watershed area, to Shuttle Meadow reservoir, and safe yield. This maximum potential loss in system safe yield would be from **17.64 MGD** to **17.48 MGD**, or **0.16 MGD**, assuming the 4768 MG (50 year) Quarry excavation is completed, without pumping back into Shuttle Meadow Reservoir.*

The slight increase in system safe yield, combined with eliminating the slight reduction in safe yield that a do nothing approach would create, makes the creation of a future Quarry reservoir beneficial on a source of supply basis. In addition, since this reservoir would be constructed without any significant direct cost to the City of New Britain, this project is desirable.

Additional studies to determine the other impacts of a Quarry Reservoir, including water quality and environmental effects would still need to be conducted, to verify the benefits of this increase in yield do not outweigh the negatives.

It must be emphasized that whereas the 2007 analysis considers increases in safe yield **only from the limited natural drainage areas for the proposed Quarry at that time.** This 2018 Environmental Study analysis utilizes both the natural drainage areas for the new Quarry limits, combined with flood skimming from Coppermine Brook pumped into this new reservoir. The proposed flood skimming provides the overwhelming percentage of water that will supply the new Storage Reservoir.

C) POTENTIAL FOR FLOOD SKIMMING ON COPPERMINE BROOK

1) Definition - "Flood skimming" can be described as utilizing surplus streamflow during periods of high streamflow for other beneficial uses. In addition to reducing the negative impacts of downstream flooding, water withdrawn during flood skimming can be utilized for beneficial uses, such as irrigation, enhancing public water supplies, etc. Section C describes existing water uses within the Coppermine Brook watershed, the history of past flood and drought flows, and the feasibility of "flood skimming" as a means to help fill the proposed 2. 31 billion gallon Storage Reservoir.

2) Existing New Britain Withdrawals from Coppermine Brook Watershed – New Britain presently has three registered diversions within the Coppermine Brook watershed, two groundwater diversions and one surface water diversion. These diversions, as well as the 15.6 square mile watershed area limits for Coppermine Brook, measured at the confluence of Polkville Brook, are shown on **Figure 4 - 2**.

   a) Lower White Bridge Wells

   The Lower White Bridge Well Field consists of a well point system installed along the canal between Polkville and Copper Mine Brooks. There are 18 shallow (20 to 32-foot deep) wells and a 50- foot diameter caisson which are connected by a 16-inch suction header. The pump station was modified in 1987, including replacement of the pumps.

   The combined capacity of the three Lower White Bridge Wellfield pumps is 2,460 gpm or **3.5 MGD**. New Britain has a DEEP registered diversion of **6.62 MGD** (4,600 gpm) for the Lower White Bridge wellfield.

   b) Upper White Bridge Wells

   The Upper White Bridge Well Field and Pump House is located about 4,000 feet to the north of the Lower White Bridge Wells and Treatment Facility. There are a total of 6 shallow wells connected by two suction headers with 3 wells on each header. This facility was also rebuilt in 1987. New pumps and a vacuum priming system were installed at that time. The two pumps have a capacity of 650 gpm each.

The combined capacity of the Lower and Upper White Bridge Well Field pump stations was designed to be 3,790 gpm or about **5.4 MGD**. Previous estimates of combined safe yield for the Lower and Upper White Bridge well fields were between 4-5 MGD, probably closer to 4 MGD (C.E. Maguire, 1987). New Britain has a DEEP registered diversion of **2.16 MGD** (1,500 gpm) for the Upper White Bridge wellfield.

c) <u>Level A Aquifer Mapping</u>

DEEP Level "A" Aquifer Mapping was completed for both the Lower and Upper Whites Bridge wellfields in 2006 by Lenard Engineering, Inc. (LEI). This work included pump testing, as well as three dimensional numerical groundwater modeling, in accordance with DEEP Level "A" Aquifer Mapping regulations. It included a 72 hour duration concurrent pumping test for both the Lower and Upper Whites Bridge wellfields, as well as projected safe yields utilizing the calibrated and approved groundwater model. Simultaneous pumping impacts from the City of Bristol's Mix Street wellfield (Wells 3, 4 and 5) were included in the groundwater modeling prediction of safe yields.

Table 4 - 1 summarizes the results of both the pump testing, as well as the numerical modeling.

Table 4 - 1: White Bridge Well Field Safe Yield

	Upper White Bridge		Lower White Bridge	
Condition	GPM	MGD	GPM	MGD
72-Hour Pump Test (June 2002)	400	0.56	600	0.86
Groundwater Modeling:				
Average Recharge Condition	753	1.08	1,960	2.82
Drought Recharge Condition	600	0.86	610	0.88

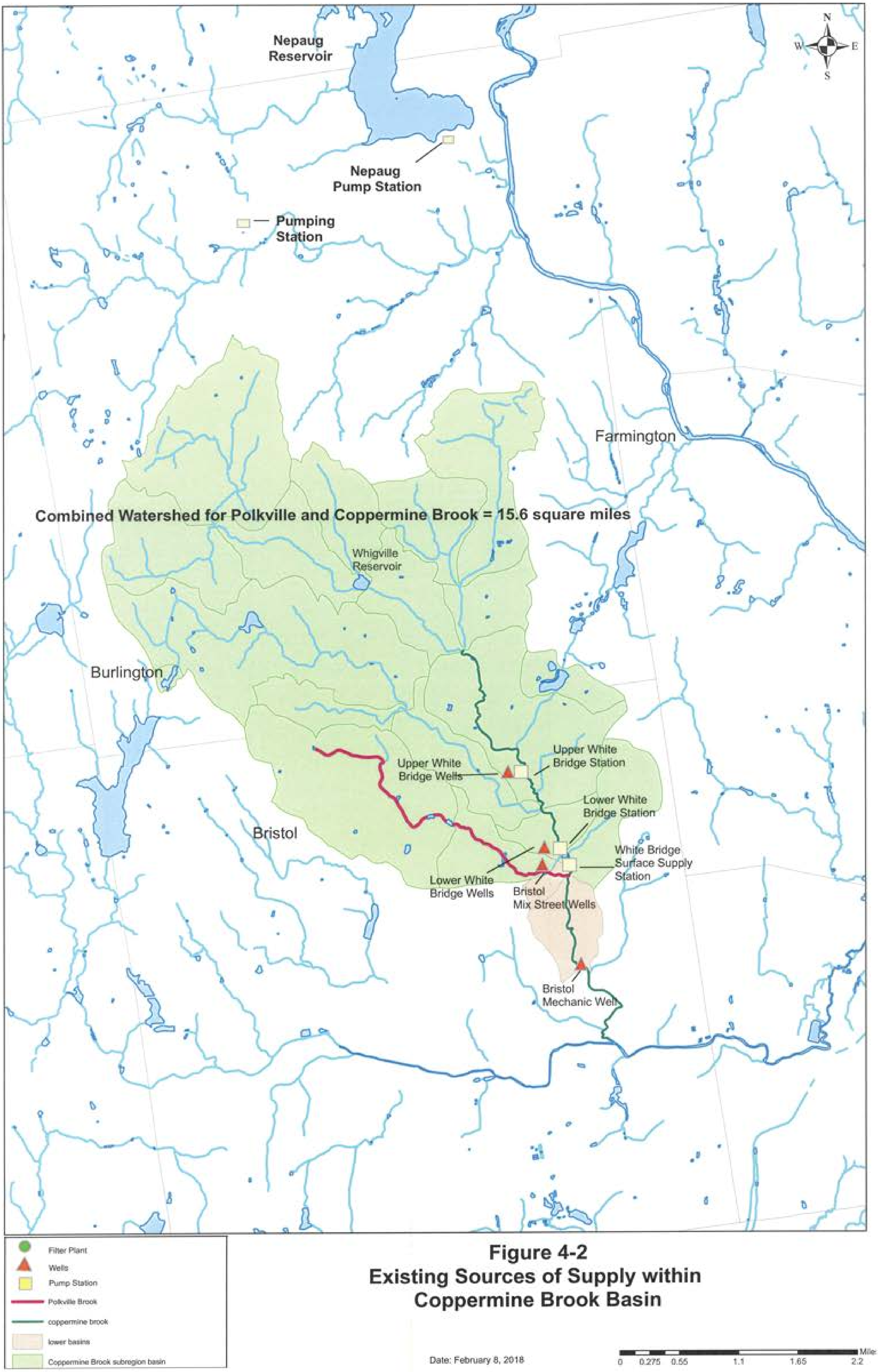

Figure 4-2
Existing Sources of Supply within Coppermine Brook Basin

Date: February 8, 2018

d) White Bridge Surface Supply

The White Bridge Surface Supply is located in Bristol, just upstream of the confluence of Polkville and Coppermine Brooks. Intakes in both brooks divert water to a small pond of 2.5 MG capacity from which a pump station draws suction. This facility can be operated in conjunction with the Lower and Upper White Bridge Well Stations, although the White Bridge Wells are adjacent to the pond and share the same watershed. The watershed tributary to the intakes is 15.6 square miles.

Water from the station flows through approximately 30,000 feet of 36-inch and then 5,000 feet of 30-inch transmission main, where it discharges to the West Canal. The West Canal then flows by gravity into Shuttle Meadow Reservoir. The station can deliver approximately 14 - 15 MGD to Shuttle Meadow Reservoir with all pumps running. The station has a DEEP Registered Diversion of 15.0 MGD (10,400 gpm). The 36-inch and 30-inch pipeline has a capacity of 16 MGD, which can carry flows from the following sources of supply: Nepaug, Whigville, Lower Whites Bridge Wellfield, Upper White Bridge Wellfield, and the White Bridge Surface Supply.

For this project, flood skimming would consist of utilizing New Britain's existing White Bridge Surface Supply pumping station, which draws from a man-made pond hydraulically connected to Coppermine Brook and Polkville Brooks, to pump during excessive-flow periods, to help fill the proposed Storage Reservoir.

Care would be taken not to over-withdraw water during periods of low flow on Coppermine Brook. This operation is discussed in detail later in this chapter.

3) Other Major Withdrawals within Coppermine Brook Watershed-

The City of Bristol Water Department has four registered diversions within the Coppermine Brook watershed. It maintains three active wells located off of Mix Street in Bristol, Wells 3, 4 and 5. They are located adjacent to Polkville Brook, a tributary to Coppermine Brook. These wells are located approximately 2000 - 2500 feet west of New Britain's Lower White Bridge Wellfield and the White Bridge Surface Supply Pumping Station.

The Bristol Water Department also utilizes Mechanic Street Well 2A as a source of supply. It is located adjacent to Coppermine Brook, over one mile downstream of New Britain's Lower Whites Bridge Wellfield and Surface Water Pumping Station.

Bristol Wells 2A, 3, 4 and 5 are also shown on **Figure 4 - 2**. **Table 4 - 2** below provides a listing of Bristol's registered groundwater diversions in the Coppermine Brook watershed.

TABLE 4 - 2- BRISTOL WATER DEPARTMENT DIVERSIONS
COPPERMINE BROOK WATERSHED

Source	Registered Diversion (mgd)	Registered Diversion (gpm)
Mix Street Well # 3	0.72	500
Mix Street Well # 4	0.86	600
Mix Street Well # 5	0.72	500
Mechanic Street Well # 2A	1.56	1,082

4) Historic Flooding and Potential Flood Mitigation Solutions on Coppermine Brook- The City of Bristol has experienced historic flooding, sometimes significant, along Coppermine Brook. In 2008, Bristol hired Milone and MacBroom (M&M) of Cheshire, CT who conducted a study entitled "Coppermine Brook Drainage Evaluation", which was completed in August 2008. A copy of the Executive Summary from this report is provided in **Appendix 4-1**.

As noted in the study, the purpose was to:

a) Evaluated current conditions within the watershed and along the stream corridor, and

b) Identify potential strategies to alleviate potential flooding problems.

The report discussed three specific problem areas on Coppermine Brook for flooding, including Richards Court/ Stevens Street, Farmington Avenue, and Frederick Street. The Farmington Avenue and Frederick Street stream crossings are located downstream of New Britain's White Bridge Upper and Lower wellfields, as well as the White Bridge Surface Supply pumping station.

Key conclusions from the 2008 M&M report included:

1) Rainfall patterns in the northeast US are changing, resulting in increasing streamflows,

2) Future land use build-out (within the watershed) could increase peak flows by 10 to 20 percent, if unmitigated,

3) Central Connecticut has suffered from an unusual series of flood events in recent years, and these have impacted the Bristol areas. Residents have referred to severe flooding in 1999, 2005, and 2006.

4) M&M utilized the USGS stream flow gauge on Bunnel (Burlington) Brook in Burlington as the nearest continuous recording point to Coppermine Brook's headwaters, to provide analogous flow estimates for Coppermine Brook during their study.

5) M&M recommended construction of watershed storage areas as one means of reducing downstream flow rates. They recommended an area between Maltby and Stevens Streets to be pursued first, which is upstream of both New Britain wellfields.

This report confirmed the occurrence of periodic flooding on Coppermine Brook in Bristol, and identified the need to develop innovative flood control methodologies to help minimize the impacts.

Flood skimming is another technique that can be utilized to also contribute to minimizing flooding impacts downstream of New Britain's White Bridge Surface Pumping Station. If the City of Bristol decides to proceed with design and permitting of flood storage structures within the Coppermine Brook watershed, New Britain should work cooperatively with Bristol to see how flood storage could enhance flood skimming operation at their station.

5) <u>Streamflow Estimates for Coppermine Brook</u>

There are no known stream gauges or records of streamflow on Coppermine Brook. Similar to the DPH Methodology for Safe Yield Analyses on un-gaged streams, LEI reviewed area stream gauging stations with long periods of records that were analogous to Coppermine Brook.

Consistent with the Safe Yield Analysis, LEI chose to use the Bunnell Brook USGS stream gauge, located in Burlington, CT. (Prior to 1995, this gauge was identified as Burlington Brook). This gauge is located in close proximity to the project site (approximately 6.6 miles northwest), and has continuous flow records from 1931 to the present. As noted in Section 4 above, M & M also utilized this gauge to predict streamflows in Coppermine Brook during their 2008 study.

Data from the Bunnell Brook stream gauge was converted into a flow per square mile basis (cfs/square mile), multiplied by the 15.6 square mile Coppermine Brook watershed calculated at its confluence with Polkville Brook, and utilized for this analysis.

LEI utilized monthly average of streamflow from this gauging station, which provided very good summaries of historic flows, for evaluating the potential for additional withdrawals during both drought and flooding periods.

Table 4 - 3 provides a summary of historic flows from the Bunnell Brook stream flow gauge, between 1932 and 2016. LEI sorted these flows from high to low, to determine which years were the driest, wettest, and median flows.

These results show that **1965** was the driest year on record, and review of New Britain rain gauge data at Shuttle Meadow Reservoir confirmed an annual rainfall of **33.18 inches**. LEI also utilized the median year of record, **1968,** which had a rainfall of **46.5 inches**. Streamflow records from these years were used to determine the feasibility of flood skimming to fill a future Storage Reservoir, taking into account the upcoming DEEP minimum streamflow regulations.

TABLE 4-3

Ranking of Bunnell Brook Annual Streamflows from Higest to Lowest

1932-2016

Burlington, CT

Monthly mean streamflow

Year	cfs		Year	cfs	
1965	3.48	Driest yr	2013	8.15	
2016	4.07		1997	8.20	
1941	4.49		1959	8.21	
1957	4.59		1992	8.23	
1966	4.70		2000	8.30	
2015	5.17		2004	8.52	Average yr
1964	5.20		1974	8.74	
2012	5.30		1987	8.75	
2002	5.37		1999	8.77	
1935	5.74		1969	8.77	
1963	5.81		1948	8.92	
1985	5.92		1982	8.95	
1944	5.97		1971	9.03	
1981	6.00		1998	9.10	
1988	6.47		1960	9.29	
1962	6.62		1934	9.57	
1933	6.83		1951	9.71	
1932	6.87		2010	9.76	
1949	6.96		1958	9.87	
1980	7.04		2009	9.88	
1970	7.08		1990	9.95	
2001	7.16		1977	10.04	
1995	7.21		1953	10.13	
1939	7.24		1979	10.26	
1947	7.25		1984	10.32	
1961	7.27		1994	10.55	
2014	7.28		1952	10.58	
2007	7.33		1989	10.66	
1946	7.33		1938	10.69	
1950	7.34		1945	10.91	
1942	7.39		2006	11.24	
1943	7.47		2005	11.62	
1956	7.66		1975	11.71	
1954	7.71		1937	11.95	
1978	7.78		2008	12.02	
1976	7.84		2003	12.45	
1991	7.88		1972	12.72	
1936	7.88		1973	13.09	
1967	7.89		1983	13.24	
1986	7.90		1996	13.73	
1940	8.05		1955	14.34	
1993	8.08		2011	16.86	Wettest yr
1968	8.12	Median yr			

See Figures 4-4 & 4-5 for plots of 1965 and 1968 streamflows vs. DEEP Minimum Requirements

6) DEEP Minimum Streamflow Release Requirements on Coppermine Brook- The DEEP released their "Streamflow Standards and Regulations" in December 2011. These standards aim to balance river and stream ecology, wildlife and recreation while providing for public health, flood control, industry, public utilities water supply, agriculture, and other lawful uses of water.

DEEP then began the process of classifying each of the state's estimated 36,000 stream segments as one of four designated streamflow classes:

- Class 1 – Free flowing, priority given to protecting ecological health,
- Class 2 - Minimally altered, free-flowing stream systems,
- Class 3 – Moderately altered, intermediate balance points between ecological and human uses, and
- Class 4 – Substantially altered, priority given to human uses requires approved, site-specific releases.

Final streamflow classifications for the Connecticut River watershed, in which Coppermine Brook and the White Bridge Surface Supply pumping station are located, were adopted in 2017. **Figure 4 - 3** is a map of the approved final streamflow classifications, in the vicinity of Coppermine Brook. Coppermine Brook, especially in the vicinity of New Britain's wells and surface water pumping station, received a Class 3 classification.

DEEP minimum streamflow requirements were primarily directed to dam owners or operators, which is not directly applicable to New Britain's current groundwater or surface water registered diversions within the Coppermine Brook watershed. In discussions with DEEP officials, they suggested any future modifications to New Britain's diversions take into account meeting these minimum streamflow requirements.

Table 4 - 4 which follows reproduces the DEEP Minimum Streamflow Release Requirements for Class 3 streams, as published in R.C.S.A. Sec. 26-1416-6, revised March 6, 2015.

LEI utilized the USGS Streamstats website (version 3.0), which publishes the minimum flows for each of these bioperiods, calculated at the confluence of Coppermine and Polkville Brooks, are provided in **Table 4 - 5** which follows. A copy of the Streamstats printouts which calculates these minimum flows is provided in **Appendix 4 - 2**.

FIGURE 4-3

DEEP STREAMFLOW CLASSIFICATION MAP, CONNECTICUT RIVER BASIN

VICINITY OF WHITE BRIDGE WELLS AND SURFACE WATER PUMPING STATION BRISTOL, CT

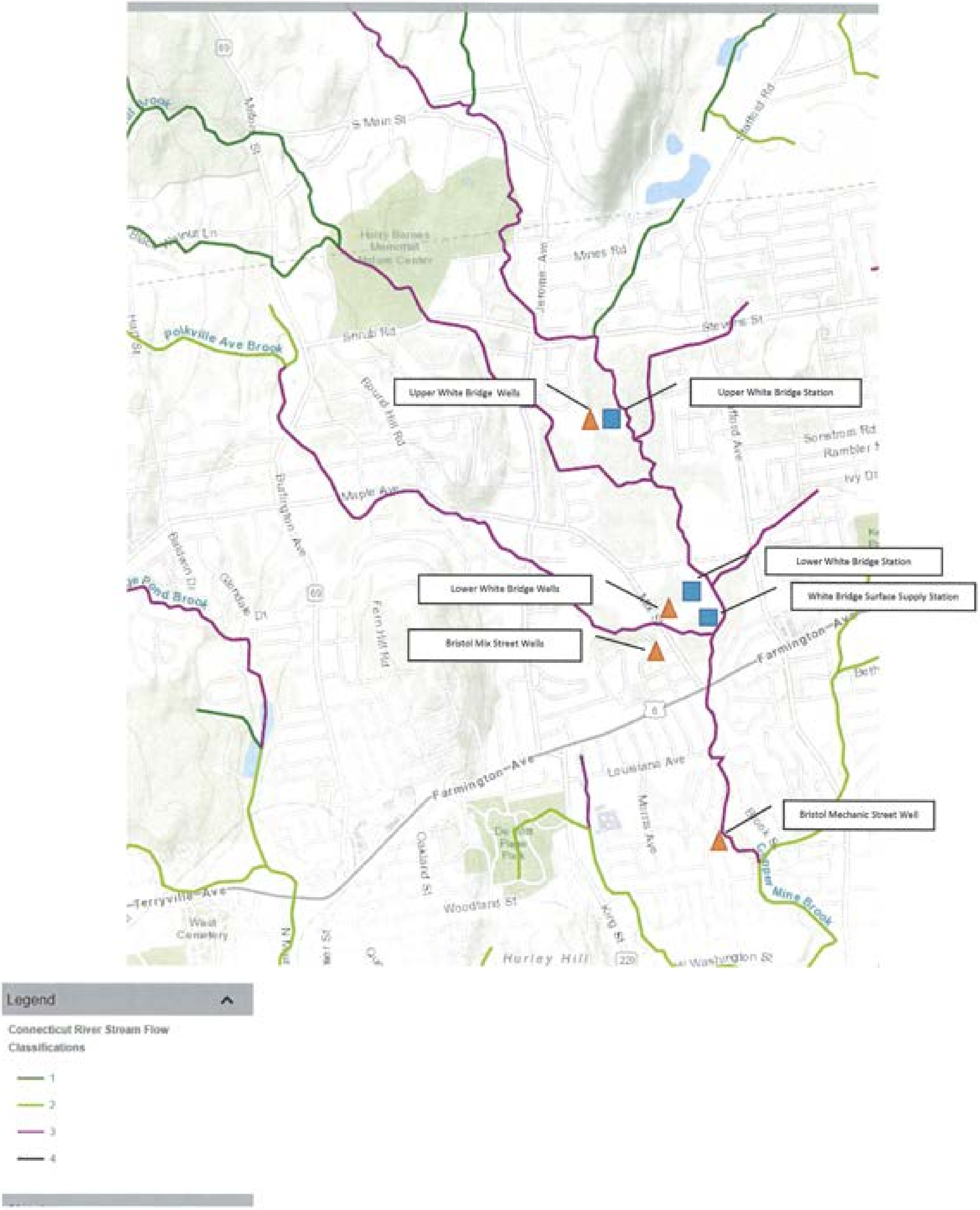

Table 4 - 4
DEEP Minimum Streamflow Requirements for Class 3 Streams

Bioperiod	**Effective Dates**	**Minimum Required Release**	
		Antecedent Period Dry	**Antecedent Period Wet**
Overwinter	Dec 1 – Feb 28/29	Bioperiod Q99	Bioperiod Q99
Habitat Forming	Mar 1 – Apr 30	Bioperiod Q 99	Bioperiod Q99
Clupeid Spawning	May 1 – May 31	Bioperiod Q 95	Bioperiod Q95
Resident Spawning	June 1 – June 30	Bioperiod Q 90	Bioperiod Q90
Rearing and Growth	July 1- Oct 31	Bioperiod Q80	Bioperiod Q50
Salmonid Spawning	Nov 1- Nov 30	Bioperiod Q90	Bioperiod Q 90

Table 4 - 5
DEEP Minimum Streamflow Requirements as Applied to the Coppermine Brook watershed, measured at the confluence with Polkville Brook (Watershed area = 15.6 square miles)

Bioperiod	**Effective Dates**	**Minimum Required Release (cfs)**	
		Antecedent Period Dry	**Antecedent Period Wet**
Overwinter	Dec 1 – Feb 28/29	3.68	3.68
Habitat Forming	Mar 1 – Apr 30	14.1	14.1
Clupeid Spawning	May 1 – May 31	13.8	13.8
Resident Spawning	June 1 – June 30	6.96	6.96
Rearing and Growth	July 1- Oct 31	3.12	6.33
Salmonid Spawning	Nov 1- Nov 30	5.11	5.11

Even though the DEEP regulations go onto allow for reductions in minimum releases, if the dam owner or operator was a public water supply during various stages of their drought contingency plan, LEI did not take into account any of these reductions in our analysis.

Figure 4 - 4 superimposes the historic streamflow predictions for Coppermine Brook for the historic dry year of record 1965 in blue, along with the current DEEP Minimum Streamflow releases, on a monthly basis. As shown, even during this historic dry year, between the months of January and April, and once again during December, surplus streamflows over the DEEP minimum requirements were present.

During these five months, in theory if New Britain were to withdraw at their maximum registered diversion rate of up to 15 MGD, and only during the months when surplus flow was available, they could capture approximately 991 million gallons of water. Compared to the approximate **2.31 billion gallons** usable storage in the proposed Storage Reservoir, it would take **2.3 years**, or **28 months** to completely fill the Storage Reservoir from flood skimming during this dry period.

Figure 4 - 5 utilizes historic streamflow data from 1968, the median year of record for the Bunnell Brook streamflow gauge. As shown, surplus streamflows over the DEEP minimum requirements were present during nine of the twelve months of the year in 1968. In theory, if New Britain were to withdraw at their maximum registered diversion rate of 15 MGD, they could capture over 3.5 billion gallons of water, while at the same time complying with DEEP's Minimum Streamflow Requirements. Compared to the approximate 2.31 billion gallons usable storage in the proposed Storage Reservoir, it would take approximately **0.5 years**, or **6 months** to fill the Storage Reservoir from flood skimming.

7) <u>Conclusions</u> - These calculations using both historic dry as well as average rainfall years show that filling a very large 2.31 billion gallon proposed Storage Reservoir is feasible, even while maintaining DEEP Minimum Streamflow releases downstream of the White Bridge Surface Supply.

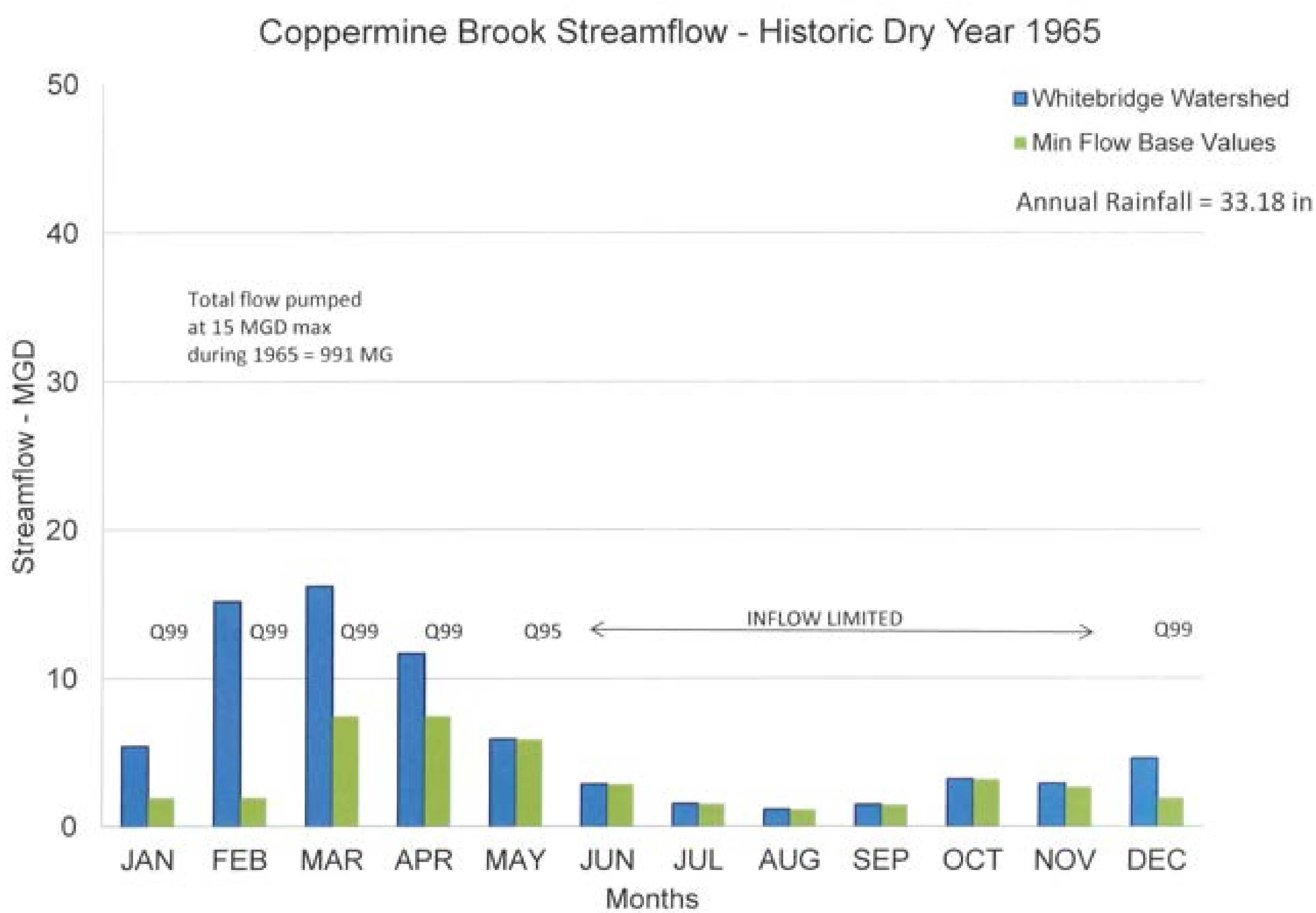

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Figure 4 - 4

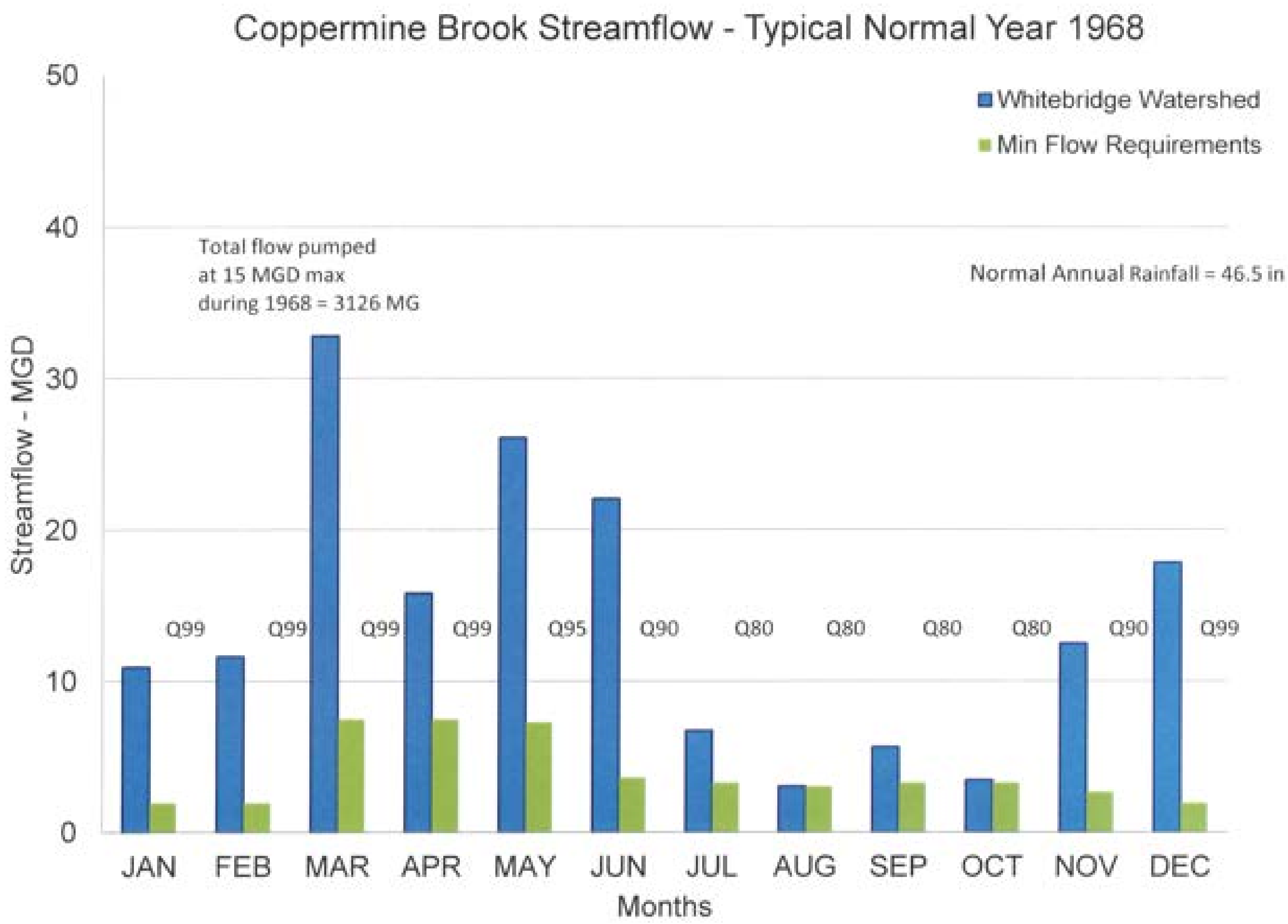

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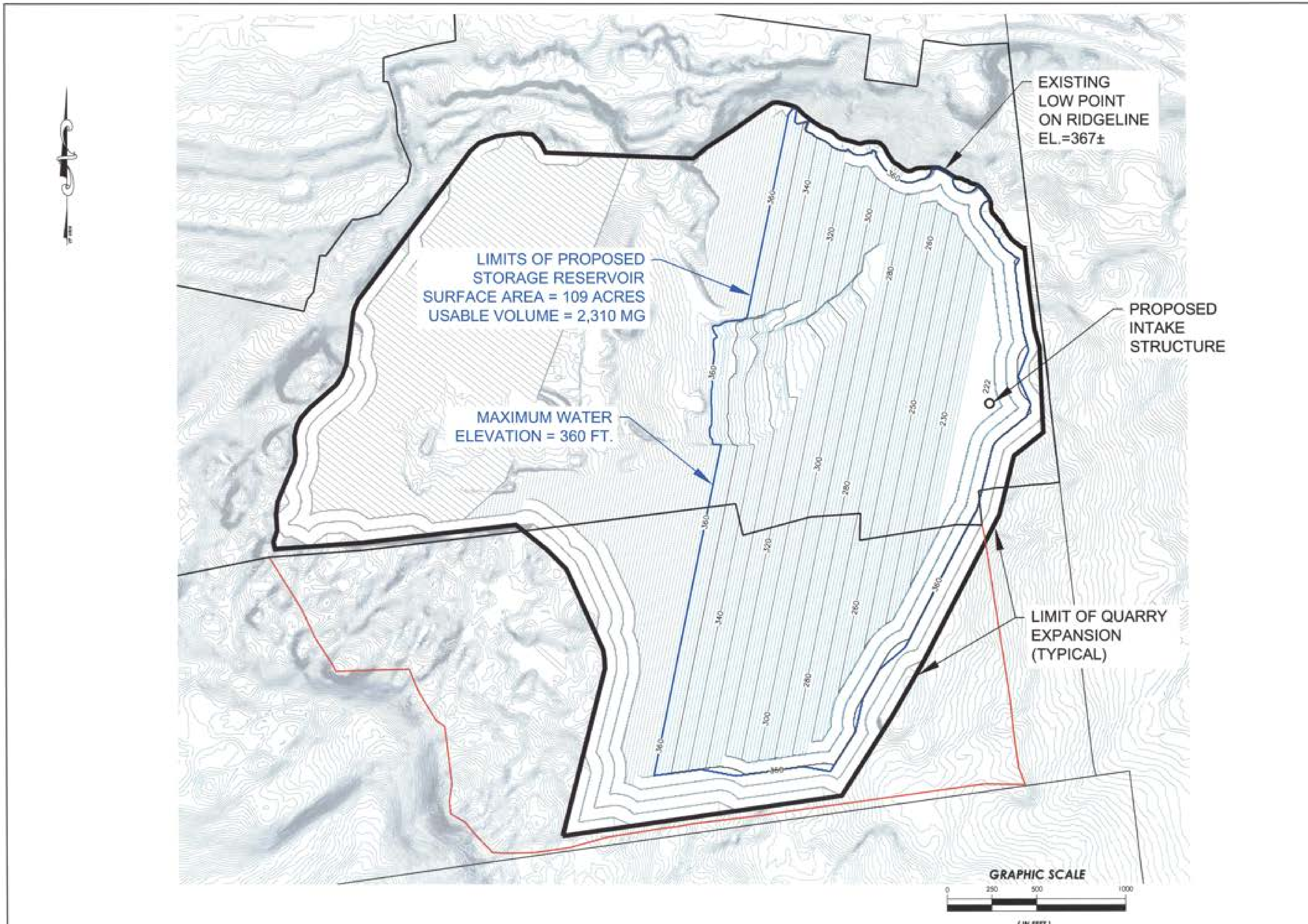
Figure 4 - 5

D. PROPOSED STORAGE RESERVOIR CHARACTERISTICS

Figure 4 - 6 shows the proposed plan for the proposed Storage Reservoir. As discussed previously in Chapter 3, the proposed reservoir was located on the eastern portions of both the existing Tilcon and New Britain parcels, which significantly reduces impacts to critical landforms and natural resources on the across the western and southwestern portions of the site, including Bradley Mountain and the sites largest vernal pool complexes.

Figure 4 – 6 also shows the location of a Storage Reservoir intake structure and pumping station. The intake structure would have a minimum floor elevation of 370 feet +/- and extend to the bottom of the reservoir at elevation 222 feet +/-. Multiple intakes would be present, to allow New Britain to utilize the entire volume of the reservoir, as well as draw water from depths where water quality is optimal. Four – 5 MGD pumps are shown, which will allow New Britain to withdraw anywhere from 0 to 20 MGD from the Quarry Reservoir, and discharge either a) into the West Canal, or b) directly into the Shuttle Meadow treatment plant.



PROPOSED STORAGE RESERVOIR

PREPARED FOR

PROPOSED STORAGE RESERVOIR

CITY OF NEW BRITAIN

0 BIDDLE PASS, PLAINVILLE, CONNECTICUT

Lenard Engineering, Inc.

Civil, Environmental and Hydrogeological Consultants

Drawing date: DEC. 8, 2017

Drawing Scale: 1"=500'

Designed By: JEE

Drawn By: KLD

Checked By: JEE

CAD File: UPDATE

Figure #: 4-6

Job #: 16-370

E. UPDATED SAFE YIELD ESTIMATE

1. General- LEI updated our previously approved safe yield model for New Britain, which continues to utilize the current DPH approved methodology specified in the DPH Water Supply Plan regulation Section 25-32d-4, entitled "Calculation of Safe Yield", which is footnoted "Adopted Effective August 10, 2000".

2. Mapping - **Figure 4 – 1** previously showed New Britain's Overall Plan of Water Sources, including the 2.3 Billion Gallon Proposed Storage Reservoir location. This reservoir is located approximately 1000 feet west of New Britain's West Canal, which flows by gravity to Shuttle Meadow Reservoir.

3. Operating Rules – LEI modified the operating rules from our two previous Safe Yield Models for New Britain, to optimize Safe Yield from this new Storage Reservoir. The basic operating rules are summarized below:

   a) As noted previously in this chapter, with the Storage Reservoir in place, New Britain can modify the operation of the White Bridge Surface Pump Station, and only pump when DEEP minimum streamflows exist downstream of the pump station at all times. If streamflows are below these values, then the station would not pump. This by itself **would provide significantly increased streamflows in Coppermine Brook over and above current regulatory conditions, especially during critical dry periods**.

   b) As also noted, the 15.6 square mile Coppermine Brook watershed routinely produces surplus streamflows, over and above the DEEP minimum streamflow values, especially during average or above-average rainfall years.

   c) During times when total storage in all New Britain reservoirs is less than 90% of full, and when streamflows are adequate to meet DEEP standards, the White Bridge Surface Supply Pump Station would operate, and pump water into the West Canal to help fill Shuttle Meadow Reservoir, just as it has for decades.

   d) During times when total storage in all New Britain reservoirs is greater than or equal to 90% of full, and when streamflows are adequate to meet minimum DEEP standards, the Surface Water Supply Pump Station would operate, and pump water into the proposed Storage Reservoir. As noted in Chapter 3, the time to fill the 2.31 billion gallon Storage Reservoir would range from 6 to 28 months, depending upon if it were an average year or drought year.

   e) Our safe yield analysis conservatively assumes that the Quarry Reservoir is maintained at 80% capacity, which reserves volume for potential flood flow storage. The Storage Reservoir would be maintained at this volume, which provides approximately **1.85 billion gallons** of storage in anticipated of a drought.

f) When a drought hits, New Britain would operate as present, and utilize existing gravity and pumped sources to help keep Shuttle Meadow and the other surface water reservoirs as full as possible.

g) Only when storage dropped to 30% of full for all the New Britain reservoirs combined, then the 1.85 billion gallons of stored water in the Proposed Storage Reservoir would be utilized to help refill Shuttle Meadow Reservoir and supply New Britain. The proposed Storage Reservoir Intake Pumping Station would operate at rates between 0 and 20 million gallons per day, and discharge to either the West Canal or directly to the Shuttle Meadow Treatment Plant to help meet system demands as well as refill Shuttle Meadow Reservoir.

h) While the proposed Storage Reservoir Intake Pumping Station is pumping, all of New Britain's remaining sources of supply would also be operational, and helping to refill Shuttle Meadow and the other existing Reservoirs, while the Proposed Storage Reservoir was meeting system demands.

i) Assuming no input from any other New Britain source, the 1.85 billion gallons of storage (80 % of the total) could meet the anticipated 2060 potential 10.7 mgd combined system water demand for **172 days**, or approximately **5.7 months, by itself.**

j) This operating assumption is extremely conservative and very unlikely to occur, as even without New Britain's own sources, New Britain's agreement with MDC which allows up to 10 MGD of purchased water over a six month period, or an average of 5 MGD of purchased water over an entire calendar year, would be utilized to help meet demands and refill Shuttle Meadow Reservoir.

k) Once the drought subsided, New Britain's gravity and pumped sources of supply would be utilized to refill Shuttle Meadow Reservoir. When Shuttle Meadow was comfortably full, the Proposed Storage Reservoir Intake Pump Station would be inactivated, and only when a) Shuttle Meadow was full and b) DEEP minimum streamflows existed at the Surface Water Supply Pump Station on Coppermine Brook, only then would the Surface Water Supply Pump Station be used to start refilling the Quarry Reservoir, in anticipation of the next drought event.

4) Model Runs- LEI created a series of model runs to evaluate the impact of various conditions on overall system safe yield, as described below:

a) Model Run 1- Base Case, Existing Conditions- **Run 1** calculates system safe yield utilizing existing sources of supply only. Minor adjustments to the operating rules were made since the original 2002 and 2007 models, to allow for quicker use of pumped sources- White Bridge Upper and Lower Wellfields, White Bridge Surface Water Pump Station, and Nepaug, which positively increased system safe yield from previous estimates of **17.64 MGD** to **18.23 MGD**. The detailed results of this model run are provided in **Appendix 4 – 3.1**.

b) Model Run 2- Subtracting out 108 acres of temporarily lost watershed area during Quarry construction – Shuttle Meadow Reservoir has a present watershed area of **2.79 square miles**, which includes contribution from both its natural watershed, as well as added watershed area from both the West and East Canals. Assuming a worst case condition that during Quarry construction no water falling in the Quarry expansion will be re-pumped for use to the West Canal, then approximately **108 acres** of watershed will be "temporarily" lost.

   Run 2 reduces the watershed area for Shuttle Meadow Reservoir from 2.79 square miles by **108 acres (0.17 square miles),** to **2.62 square miles**. The effect is reducing overall system safe yield by **0.07 MGD**, from **18.23 MGD** to **18.16 MGD**. The detailed results of this model run are provided in **Appendix 4 -3.2**.

c) Model Run 3- Add 2.31 billion gallon Storage Reservoir, and 20 MGD Pump to Discharge to West Canal– Run 3 assumes the Storage Reservoir is completed, and at approximately 80 % of full capacity, which envisions leaving room to store a potential flood event on Coppermine Brook. As noted previously, this reservoir can be completely filled by flood skimming operations on Coppermine Brook within approximately 6 months during average rainfall years, and 28 months during periods of extremely low rainfall years.

   The Storage Reservoir Intake Pump Station will begin pumping stored water to the West Canal when storage in the combined New Britain reservoirs approaches 30 % of capacity, indicating a drought is in progress.

   Run 3 predicts an increase in safe yield from **18.16 MGD** to **19.68 MGD**, or **1.52 MGD** net increase. Through trial and error, additional increases in safe yield are possible, but are restricted by the current 22 MGD pumping capacity between Shuttle Meadow Reservoir and the Treatment Plant. The detailed results of this model run are provided in **Appendix 4 -3.3.**

d) Model Run 4- Add 2.31 billion gallon Quarry Reservoir, and 20 MGD Pump to Discharge to West Canal, Increase Shuttle Meadow Intake Pump Capacity to 26 MGD - Run 4 expands upon Run 3, by more efficiently utilizing water from White Bridge Surface Supply, the Nepaug interconnection, and increasing the Shuttle Meadow Reservoir intake pump station from 22 to 26 MGD, which is also the peak flow treatment capacity of the Shuttle Meadow Plant. Increased ponding of water at White Bridge Surface Supply increases Safe Yield to **23.16 MGD**. Note no DEEP minimum streamflows are provided in Run 4. The detailed results of this model run are provided in **Appendix 4 -3.4.**

e) Model Run 5- Applies DEEP Minimum Streamflow Requirement to White Bridge Surface Supply - Run 5 applies the DEEP Minimum Streamflow Requirements at the White Bridge Surface Supply. The results of this model run are provided in **Appendix 4.3.5**. Applying DEEP Minimum Streamflow Release Requirements, the system safe yield is reduced from **23.16 MGD** to **20.20 MGD**. Note this value increases safe yield over baseline conditions from **18.23 MGD** to **20.20 MGD**, or approximately **1.97 MGD**.

5) Conclusions- Through the addition of a 2.31 billion gallon Storage Reservoir, New Britain can increase system safe yield by **approximately 2 MGD** over current estimates, up to approximately **20.20 MGD**.

Table 4 – 6 below summarizes the five model runs conducted for this study.

TABLE 4-6
SAFE YIELD MODELING RUN SUMMARY

Model Run #	Assumptions	Results (mgd)	Comments
1	Existing Conditions	18.23	Utilizes pumped sources earlier than past models.
2	Temporary Safe Yield during Quarry Construction	18.16	Assumes no water is re-pumped to West Canal during Quarry construction.
3	Add 2.31 billion gallon Quarry Res.	19.68	Safe yield limited by existing treatment plant intake capacity.
4	Maximize Water Capture from Coppermine, Nepaug	23.16	Maximum theoretical safe yield, increasing intake capacity
5	Apply DEEP Min. Streamflow Req. at White Bridge Surface Supply	20.20	Same as Run 4, but imposes DEEP minimum streamflows at White Bridge Surface Supply

Appendix 4-1

Executive Summary, Coppermine Brook Drainage Evaluation,
Milone and MacBroom, August 2008.

Lenard Engineering, Inc.

EXECUTIVE SUMMARY

COPPERMINE BROOK DRAINAGE EVALUATION

Bristol, Connecticut

August 28, 2008

MMI #2235-19

Prepared for:

City of Bristol
Department of Public Works
111 North Main Street
Bristol, CT 06010

Prepared by:

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99 Realty Drive
Cheshire, Connecticut 06410
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INTRODUCTION

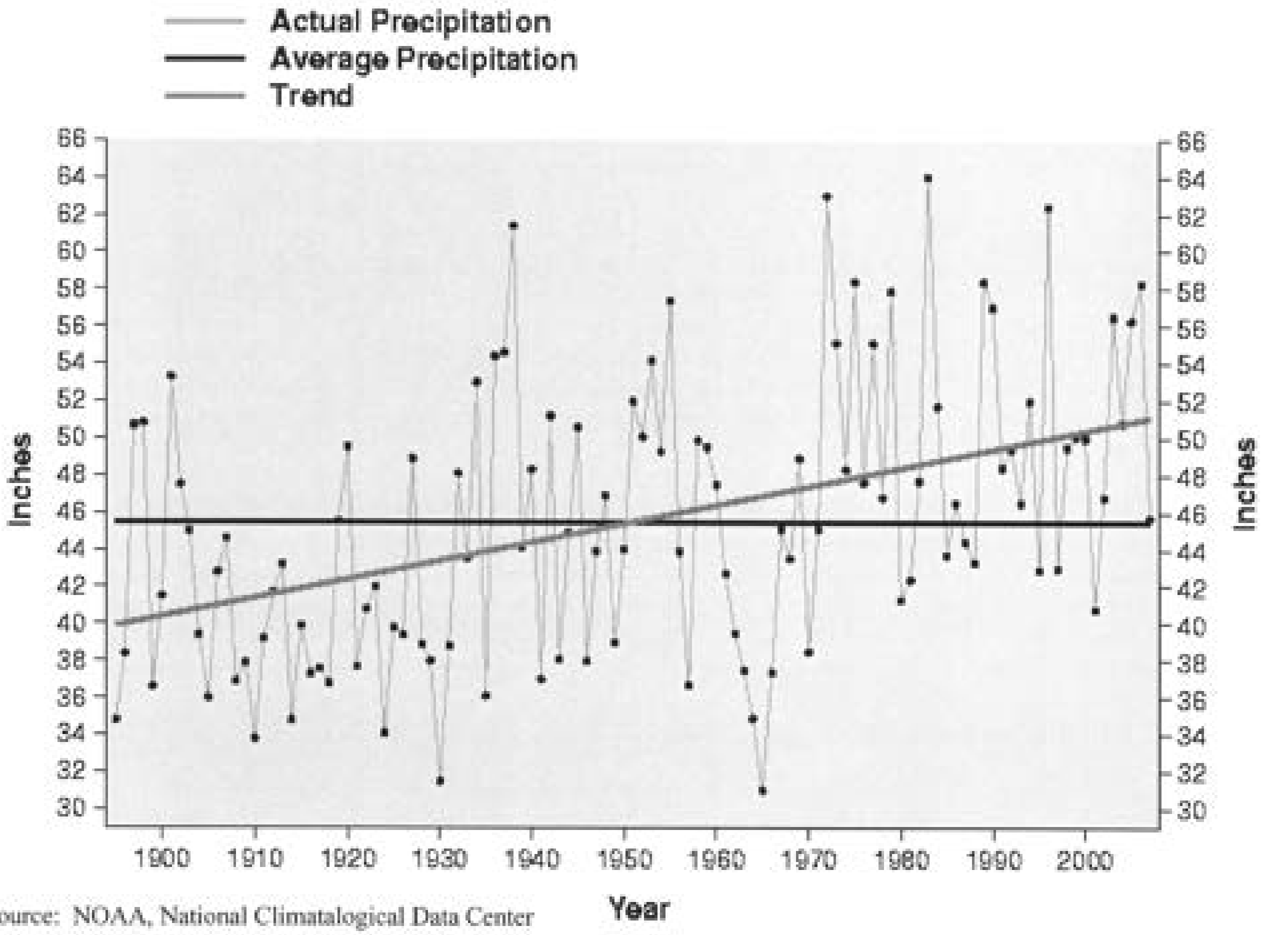
The City of Bristol contracted Milone & MacBroom, Inc. (MMI) to prepare a detailed evaluation of the Coppermine Brook watershed and stream channel. In recent years, residents along the Coppermine Brook channel have experienced repeated flooding of yards and residential structures. Many residents have expressed concern that the problem is becoming more severe as the frequency of events increases.

Flooding along streams and rivers is a normal, natural phenomenon that occurs due to excess surface runoff from precipitation or snow melt. Human activities and climate change can modify natural flooding patterns. Watershed topography, geology, and vegetation influence runoff rates which, in turn influence the shape, size, and slope of stream channels and floodplains. These factors then influence the presence, depth, and velocity of flood waters which may damage public and private property.

Erosion and deposition of sediments along alluvial channels often creates large, nearly level areas of land called floodplains. Floodplains help convey floodwaters to supplement the channel's capacity. Many floodplains have level, stone-free surfaces that are attractive locations for farms, roads, and communities. However, they remain prone to inundation and flood damages occur. Coppermine Brook has extensive floodplains that are now flood prone developed areas.

The purpose of this study was to evaluate current conditions in the watershed and along the channel corridor and identify potential strategies to alleviate the flooding problems. Three specific problem areas were identified based on discussions with residents and town staff alike: Richards Court/Stevens Street; Farmington Avenue; and Frederick Street. In completing this project, MMI developed a hydrologic model of the watershed, a hydraulic analysis of the channel corridor and an analysis of alternative improvements that may decrease the frequency of flooding.

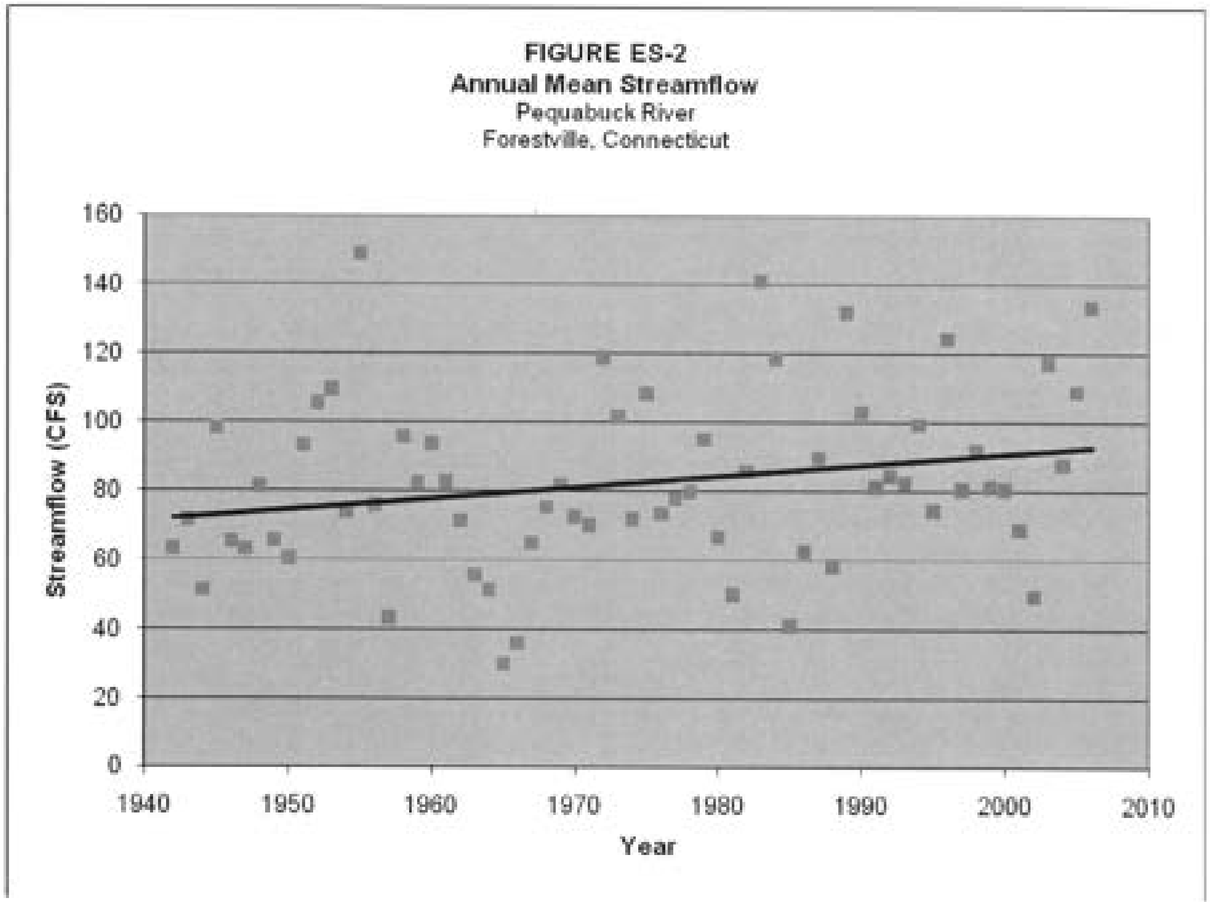
In evaluating and understanding drainage and flooding, it is imperative to understand rainfall trends and how these relate to changes in streamflow. In New England, the effects of urbanization are exacerbated by changes in rainfall patterns that have been observed. Connecticut's annual mean precipitation has consistently increased through the last century, with the increase generally measuring 0.96 inches per decade. This trend is depicted graphically in Figure ES-1.



Source: NOAA, National Climatalogical Data Center

FIGURE ES-1: Precipitation Trends in Connecticut 1895-2003

The combination of increased rainfall intensity and increased runoff rates (which can be attributed to a combination of increased rainfall and increased development) will invariably result in increases in annual streamflows. This trend is already evident when evaluating streamflow data in Connecticut. Figure ES-2 depicts the mean annual flow rates in the Pequabuck River from 1942 and 2006. In the 45.8 square mile watershed of Pequabuck River upstream of this gauge, annual stream flow has increased some 20 cubic feet per second over the 64 year period of record.



The impact of land use on runoff patterns is well documented. As part of this study, the land use regulations of both Burlington and Bristol were reviewed to identify requirements and standards that may be adversely impacting the Coppermine Brook channel. One general observation is that the regulations of the both communities should be updated to reference the 2004 Connecticut Stormwater Quality Manual. In addition, Bristol's regulations do not appear to currently have a floodplain overlay district. The zoning regulations must incorporate reference to requirements of the Federal Emergency Management Agency for development in flood prone areas. This will allow the City to have some control over the type of development that occurs within the mapped floodplains. The MMI report also identified specific stormwater management and "low impact development" standards that may be suitable for use on projects within the Coppermine Brook watershed.

HYDROLOGY OF COPPERMINE BROOK

Flow rates in a river channel are a function of the watershed size, land use characteristics, soil characteristics, vegetation and rainfall patterns. Hydrology is the science of using this information to determine streamflow rates. This streamflow data can then be used in conjunction with information on the river channel characteristics to predict the depth of water flow during various flood events.

As part of this study, the computer modeling program known as the Hydrologic Modeling System HEC-HMS 3.2 was used to estimate flow rates for the various storm events.

Existing Conditions

Table ES-1 presents the predicted channel flow rates at select areas within the watershed.

TABLE ES-1
Results of Existing Conditions Analysis

Description	Predicted Peak Flows (cfs)					
	2-Year	10-Year	25-Year	50-Year	100-Year	500-Year
Downstream of Stevens Street	454	1,382	2,033	2,687	3,388	5,579
Downstream of confluence with Polkville Brook	551	1,499	2,329	2,888	4,071	8,096
Upstream of Frederick Street	656	1,736	2,678	3,360	4,619	9,189
Confluence with Pequabuck River	656	1,737	2,679	3,362	4,606	9,181

The flows computed by MMI for this study are greater than the FEMA flows for the watershed area upstream of Negro Hill Brook, while at the Pequabuck River MMI predicted flow rates that were slightly lower than those used in the FEMA study. The reduction in flows is due to the extensive wetland storage between Stevens Street and Farmington Avenue, which MMI accounted for in the modeling for this study. Flood storage in wetlands and waterbodies serves to attenuate flood flows, allowing for a more controlled release of water downstream.

Potential Future Storage

MMI evaluated three areas in the Coppermine Brook watershed where it may be possible to increase flood storage. The purpose of developing such storage is to reduce the peak flow rates downstream of the storage area during large rainfall events. Generally, such decrease in peak flow translates to a decrease in flood heights. The three areas evaluated included: 1) A wetland area in Nassahegan State Forest in the Negro Hill Brook watershed; 2) a wetland area upstream of Whigville Reservoir; and 3) excavated upland area to increase storage between Stevens Street and Maltby Street. Table ES-2 depicts the results of this analysis assuming that all three storage locations are implemented.

TABLE ES-2
Comparison of Existing and Proposed Conditions Peak Flows – Combined Storage at Three Locations

Storm Frequency	Downstream Negro Hill Brook			Confluence of Pequabuck River		
	Existing	Proposed	% Change	Existing	Proposed	% Change
10	1,606	1,253	-22.0	1,737	1,553	-10.6
25	2,411	1,954	-19.0	2,679	2,376	-11.3
50	3,396	2,562	-24.6	3,362	3,139	-6.6
100	4,380	3,083	-29.6	4,606	3,597	-21.9

Changes in Flow from Watershed Development

In the interest of understanding the potential changes in flow that may occur in Coppermine Brook as development continues in the watershed, the City requested that MMI run the hydrologic model assuming that all property in the watershed is developed to its maximum capacity given the current zoning regulations of Bristol and Burlington. Table ES-3 presents the results of this analysis. Not surprisingly, future development within this watershed has the potential to increase peak flows significantly.

TABLE ES-3
Comparison of Existing and Future Conditions Peak Flows

Storm Frequency	Downstream Negro Hill Brook			Confluence of Pequabuck River		
	Existing	Future	% Change	Existing	Future	% Change
10	1,606	1,897	+18.1	1,737	2,050	+18.0
25	2,411	2,860	+18.6	2,679	3,032	+13.2
50	3,396	3,875	+14.1	3,362	3,639	+8.2
100	4,380	4,865	+11.1	4,606	5,589	+21.3

Future Flows at Watershed Build Out with Proposed Storage

The future build out model was modified to reflect the impact of providing additional storage in the watershed as described previously. Table ES-4 compares future flows with and without increased storage.

TABLE ES-4
Comparison of Future Conditions Peak Flows With and Without Proposed Storage

Storm Frequency	Downstream Negro Hill Brook			Confluence of Pequabuck River		
	Future	Future with Storage	% Change	Future	Future with Storage	% Change
10	1,897	1,482	-22	2,050	1,761	-14
25	2,860	2,213	-23	3,032	2,679	-12
50	3,875	2,778	-28	3,639	3,351	-8
100	4,865	3,355	-31	5,589	3,988	-29

HYDRAULIC ANALYSIS

The term "hydraulic analysis" refers to the computational prediction of the river's water elevations, depths, and velocities for specified water discharge rates. This analysis is used to predict the elevation that floodwaters will reach given different river flows.

Hydraulic analysis is commonly performed using the Army Corps of Engineers (ACOE) HEC-RAS (River Analysis System) software. The FEMA model, upon which the City's Flood Insurance Study is based, was used as the basis for this effort. MMI then verified bridge dimensions and performed field survey of additional cross sections in the channel corridor. Following development of a current existing conditions model, MMI evaluated strategies to alleviate flooding in the flood prone areas along Coppermine Brook.

Stevens Street / Richards Court

The following potential improvements were identified and evaluated at this area:

- Removal of sediment from beneath Stevens Street Bridge.
- Repair of the berm upstream of Stevens Street at its current elevation.
- Replacement of the berm upstream of Stevens Street at an elevation that fully contains the 100-year flood.
- Removal of the berm upstream of Stevens Street and creation of a compound channel.
- Relocation of the berm farther from the channel.
- Combination of modifying channel downstream of Stevens Street, lowering the channel at the bridge, and relocating the berm further from channel

Each of these alternatives was evaluated using the existing conditions HEC-RAS model. Results of each of these are presented as follows. For all alternatives, sealing the existing drain pipe under the earth berm at #72 Richards Court is essential. A flap gate could be used, but a pump station may be the ultimate solution.

Farmington Avenue

Based on input from residents and city staff, the area around Farmington Avenue was identified for evaluation. Farmington Avenue is a state highway with densely developed commercial properties surrounding the bridge. This structure was replaced by the Connecticut Department of Transportation in 2005. The existing conditions hydraulic analysis indicates that Farmington Avenue passes up to a 10-year storm event without overtopping. Under existing conditions, the model predicts that Farmington Avenue overtops by two to four feet for the storm events ranging from a 25-year to 100-year event. This cannot be corrected just by using a longer bridge.

Also affecting flooding in this area is a narrow private bridge that connects the Staples parking lot with the commercial property on the east bank of the river. This structure appears quite old and is narrow when compared to the upstream channel. Compounding the problem in this area is the fact that the channel is narrowing downstream of the large wetland floodplain area that exists at Maltby Road.

Further creating hydraulic restrictions here is the downstream channel. Recall from Section 2.3 that the channel downstream of this bridge is incising, which separates the channel from its floodplain. While incision is part of the natural progression of channel evolution, it does restrict the capacity of the channel.

The following alternatives were evaluated for this area:

- Removal of the Farmington Avenue Bridge.
- Removal of the undersized private bridge.
- Removal of Farmington Avenue and undersized private bridge.

It should be noted that numerous reports were provided by residents and city staff that flooding at Farmington Avenue is not solely the result of these structures. Many reports were provided that indicated water enters Mix Street north of Staples and then flows down Mix Street to the intersection at Farmington Avenue. This condition may occur because the channel constricts from the broad floodplain at the confluence of Polkville Brook to the narrow channel that is observed near Farmington Avenue. This constriction limits the amount of flow in the channel. The elevation of Mix Street is only slightly higher than the floodplain wetland in this area, allowing water to readily enter the street. Correcting this condition cannot be easily accomplished due to floodplain development.

Frederick Street

Frederick Street is located approximately 450 feet upstream of the confluence of Coppermine Brook with Pequabuck River. The existing bridge has a waterway opening width of 33 feet. Concrete parapet walls approximately 3.25 feet higher than the roadway elevation are located on the upstream and downstream face of the crossing. There is a maximum of nine feet of clearance between the channel bed and the low chord of the structure at its upstream face, but part of the waterway is filled with sediment.

Upstream of the bridge Coppermine Brook is contained within an earthen berm on the right bank. On the left bank a vegetated sediment bar has developed and the channel makes two approximately 90 degree bends immediately before entry to the bridge. The earth channel below the Frederick Street crossing is trapezoidal in shape, and appears to have been significantly manipulated over time.

Critical elevations in the vicinity of this crossing are as follows:

- Low point of Frederick Street: 215.31 feet (NDVD 29).
- Roadway elevation at bridge: 217.98 feet (NGVD 29).
- Finished floor elevation at the house located on the right bank upstream of Frederick Street: 219.95 feet (NGVD29)
- Bottom of bridge beam: 214.48 feet (NGVD29)
- Dike Elevation: 217.00 to 217.98 feet (NGVD29)
- Pequabuck River 10-year: 212.20 feet (NGVD29)
- Pequabuck River 50year: 216.00 feet (NGVD29)
- Pequabuck River 100year: 216.40 feet (NGVD29)

The key elevations indicate that the yard at the house located on the right bank upstream of Frederick Street will be flooded from the Pequabuck River if Coppermine Brook was not present. It has been reported that Frederick Street crossing overtops during flood events due to inadequate hydraulic capacity of the bridge. This is the result of both tailwater flooding from the Pequabuck River as well as Coppermine Brook flows. Nuisance flooding occurs with water flowing across Frederick Street at its low point. Flooding has also occurred upstream of bridge, when the channel overtops behind Black Bear Auto and flows through the parking lot of that property and into Frederick Street, re-entering Coppermine Brook downstream of Frederick Street. The houses located on the right bank upstream of the crossing also reportedly experience flooding due to water overtopping the berm that bounds the brook.

The following alternatives were evaluated to relieve flooding at this location:

- Removal of Frederick Street crossing.
- Replacement of Frederick Street crossing with a structure capable of passing the 25-, 50- and 100-year storm events.
- Construction of a high overflow culvert on the right bank through the existing parking lot.
- Construction of a formal compound channel upstream of Frederick Street behind Black Bear Auto.
- Relocation of the channel behind Black Bear Auto to eliminate the meander.

Each of these alternatives was evaluated by modifying the existing conditions HEC-RAS model to reflect proposed changes discussed above. There has been much public comment about the influence of the Pequabuck River on flooding in this reach of Coppermine Brook. In order to more fully understand that influence, MMI performed one model run assuming the Pequabuck River had no influence on Coppermine Brook and compared it to runs that assumed the Pequabuck River had some influence. Based on this we believe that the Pequabuck River has some influence up the Frederick Street crossing, but limited influence upstream of it.

CONCLUSIONS AND RECOMMENDATIONS

The study completed by MMI included a comprehensive evaluation of watershed and stream corridor conditions along Coppermine Brook. The result of the analyses is recommendations that may reduce the severity of flooding in some locations; however, even if these improvements are made the fact remains that a number of issues contribute to the flooding problems that residents have been experiencing. These have been described in detail in the report but are summarized here:

1. Rainfall patterns in the northeast are changing, resulting in increasing streamflows. There has been widespread flooding in central Connecticut in recent years, including 1999, 2005 and 2006. These events were not unique to Coppermine Brook. Federal records also confirm a long term increase in stream flow throughout Connecticut.

2. Historic development has resulted in floodplain encroachment that cannot be easily mitigated. Much of this development pre-dates FEMA's Flood Insurance Program and certainly pre-dates the increasing rainfall patterns and stream flows discussed above.

3. The FEMA study is outdated and based on our analysis some properties should be identified within the floodplain that are currently not. These properties will not be eligible for federal flood insurance unless FEMA approves a floodplain modification.

4. Future land use build-out could theoretically increase peak flows by 10 to 20 percent, if unmitigated.

5. New Britain's Whigville Reservoir does not have any facilities that could be operated so as to suddenly cause a significant increase in stream flow rates. The source of the flood flow that was reported by residents could not be identified with certainty, but it is possible that the failure of weir boards in one or more of the three dams located upstream of Jerome Avenue contributed to this.

6. Some bridges along the channel corridor are undersized resulting in overtopping during some storm events. In some instances this is due to floodplain encroachment as much as it is undersized structures. For example, even if the Farmington Avenue bridge were removed, the roadway would still be flooded. The only solution evaluated that could correct this problem is increasing the size of this structure slightly in conjunction with

widening the channel upstream. Such widening would impact the existing land uses in the floodplain such as Staples.

It is absolutely critical that residents and town officials alike recognize that it will not be possible to stop all flooding of structures along Coppermine Brook. The recommendations herein are expected, however, to decrease the severity and frequency of flooding.

Based on the work completed we recommend the following:

1. **Pursue the construction of watershed storage areas.** The hydrologic analysis indicated that upstream storage could be very effective at reducing downstream flow rates. We recommend that the area identified between Maltby Street and Stevens Street be pursued first. This is because the area appears generally to be upland and state and federal regulators frown on the use of existing wetlands for flood storage. In other words, we think this will be the easiest area to obtain permits for construction. Design and permitting of this basin is expected to be on the order of $50,000 to $75,000 depending on the level of permitting required.

2. **Manage flooding at Richards Court through dike improvements, sealing the existing storm drain through the dike, and channel improvements downstream of Stevens Street Bridge**. The problems at Richards Court are caused by a number of issues. Regardless of the improvements that are made as a result of this study, the fact remains that this neighborhood sits atop what was once mapped as floodplain soils. The issues here are compounded by the fact that much of the improvements suggested are on private property. The exception is the downstream channel improvements, which would occur on property we believe to be owned by the City of New Britain. It is not clear what obligation the City has to repair to former dike, which is located on private property. Design and permitting of this work is expected to be on the order of $70,000 to $100,000 depending on the level of permitting required and the final solution selected for the drainage pipe at 72 Richards Court.

3. **Make improvements near Farmington Avenue.** Flooding at and upstream of Farmington Avenue is occurring because of floodplain construction and development, and high tailwater along the low gradient channel. Bridge improvements alone cannot solve flood hazards, but the combination of removing the private driveway bridge supplemented by channel improvements may provide some benefit. As with the improvements at Richards Court, both of these recommendations involve work on private property. Modification of the Farmington Avenue bridge is not suggested at this time as this is clearly not the responsibility of the City. That being said, once the upstream channel improvements suggested herein are completed, the City may choose to discuss Farmington Avenue with the DOT. Design and permitting of this work is expected to be on the order of $35,000 to $45,000 depending on the level of permitting required.

4. **Make improvements at Frederick Street**. The Frederick Street area is subject to flooding and erosion due to riverine sources, bridge construction, and Pequabuck River

backwater. Bridge and channel improvements could reduce the frequency of flooding, but long term hazards remain. At this point, given the age of this structure the most prudent alternative would be replacement of this bridge. It needs to be clear that this will not fully alleviate flooding at Frederick Street as the nearby residences are within the floodplain. Design and permitting of this work is expected to be on the order of $80,000 to $90,000 depending on the level of permitting required.

Appendix 4-2

Streamstats Printout for Minimum Streamflow Requirements
Coppermine Brook at Polkville Brook Confluence

Lenard Engineering, Inc.

StreamStats Version 3.0

Flow Statistics Ungaged Site Report

Date: Thurs Nov 30, 2017 12:20:37 PM GMT-5
Study Area: Connecticut
NAD 1983 Latitude: 41.6962 (41 41 46)
NAD 1983 Longitude: -72.9139 (-72 54 50)
Drainage Area: 15.6 mi2

Peak Flows Region Grid Basin Characteristics

100% Statewide Multiparameter (15.6 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	15.6	1.69	715
24 Hour 2 Year Precipitation (inches)	3.604	2.95	3.82
24 Hour 10 Year Precipitation (inches)	5.319	4.15	5.53
24 Hour 25 Year Precipitation (inches)	6.648	4.93	7
24 Hour 50 Year Precipitation (inches)	7.871	5.62	8.36
24 Hour 100 Year Precipitation (inches)	9.321	6.41	9.99
Mean Basin Elevation (feet)	601	169	1310

SALMONID SPAWNING Basin Characteristics

100% Duration Flow 2010 5052 (15.6 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	15.6	0.92	150
Mean November Precipitation (inches)	4.5	3.48	4.93
Percent Coarse Stratified Drift (percent)	34	0.1	55.1
Mean Annual Winter Precipitation (inches)	3.9	3.19	4.4
Percent Wetlands (percent)	0.91	0.3	18.1
Mean Basin Elevation (feet)	601	168	1287

OVERWINTER Basin Characteristics

100% Duration Flow 2010 5052 (15.6 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	15.6	0.92	150
Mean November Precipitation (inches)	4.5	3.48	4.93
Percent Coarse Stratified Drift (percent)	34	0.1	55.1
Mean Annual Winter Precipitation (inches)	3.9	3.19	4.4
Percent Wetlands (percent)	0.91	0.3	18.1
Mean Basin Elevation (feet)	601	168	1287

HABITAT FORMING Basin Characteristics

100% Duration Flow 2010 5052 (15.6 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	15.6	0.92	150
Mean November Precipitation (inches)	4.5	3.48	4.93
Percent Coarse Stratified Drift (percent)	34	0.1	55.1
Mean Annual Winter Precipitation (inches)	3.9	3.19	4.4
Percent Wetlands (percent)	0.91	0.3	18.1
Mean Basin Elevation (feet)	601	168	1287

CLUPEID SPAWNING Basin Characteristics

100% Duration Flow 2010 5052 (15.6 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	15.6	0.92	150
Mean November Precipitation (inches)	4.5	3.48	4.93
Percent Coarse Stratified Drift (percent)	34	0.1	55.1
Mean Annual Winter Precipitation (inches)	3.9	3.19	4.4
Percent Wetlands (percent)	0.91	0.3	18.1
Mean Basin Elevation (feet)	601	168	1287

RESIDENT SPAWNING Basin Characteristics

100% Duration Flow 2010 5052 (15.6 mi2)

Parameter	Value	Regression Equation Valid Range	
		Min	Max
Drainage Area (square miles)	15.6	0.92	150
Mean November Precipitation (inches)	4.5	3.48	4.93
Percent Coarse Stratified Drift (percent)	34	0.1	55.1
Mean Annual Winter Precipitation (inches)	3.9	3.19	4.4
Percent Wetlands (percent)	0.91	0.3	18.1

Mean Basin Elevation (feet)	601	168	128

REARING AND GROWTH Basin Characteristics

100% Duration Flow 2010 5052 (15.6 mi2)

Parameter	Value	Regression Equation Valid Range Min	Max
Drainage Area (square miles)	15.6	0.92	150
Mean November Precipitation (inches)	4.5	3.48	4.93
Percent Coarse Stratified Drift (percent)	34	0.1	55.1
Mean Annual Winter Precipitation (inches)	3.9	3.19	4.4
Percent Wetlands (percent)	0.91	0.3	18.1
Mean Basin Elevation (feet)	601	168	1287

Period-of-Record Basin Characteristics

100% Duration Flow 2010 5052 (15.6 mi2)

Parameter	Value	Regression Equation Valid Range Min	Max
Drainage Area (square miles)	15.6	0.92	150
Mean November Precipitation (inches)	4.5	3.48	4.93
Percent Coarse Stratified Drift (percent)	34	0.1	55.1
Mean Annual Winter Precipitation (inches)	3.9	3.19	4.4
Percent Wetlands (percent)	0.91	0.3	18.1
Mean Basin Elevation (feet)	601	168	1287

Peak Flows Region Grid Statistics

Statistic	Value	Unit	Prediction Error (percent)	Equivalent years of record	90-Percent Prediction Interval Min	Max
PK2	636	ft3/s	32	3.5		
PK10	1440	ft3/s	33	8.1		
PK25	1930	ft3/s	34	11		
PK50	2340	ft3/s	36	13		
PK100	2770	ft3/s	38	14		
PK500	3460	ft3/s	45	15		

http://water.usgs.gov/pubs/sir/2004/5160/ (http://water.usgs.gov/pubs/sir/2004/5160/)
Ahearn, E.A., 2004, Regression Equations for Estimating Flood Flows for the 2-, 10-, 25-, 50-, 100-, and 500-Year Recurrence Intervals in Connecticut: U.S. Geological Survey SIR 2004-5160, 62 p.

SALMONID SPAWNING Statistics

Statistic	Value	Unit	Estimation Error (percent)	Equivalent years of record	90-Percent Prediction Interval Min	Max
NOVD25	31.8	ft3/s	21			
NOVD50	17.1	ft3/s	21			
NOVD75	8.53	ft3/s	27			
NOVD90	5.11	ft3/s	36			
NOVD99	2.43	ft3/s	55			

http://pubs.usgs.gov/sir/2010/5052/ (http://pubs.usgs.gov/sir/2010/5052/)
Ahearn, E.A., 2010, Regional regression equations to estimate flow-duration statistics in Connecticut: U. S. Geological Survey Scientific Investigations Report 2010-5052, 45 p.

OVERWINTER Statistics

Statistic	Value	Unit	Estimation Error (percent)	Equivalent years of record	90-Percent Prediction Interval Min	Max
D25 12 02	41	ft3/s	19			
D50 12 02	24.6	ft3/s	21			
D75 12 02	14.9	ft3/s	21			
D95 12 02	6.81	ft3/s	25			
D99 12 02	3.68	ft3/s	28			

http://pubs.usgs.gov/sir/2010/5052/ (http://pubs.usgs.gov/sir/2010/5052/)
Ahearn, E.A., 2010, Regional regression equations to estimate flow-duration statistics in Connecticut: U. S. Geological Survey Scientific Investigations Report 2010-5052, 45 p.

HABITAT FORMING Statistics

Statistic	Value	Unit	Estimation Error (percent)	Equivalent years of record	90-Percent Prediction Interval Min	Max
D25 03 04	66.2	ft3/s	11			
D50 03 04	42.5	ft3/s	11			
D75 03 04	31.6	ft3/s	13			
D95 03 04	19.4	ft3/s	19			
D99 03 04	14.1	ft3/s	21			

http://pubs.usgs.gov/sir/2010/5052/ (http://pubs.usgs.gov/sir/2010/5052/)
Ahearn, E.A., 2010, Regional regression equations to estimate flow-duration statistics in Connecticut: U. S. Geological Survey Scientific Investigations Report 2010-5052, 45 p.

CLUPEID SPAWNING Statistics

Statistic	Value	Unit	Estimation Error (percent)	Equivalent years of record	90-Percent Prediction Interval Min	Max
MAYD25	44.3	ft3/s	15			
MAYD50	31.3	ft3/s	17			

AYD75	22.5	ft3/s	19			
MAYD95	13.8	ft3/s	28			
MAYD99	10.1	ft3/s	37			

http://pubs.usgs.gov/sir/2010/5052/ (http://pubs.usgs.gov/sir/2010/5052/)
Ahearn, E.A., 2010, Regional regression equations to estimate flow-duration statistics in Connecticut: U. S. Geological Survey Scientific Investigations Report 2010-5052, 45 p.

RESIDENT SPAWNING Statistics

Statistic	Value	Unit	Estimation Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
					Min	Max
JUND25	23.1	ft3/s	22			
JUND50	13.5	ft3/s	25			
JUND75	8.35	ft3/s	32			
JUND90	6.96	ft3/s	41			
JUND99	3.74	ft3/s	67			

http://pubs.usgs.gov/sir/2010/5052/ (http://pubs.usgs.gov/sir/2010/5052/)
Ahearn, E.A., 2010, Regional regression equations to estimate flow-duration statistics in Connecticut: U. S. Geological Survey Scientific Investigations Report 2010-5052, 45 p.

REARING AND GROWTH Statistics

Statistic	Value	Unit	Estimation Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
					Min	Max
D25 07 10	12	ft3/s	31			
D50 07 10	6.33	ft3/s	41			
D75 07 10	3.58	ft3/s	54			
D80 07 10	3.12	ft3/s	59			
D99 07 10	0.84	ft3/s	160			

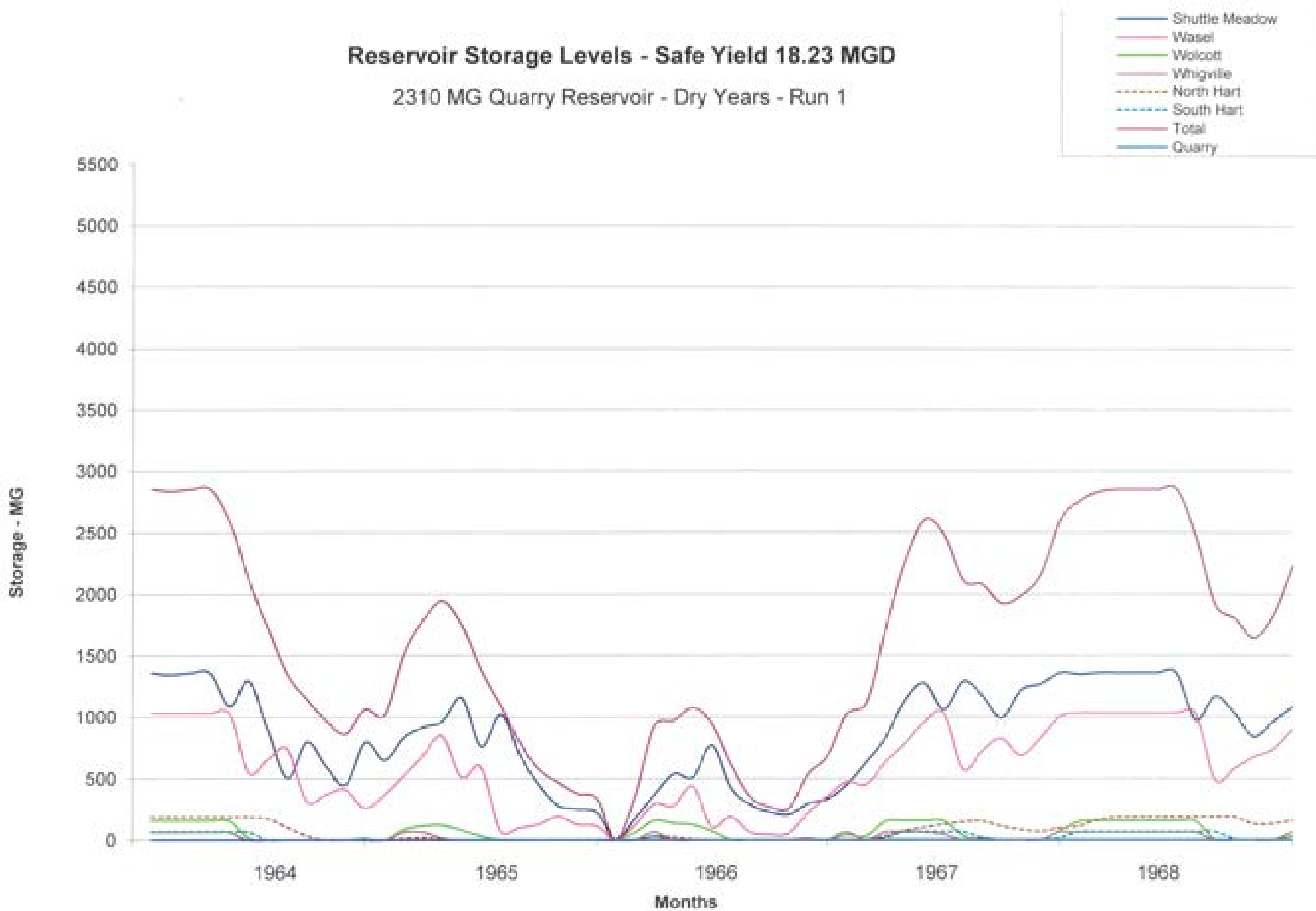
http://pubs.usgs.gov/sir/2010/5052/ (http://pubs.usgs.gov/sir/2010/5052/)
Ahearn, E.A., 2010, Regional regression equations to estimate flow-duration statistics in Connecticut: U. S. Geological Survey Scientific Investigations Report 2010-5052, 45 p.

Period-of-Record Statistics

Statistic	Value	Unit	Estimation Error (percent)	Equivalent years of record	90-Percent Prediction Interval	
					Min	Max
D25	36.5	ft3/s	15			
D99	1.46	ft3/s	110			

http://pubs.usgs.gov/sir/2010/5052/ (http://pubs.usgs.gov/sir/2010/5052/)
Ahearn, E.A., 2010, Regional regression equations to estimate flow-duration statistics in Connecticut: U. S. Geological Survey Scientific Investigations Report 2010-5052, 45 p.

Appendix 4-3.1
Safe Yield Run # 1 Results (18.23 MGD)



Reservoir Storage Levels - Safe Yield 18.23 MGD
2310 MG Quarry Reservoir - Dry Years - Run 1
Shuttle Meadow
Wasel
Wolcott
Whigville
North Hart
South Hart
Total
Quarry
Storage - MG
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1964
1965
1966
1967
1968
Months

DATE: 12/7/17

NEW BRITAIN WATER SUPPLY ROUTING
FILTRATION PLANT
Water Mass Balance for 100% Stream Gage Inflow

SYSTEM SAFE YIELD 18.23 MGD

PERIOD		INFLOW, MGD								REQUIRED OUTFLOW, MGD	
		DIVERSIONS (Note 2)								WATER SUPPLY DRAFT	
YEAR	MONTH	WHIGVILLE	WASEL	SHUTTLE MEAD	WB POND	WB WELLS	NEPAUG	QUARRY	TOTAL	VARIATION %	DRAFT
										See Note 1	18.23
	JAN	0.00	0.00	3.74	10.00	3.91	0.00	0.00	17.65	97	17.65
	FEB	3.59	0.35	2.75	6.48	2.92	0.00	0.00	16.08	88	16.08
	MAR	0.00	0.00	3.37	10.00	3.91	0.00	0.00	17.27	95	17.27
	APR	0.00	0.00	3.74	10.00	3.91	0.00	0.00	17.65	97	17.65
	MAY	2.82	0.00	9.32	4.69	2.63	0.00	0.00	19.46	107	19.46
1964	JUN	1.28	15.96	0.00	0.89	2.02	0.00	0.00	20.15	111	20.15
	JUL	0.00	0.00	18.57	0.00	1.81	0.00	0.00	20.38	112	20.38
	AUG	0.00	0.00	18.46	0.00	1.74	0.00	0.00	20.21	111	20.21
	SEP	0.00	16.67	0.00	0.00	1.74	0.00	0.00	18.41	101	18.41
	OCT	0.00	0.00	16.17	0.00	1.74	0.00	0.00	17.91	98	17.91
	NOV	0.00	0.00	14.90	0.00	1.80	0.00	0.00	16.70	92	16.70
	DEC	0.82	9.44	0.00	4.09	2.53	0.00	0.00	16.89	93	16.89
	JAN	0.02	0.00	13.26	2.15	2.22	0.00	0.00	17.65	97	17.65
	FEB	2.45	0.00	0.00	10.00	3.63	0.00	0.00	16.08	88	16.08
	MAR	2.73	0.00	0.77	10.00	3.77	0.00	0.00	17.27	95	17.27
	APR	4.09	0.00	2.71	7.73	3.12	0.00	0.00	17.65	97	17.65
	MAY	0.47	14.16	0.00	2.55	2.29	0.00	0.00	19.46	107	19.46
1965	JUN	0.00	0.00	18.30	0.00	1.85	0.00	0.00	20.15	111	20.15
	JUL	0.00	18.64	0.00	0.00	1.74	0.00	0.00	20.38	112	20.38
	AUG	0.00	0.00	18.46	0.00	1.74	0.00	0.00	20.21	111	20.21
	SEP	0.00	0.00	16.67	0.00	1.74	0.00	0.00	18.41	101	18.41
	OCT	0.37	0.00	15.49	0.15	1.90	0.00	0.00	17.91	98	17.91
	NOV	1.08	3.70	10.07	0.00	1.85	0.00	0.00	16.70	92	16.70
	DEC	1.70	2.51	9.17	1.41	2.10	0.00	0.00	16.89	93	16.89
	JAN	1.28	5.66	8.43	0.36	1.93	0.00	0.00	17.65	97	17.65
	FEB	3.18	0.90	4.26	5.05	2.69	0.00	0.00	16.08	88	16.08
	MAR	2.59	0.00	0.77	10.00	3.91	0.00	0.00	17.27	95	17.27
	APR	3.34	5.54	0.00	5.93	2.83	0.00	0.00	17.65	97	17.65
	MAY	2.10	0.00	7.03	7.28	3.05	0.00	0.00	19.46	107	19.46
1966	JUN	0.62	14.49	0.00	2.73	2.31	0.00	0.00	20.15	111	20.15
	JUL	0.00	0.00	18.64	0.00	1.74	0.00	0.00	20.38	112	20.38
	AUG	0.50	4.65	13.31	0.00	1.74	0.00	0.00	20.21	111	20.21
	SEP	1.65	3.20	10.37	1.14	2.06	0.00	0.00	18.41	101	18.41
	OCT	2.23	2.35	8.34	2.68	2.31	0.00	0.00	17.91	98	17.91
	NOV	2.69	0.00	1.84	8.87	3.30	0.00	0.00	16.70	92	16.70
	DEC	1.36	0.00	7.99	4.88	2.66	0.00	0.00	16.89	93	16.89
	JAN	3.14	1.18	0.00	9.87	3.46	0.00	0.00	17.65	97	17.65
	FEB	3.06	5.06	0.00	5.24	2.72	0.00	0.00	16.08	88	16.08
	MAR	2.59	0.00	0.77	10.00	3.91	0.00	0.00	17.27	95	17.27
	APR	2.59	1.15	0.00	10.00	3.91	0.00	0.00	17.65	97	17.65
	MAY	2.59	0.00	2.96	10.00	3.91	0.00	0.00	19.46	107	19.46
1967	JUN	2.85	0.00	9.93	4.74	2.64	0.00	0.00	20.15	111	20.15
	JUL	1.28	14.68	0.00	2.19	2.23	0.00	0.00	20.38	112	20.38
	AUG	1.12	0.00	11.62	4.81	2.65	0.00	0.00	20.21	111	20.21
	SEP	0.00	0.00	15.23	1.13	2.06	0.00	0.00	18.41	101	18.41
	OCT	1.47	7.93	0.00	5.72	2.79	0.00	0.00	17.91	98	17.91
	NOV	1.95	0.00	4.68	7.06	3.01	0.00	0.00	16.70	92	16.70
	DEC	0.36	0.00	2.62	10.00	3.91	0.00	0.00	16.89	93	16.89
	JAN	3.83	0.00	3.71	7.09	3.01	0.00	0.00	17.65	97	17.65
	FEB	2.52	0.21	2.53	7.70	3.11	0.00	0.00	16.08	88	16.08
	MAR	0.00	0.00	3.37	10.00	3.91	0.00	0.00	17.27	95	17.27
	APR	0.40	0.34	3.19	10.00	3.72	0.00	0.00	17.65	97	17.65
	MAY	1.57	0.41	3.57	10.00	3.91	0.00	0.00	19.46	107	19.46
1968	JUN	0.61	0.54	5.09	10.00	3.91	0.00	0.00	20.15	111	20.15
	JUL	2.23	0.00	12.47	3.27	2.40	0.00	0.00	20.38	112	20.38
	AUG	0.91	17.43	0.00	0.00	1.87	0.00	0.00	20.21	111	20.21
	SEP	0.05	0.00	13.78	2.33	2.25	0.00	0.00	18.41	101	18.41
	OCT	0.00	0.00	15.62	0.36	1.93	0.00	0.00	17.91	98	17.91
	NOV	2.55	2.42	0.00	8.49	3.24	0.00	0.00	16.70	92	16.70
	DEC	2.59	0.39	0.00	10.00	3.91	0.00	0.00	16.89	93	16.89

Notes

1. Variation in water supply draft is based on weighted monthly demand values from 1995-2000 New Britain Water Dept records.
2. All these inflows to the Filter Plant,in reality, flow through Shuttle Meadow. (They are presented this way as a convenient math construct)

DATE: 12/7/17 TOTAL DRAINAGE AREA: 0.00 SQ MI
RESERVOIR: QUARRY EFFECTIVE DRAINAGE AREA (Note 6): 0.00 SQ MI =K1-AM77/640
WATERSHED: QUARRY MIN REQ. DOWNSTREAM FLOW: 0 MGD

NEW BRITAIN WATER SUPPLY ROUTING
QUARRY RESERVOIR
Water Mass Balance for 100% Stream Gage Inflow

Pump Rate(MGD): 0
%SM: 50
SYSTEM SAFE YIELD: 18.23 MGD
MINIMUM STORAGE (Note 7): 0.01 MG
PERCENT OF CAPACITY: #DIV/0! (WATER REMAINING)

PERIOD: YEAR	PERIOD: MONTH	INFLOW MGD: STREAM FLOW AVG (CFS)	INFLOW MGD: STREAM FLOW INFLOW	INFLOW MGD: DIRECT PRECIPITATION RAIN ("/MO)	INFLOW MGD: DIRECT PRECIPITATION DAILY VOL	INFLOW MGD: NATURAL TOTAL	INFLOW MGD: DIVERSION WB	INFLOW MGD: DIVERSION	INFLOW MGD: DIVERSION	INFLOW MGD: DIVERSION TOTAL	INFLOW MGD: NET INFLOW	TOTAL MONTHLY INFLOW MG	OUTFLOW MGD: NATURAL OUTFLOW STREAMFLOW OUT(MIN)	OUTFLOW MGD: NATURAL OUTFLOW STREAMFLOW LEAKAGE	OUTFLOW MGD: NATURAL OUTFLOW EVAPORATION RATE ("/MO)	OUTFLOW MGD: NATURAL OUTFLOW EVAPORATION DAILY VOL	OUTFLOW MGD: NATURAL LOSS TOTAL	OUTFLOW MGD: DIVERSION OUT TO SM	OUTFLOW MGD: DIVERSION OUT TO FLT PLANT	OUTFLOW MGD: DIVERSION OUT TOTAL	OUTFLOW MGD: NET OUTFLOW	TOTAL MONTHLY OUTFLOW MG	RESERVOIR STATUS (MONTH END): STAGE FT	RESERVOIR STATUS (MONTH END): SURFACE AREA AC (Note 8)	RESERVOIR STATUS (MONTH END): TOTAL STORAGE MG (Note 8)	WATER MANAGEMENT: DIVERSION OUT MGD	WATER MANAGEMENT: STORAGE MGD	WATER MANAGEMENT: OVER SPILLWAY MGD	WATER MANAGEMENT: MONTH-END AVAIL STORAGE MG
INITIAL STATUS		Note 1		Note 2										Note 4	Note 3								0.0	0.00 0.00	0.00 0.0				
	JAN	0.00	0.00	4.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	FEB	0.00	0.00	3.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAR	0.00	0.00	2.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	APR	0.00	0.00	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAY	0.00	0.00	1.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	4.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
1964	JUN	0.00	0.00	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JUL	0.00	0.00	3.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	AUG	0.00	0.00	3.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	SEP	0.00	0.00	2.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	OCT	0.00	0.00	1.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	NOV	0.00	0.00	2.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	DEC	0.00	0.00	4.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JAN	0.00	0.00	3.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	FEB	0.00	0.00	4.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAR	0.00	0.00	1.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	APR	0.00	0.00	2.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAY	0.00	0.00	1.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	4.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
1965	JUN	0.00	0.00	1.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JUL	0.00	0.00	4.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	AUG	0.00	0.00	2.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	SEP	0.00	0.00	2.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	OCT	0.00	0.00	3.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	NOV	0.00	0.00	2.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	DEC	0.00	0.00	1.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JAN	0.00	0.00	2.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	FEB	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAR	0.00	0.00	3.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	APR	0.00	0.00	1.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAY	0.00	0.00	3.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	4.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
1966	JUN	0.00	0.00	1.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JUL	0.00	0.00	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	AUG	0.00	0.00	1.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	SEP	0.00	0.00	6.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	OCT	0.00	0.00	4.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	NOV	0.00	0.00	4.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	DEC	0.00	0.00	3.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JAN	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	FEB	0.00	0.00	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAR	0.00	0.00	5.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	APR	0.00	0.00	4.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAY	0.00	0.00	6.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	4.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
1967	JUN	0.00	0.00	2.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JUL	0.00	0.00	2.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	AUG	0.00	0.00	4.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	SEP	0.00	0.00	2.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	OCT	0.00	0.00	3.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	NOV	0.00	0.00	2.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	DEC	0.00	0.00	6.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JAN	0.00	0.00	2.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	FEB	0.00	0.00	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAR	0.00	0.00	5.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	APR	0.00	0.00	3.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAY	0.00	0.00	5.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	4.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
1968	JUN	0.00	0.00	6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JUL	0.00	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	AUG	0.00	0.00	2.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	SEP	0.00	0.00	3.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	OCT	0.00	0.00	2.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	NOV	0.00	0.00	6.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	DEC	0.00	0.00	6.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46

NOTES:
1. Based on gage data in cfs per sq mile for the Safford Brook watershed.
2. Rainfall data from the Shuttle Meadow rain gage during 1964-1968 period.
3. Evaporation is based on standard monthly values. Reservoir yield analysis, CT DOH, Jan 1989.
4. Leakage from the quarry is assumed to be zero.
5. Variation in water supply draft is based on weighted monthly demand values from 1995-2000 New Britain Water Dept records.
6. Effective drainage area = Total watershed area - reservoir surface area.
7. Minimum available storage above the water supply invert during the critical drought month.
8. First entry is the max value for the quarry. The second is the starting value.

DATE 12/7/2017

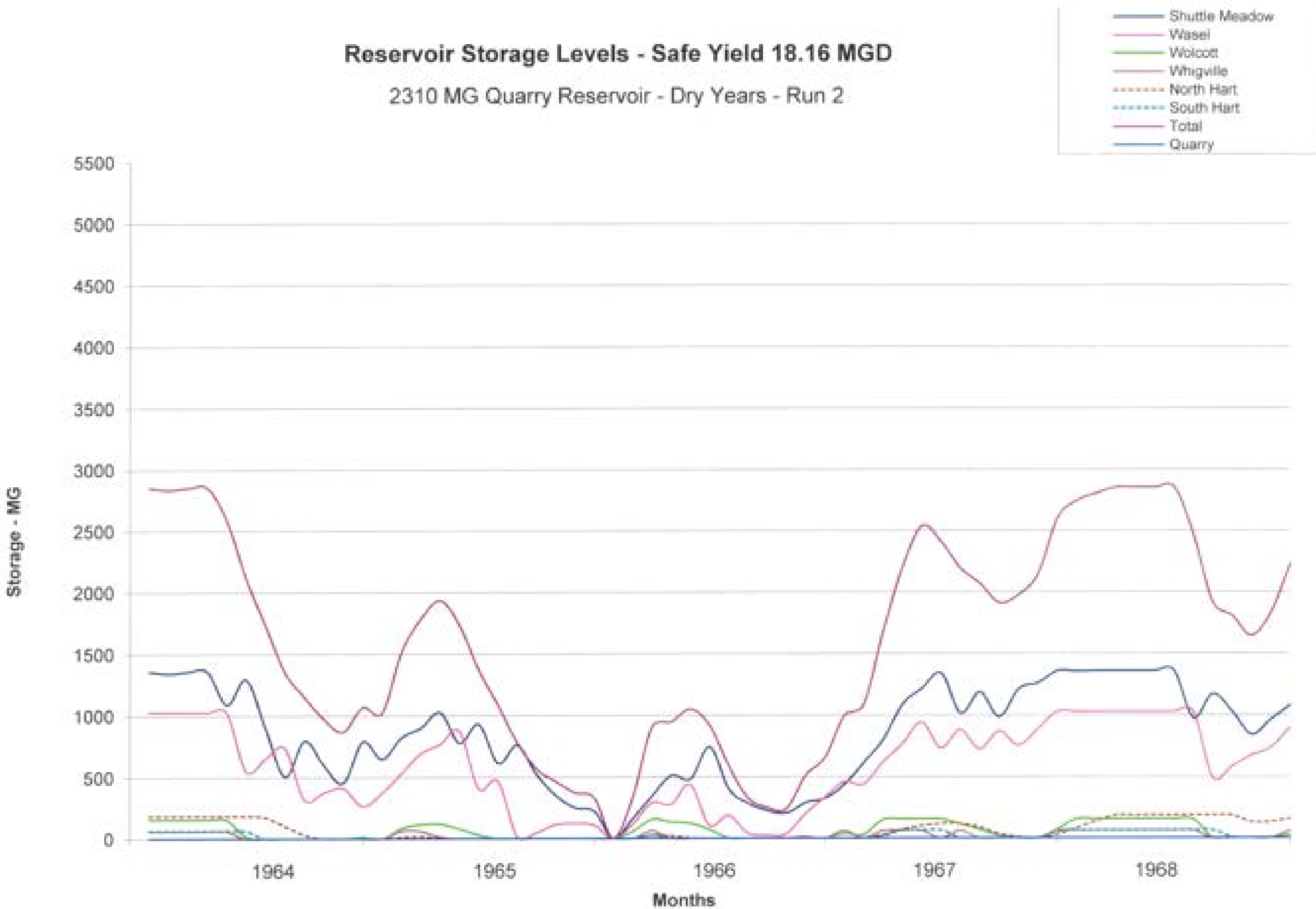
NEW BRITAIN WATER SUPPLY RESERVOIR ROUTING
SYSTEM SUMMARY
Water Mass Balance for 100% Stream Gage Inflow

PERIOD		RESERVOIRS																							
		SHUTTLE MEADOW			WASEL				WOLCOTT			WHIGVILLE			NORTH HART POND			SOUTH HART POND			QUARRY				TOTAL
YEAR	MONTH	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	Loss4 MG	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STORAGE w/o QUARRY MG	STORAGE MG
INITIAL STATUS			1359.9			1030.4				154.6			61.6			186.7			63.0			0.0		2856.1	2856.1
	JAN	25.6	1359.9	3.63	72.0	1030.4	0.81	0.00	21.8	154.6	5.7	31.0	61.6	6.3	11.3	186.7	3.3	6.5	63.0	2.5	0.0	0.0	0.0	2856.1	2856.1
	FEB	25.3	1345.0	0.00	71.8	1030.4	0.00	0.00	21.8	154.6	1.9	30.9	61.6	0.0	11.3	186.7	1.9	6.5	63.0	1.5	0.0	0.0	0.0	2841.2	2841.2
	MAR	25.6	1359.9	2.83	72.0	1030.4	0.56	0.00	21.8	154.6	5.6	31.0	61.6	9.5	11.3	186.7	4.5	6.5	63.0	3.7	0.0	0.0	0.0	2856.1	2856.1
	APR	25.6	1359.9	3.38	72.0	1030.4	0.71	0.00	21.8	154.6	5.7	31.0	61.6	8.3	11.3	186.7	4.1	6.5	63.0	3.3	0.0	0.0	0.0	2856.1	2856.1
	MAY	21.3	1090.9	0.00	72.0	1030.4	0.00	0.00	21.8	154.6	0.7	31.0	61.6	0.0	11.3	186.7	1.1	6.5	63.0	1.0	0.0	0.0	0.0	2587.1	2587.1
1964	JUN	24.5	1294.2	0.00	56.3	551.7	0.00	0.00	10.1	17.8	0.0	0.0	0.0	0.0	11.3	186.7	0.4	6.5	63.0	0.5	0.0	0.0	0.0	2113.4	2113.4
	JUL	18.0	896.7	0.00	60.0	655.5	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	10.8	176.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1728.7	1728.7
	AUG	10.9	505.0	0.00	62.8	738.3	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	7.5	104.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1347.4	1347.4
	SEP	16.3	794.6	0.00	45.3	317.7	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	3.6	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1145.6	1145.6
	OCT	12.7	594.5	0.00	48.3	372.4	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	967.0	967.0
	NOV	9.8	450.3	0.00	50.3	412.1	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	862.5	862.5
	DEC	16.3	791.6	0.00	42.3	262.4	0.00	0.00	8.8	11.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1065.4	1065.5
	JAN	13.7	650.4	0.00	48.0	367.9	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1018.4	1018.4
	FEB	16.9	833.3	0.00	55.3	528.8	0.00	0.00	17.2	82.5	0.0	31.0	61.6	0.5	2.1	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1519.2	1519.2
	MAR	18.3	916.3	0.00	61.3	689.7	0.00	0.00	19.2	111.7	0.0	31.0	61.6	3.0	2.6	18.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1798.0	1798.0
	APR	19.2	964.4	0.00	66.3	845.1	0.00	0.00	19.6	117.7	0.0	14.4	14.7	0.0	1.3	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1947.3	1947.4
	MAY	22.3	1157.6	0.00	54.8	513.4	0.00	0.00	16.8	78.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1749.4	1749.4
1965	JUN	15.6	758.1	0.00	57.8	596.1	0.00	0.00	11.8	28.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1383.1	1383.1
	JUL	20.1	1020.0	0.00	27.3	75.1	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1095.1	1095.1
	AUG	14.4	692.9	0.00	31.0	99.9	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	792.8	792.8
	SEP	9.9	452.4	0.00	33.3	127.4	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	579.8	579.8
	OCT	6.4	279.8	0.00	37.8	191.6	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	471.4	471.4
	NOV	5.8	251.5	0.00	33.3	126.9	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	378.4	378.4
	DEC	5.3	223.0	0.00	32.3	114.2	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	337.2	337.2
	JAN	0.0	0.0	0.00	7.0	4.3	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	4.3
	FEB	4.1	172.0	0.00	32.5	116.9	0.00	0.00	14.9	56.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	345.4	345.4
	MAR	8.3	367.9	0.00	44.0	293.0	0.00	0.00	21.8	154.6	0.9	31.0	61.6	4.2	3.3	28.3	0.0	3.7	24.8	0.0	0.0	0.0	0.0	930.2	930.2
	APR	11.6	538.5	0.00	43.0	277.7	0.00	0.00	20.5	133.4	0.0	0.0	0.0	0.0	2.8	22.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	972.1	972.1
	MAY	11.1	511.8	0.00	51.3	438.1	0.00	0.00	19.8	122.0	0.0	0.0	0.0	0.0	1.3	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1078.1	1078.1
1966	JUN	15.8	768.6	0.00	31.5	106.0	0.00	0.00	16.2	69.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	944.4	944.4
	JUL	9.3	422.3	0.00	37.8	189.2	0.00	0.00	5.8	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	613.6	613.7
	AUG	6.6	286.8	0.00	24.5	62.2	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	349.1	349.1
	SEP	5.3	226.1	0.00	19.8	42.3	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	268.4	268.5
	OCT	4.8	206.7	0.00	22.0	51.8	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	258.4	258.4
	NOV	6.8	294.2	0.00	39.5	215.8	0.00	0.00	8.9	11.9	0.0	13.2	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	534.4	534.4
	DEC	7.5	330.4	0.00	47.0	350.3	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	680.8	680.8
	JAN	9.9	451.0	0.00	53.0	473.1	0.00	0.00	13.2	39.3	0.0	30.8	60.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1024.2	1024.2
	FEB	13.3	634.5	0.00	52.0	452.9	0.00	0.00	11.8	28.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1116.2	1116.2
	MAR	16.9	831.2	0.00	59.3	632.9	0.00	0.00	21.4	149.3	0.0	31.0	61.6	3.2	3.4	30.0	0.0	2.8	15.6	0.0	0.0	0.0	0.0	1720.6	1720.6
	APR	22.0	1134.7	0.00	64.0	776.7	0.00	0.00	21.8	154.6	6.7	31.0	61.6	8.8	5.8	72.3	0.0	6.5	63.0	0.3	0.0	0.0	0.0	2262.8	2262.8
	MAY	24.3	1275.9	0.00	69.8	953.0	0.00	0.00	21.8	154.6	4.5	31.0	61.6	4.5	7.3	101.3	0.0	6.5	63.0	0.2	0.0	0.0	0.0	2609.4	2609.4
1967	JUN	20.8	1062.1	0.00	72.0	1030.4	0.00	0.00	21.8	154.6	0.1	26.1	44.4	0.0	8.6	126.3	0.0	6.5	63.0	0.7	0.0	0.0	0.0	2480.8	2480.8
	JUL	24.5	1291.4	0.00	57.0	575.4	0.00	0.00	12.4	33.6	0.0	0.0	0.0	0.0	9.5	146.3	0.0	6.5	63.0	0.6	0.0	0.0	0.0	2109.7	2109.7
	AUG	22.7	1176.0	0.00	62.3	719.9	0.00	0.00	0.0	0.0	0.0	14.8	15.3	0.0	9.8	153.0	0.0	2.9	16.7	0.0	0.0	0.0	0.0	2081.0	2081.0
	SEP	19.7	991.9	0.00	65.5	822.5	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	7.8	112.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1926.7	1926.7
	OCT	23.3	1219.5	0.00	61.0	687.4	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	6.5	85.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1992.2	1992.2
	NOV	24.2	1270.8	0.00	65.8	825.7	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	5.6	67.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2164.5	2164.5
	DEC	25.6	1359.9	2.23	71.0	1003.0	0.00	0.00	16.3	72.0	0.0	31.0	61.6	5.3	7.2	97.3	0.0	2.8	15.6	0.0	0.0	0.0	0.0	2609.4	2609.4
	JAN	25.3	1347.5	0.00	72.0	1030.4	0.00	0.00	21.3	147.2	0.0	31.0	61.6	0.0	7.8	111.7	0.0	6.5	63.0	0.0	0.0	0.0	0.0	2761.4	2761.4
	FEB	25.6	1359.9	0.00	71.8	1030.4	0.00	0.00	21.8	154.6	2.5	31.0	61.6	1.5	10.3	166.8	0.0	6.5	63.0	1.6	0.0	0.0	0.0	2836.2	2836.2
	MAR	25.6	1359.9	9.52	72.0	1030.4	1.22	0.00	21.8	154.6	10.5	31.0	61.6	11.8	11.3	186.7	5.1	6.5	63.0	4.6	0.0	0.0	0.0	2856.1	2856.1
	APR	25.6	1359.9	0.00	72.0	1030.4	0.00	0.00	21.8	154.6	2.8	31.0	61.6	5.2	11.3	186.7	2.7	6.5	63.0	2.2	0.0	0.0	0.0	2856.1	2856.1
	MAY	25.5	1359.9	0.00	71.8	1030.4	0.00	0.00	21.8	154.6	3.2	31.0	61.6	7.8	11.3	186.7	4.5	6.5	63.0	3.6	0.0	0.0	0.0	2856.1	2856.1
1968	JUN	25.5	1359.9	0.00	71.8	1030.4	0.00	0.00	21.8	154.6	4.5	31.0	61.6	7.2	11.3	186.7	3.8	6.5	63.0	3.1	0.0	0.0	0.0	2856.1	2856.1
	JUL	19.3	973.2	0.00	71.8	1030.4	0.00	0.00	21.6	151.7	0.0	30.9	61.6	0.0	11.3	186.7	0.6	6.5	63.0	0.7	0.0	0.0	0.0	2466.6	2466.6
	AUG	22.5	1168.6	0.00	53.8	490.2	0.00	0.00	6.5	3.5	0.0	0.0	0.0	0.0	11.3	186.7	0.2	6.5	63.0	0.3	0.0	0.0	0.0	1911.9	1912.0
	SEP	20.3	1026.7	0.00	57.3	583.1	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	11.3	186.7	0.2	2.0	7.9	0.0	0.0	0.0	0.0	1804.5	1804.5
	OCT	17.0	836.5	0.00	60.5	672.8	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	8.8	131.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1641.2	1641.2
	NOV	19.1	960.0	0.00	62.8	733.6	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	8.8	133.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1827.0	1827.0
	DEC	21.2	1083.0	0.00	67.8	894.4	0.00	0.00	11.8	29.2	0.0	31.0	61.6	1.9	10.0	158.9	0.0	0.8	1.8	0.0	0.0	0.0	0.0	2228.9	2228.9

Appendix 4-3.2

Safe Yield Run # 2 Results (18.16 MGD)

Lenard Engineering, Inc.



Reservoir Storage Levels - Safe Yield 18.16 MGD
2310 MG Quarry Reservoir - Dry Years - Run 2
Shuttle Meadow
Wasel
Wolcott
Whigville
North Hart
South Hart
Total
Quarry
Storage - MG
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1964
1965
1966
1967
1968
Months

DATE: 12/7/17

SYSTEM SAFE YIELD 18.16 MGD

NEW BRITAIN WATER SUPPLY ROUTING
FILTRATION PLANT
Water Mass Balance for 100% Stream Gage Inflow

PERIOD		INFLOW, MGD								REQUIRED OUTFLOW, MGD	
		DIVERSIONS (Note 2)								WATER SUPPLY DRAFT	
YEAR	MONTH	WHIGVILLE	WASEL	SHUTTLE MEAD	WB POND	WB WELLS	NEPAUG	QUARRY	TOTAL	VARIATION %	DRAFT
										See Note 1	18.16
	JAN	0.00	0.00	3.68	10.00	3.91	0.00	0.00	17.58	97	17.58
	FEB	3.59	0.35	2.69	6.48	2.92	0.00	0.00	16.02	88	16.02
	MAR	0.00	0.00	3.30	10.00	3.91	0.00	0.00	17.21	95	17.21
	APR	0.00	0.00	3.68	10.00	3.91	0.00	0.00	17.58	97	17.58
	MAY	2.82	0.00	9.25	4.69	2.63	0.00	0.00	19.39	107	19.39
1964	JUN	1.28	15.88	0.00	0.89	2.02	0.00	0.00	20.07	111	20.07
	JUL	0.00	0.00	18.49	0.00	1.81	0.00	0.00	20.30	112	20.30
	AUG	0.00	0.00	18.39	0.00	1.74	0.00	0.00	20.13	111	20.13
	SEP	0.00	16.60	0.00	0.00	1.74	0.00	0.00	18.34	101	18.34
	OCT	0.00	0.00	16.10	0.00	1.74	0.00	0.00	17.84	98	17.84
	NOV	0.00	0.00	14.84	0.00	1.80	0.00	0.00	16.64	92	16.64
	DEC	0.82	9.38	0.00	4.09	2.53	0.00	0.00	16.82	93	16.82
	JAN	0.02	0.00	13.19	2.15	2.22	0.00	0.00	17.58	97	17.58
	FEB	2.39	0.00	0.00	10.00	3.63	0.00	0.00	16.02	88	16.02
	MAR	2.73	0.00	0.71	10.00	3.77	0.00	0.00	17.21	95	17.21
	APR	4.09	2.65	0.00	7.73	3.12	0.00	0.00	17.58	97	17.58
	MAY	0.47	0.00	14.08	2.55	2.29	0.00	0.00	19.39	107	19.39
1965	JUN	0.00	18.23	0.00	0.00	1.85	0.00	0.00	20.07	111	20.07
	JUL	0.00	0.00	18.56	0.00	1.74	0.00	0.00	20.30	112	20.30
	AUG	0.44	15.14	2.81	0.00	1.74	0.00	0.00	20.13	111	20.13
	SEP	0.00	0.00	16.60	0.00	1.74	0.00	0.00	18.34	101	18.34
	OCT	0.00	0.00	15.80	0.15	1.90	0.00	0.00	17.84	98	17.84
	NOV	1.08	1.26	12.44	0.00	1.85	0.00	0.00	16.64	92	16.64
	DEC	1.70	2.50	9.11	1.41	2.10	0.00	0.00	16.82	93	16.82
	JAN	1.28	5.65	8.37	0.36	1.93	0.00	0.00	17.58	97	17.58
	FEB	3.18	0.83	4.26	5.05	2.69	0.00	0.00	16.02	88	16.02
	MAR	2.59	0.00	0.71	10.00	3.91	0.00	0.00	17.21	95	17.21
	APR	3.34	5.48	0.00	5.93	2.83	0.00	0.00	17.58	97	17.58
	MAY	2.10	0.00	6.90	7.28	3.05	0.00	0.00	19.39	107	19.39
1966	JUN	0.48	14.55	0.00	2.73	2.31	0.00	0.00	20.07	111	20.07
	JUL	0.00	0.00	18.56	0.00	1.74	0.00	0.00	20.30	112	20.30
	AUG	0.50	5.25	12.64	0.00	1.74	0.00	0.00	20.13	111	20.13
	SEP	1.65	3.14	10.35	1.14	2.06	0.00	0.00	18.34	101	18.34
	OCT	2.23	2.33	8.29	2.68	2.31	0.00	0.00	17.84	98	17.84
	NOV	2.69	0.00	1.78	8.87	3.30	0.00	0.00	16.64	92	16.64
	DEC	1.36	0.00	7.92	4.88	2.66	0.00	0.00	16.82	93	16.82
	JAN	3.14	1.11	0.00	9.87	3.46	0.00	0.00	17.58	97	17.58
	FEB	3.06	5.00	0.00	5.24	2.72	0.00	0.00	16.02	88	16.02
	MAR	2.59	0.00	0.71	10.00	3.91	0.00	0.00	17.21	95	17.21
	APR	2.59	1.08	0.00	10.00	3.91	0.00	0.00	17.58	97	17.58
	MAY	2.59	0.00	2.89	10.00	3.91	0.00	0.00	19.39	107	19.39
1967	JUN	2.85	9.85	0.00	4.74	2.64	0.00	0.00	20.07	111	20.07
	JUL	0.06	0.00	15.82	2.19	2.23	0.00	0.00	20.30	112	20.30
	AUG	2.84	9.83	0.00	4.81	2.65	0.00	0.00	20.13	111	20.13
	SEP	0.00	0.00	15.16	1.13	2.06	0.00	0.00	18.34	101	18.34
	OCT	1.47	7.86	0.00	5.72	2.79	0.00	0.00	17.84	98	17.84
	NOV	1.95	0.00	4.61	7.06	3.01	0.00	0.00	16.64	92	16.64
	DEC	0.90	0.00	2.02	10.00	3.91	0.00	0.00	16.82	93	16.82
	JAN	3.83	0.39	3.26	7.09	3.01	0.00	0.00	17.58	97	17.58
	FEB	2.39	0.21	2.60	7.70	3.11	0.00	0.00	16.02	88	16.02
	MAR	0.00	0.00	3.30	10.00	3.91	0.00	0.00	17.21	95	17.21
	APR	0.53	0.34	2.99	10.00	3.72	0.00	0.00	17.58	97	17.58
	MAY	1.72	0.41	3.35	10.00	3.91	0.00	0.00	19.39	107	19.39
1968	JUN	0.86	0.54	4.76	10.00	3.91	0.00	0.00	20.07	111	20.07
	JUL	2.23	0.00	12.40	3.27	2.40	0.00	0.00	20.30	112	20.30
	AUG	0.91	17.35	0.00	0.00	1.87	0.00	0.00	20.13	111	20.13
	SEP	0.05	0.00	13.71	2.33	2.25	0.00	0.00	18.34	101	18.34
	OCT	0.00	0.00	15.55	0.36	1.93	0.00	0.00	17.84	98	17.84
	NOV	2.55	2.36	0.00	8.49	3.24	0.00	0.00	16.64	92	16.64
	DEC	2.59	0.32	0.00	10.00	3.91	0.00	0.00	16.82	93	16.82

Notes

1. Variation in water supply draft is based on weighted monthly demand values from 1995-2000 New Britain Water Dept records.
2. All these inflows to the Filter Plant in reality, flow through Shuttle Meadow. (They are presented this way as a convenient math construct)

DATE: 12/7/17 RESERVOIR: QUARRY WATERSHED: QUARRY

TOTAL DRAINAGE AREA 0.00 SQ MI
EFFECTIVE DRAINAGE AREA (Note 6) 0.00 SQ MI =K1-AM77840
MIN REQ. DOWNSTREAM FLOW 0 MGD

NEW BRITAIN WATER SUPPLY ROUTING
QUARRY RESERVOIR
Water Mass Balance for 100% Stream Gage Inflow

Pump Rate(MGD) 0
NSM 50

SYSTEM SAFE YIELD 18.16 MGD
MINIMUM STORAGE (Note 7) 0.01 MG
PERCENT OF CAPACITY #DIV/0! (WATER REMAINING)

PERIOD YEAR	PERIOD MONTH	INFLOW MGD: STREAM FLOW AVG (CFS)	STREAM FLOW INFLOW	DIRECT PRECIPITATION RAIN ("/MO)	DIRECT PRECIPITATION DAILY VOL	NATURAL TOTAL	DIVERSION WB	DIVERSION	DIVERSION	DIVERSION TOTAL	NET INFLOW	TOTAL MONTHLY INFLOW MG	OUTFLOW MGD: NATURAL OUTFLOW STREAMFLOW OUT(MIN)	STREAMFLOW LEAKAGE	EVAPORATION RATE ("/MO)	EVAPORATION DAILY VOL	NATURAL LOSS TOTAL	DIVERSION OUT TO SM	DIVERSION OUT TO FLT PLANT	DIVERSION OUT TOTAL	NET OUTFLOW	TOTAL MONTHLY OUTFLOW MG	RESERVOIR STATUS (MONTH END) STAGE FT	SURFACE AREA AC (Note 8)	TOTAL STORAGE MG (Note 8)	WATER MANAGEMENT DIVERSION OUT MGD	STORAGE MGD	OVER SPILLWAY MGD	MONTH-END AVAIL STORAGE MG
INITIAL STATUS		Note 1		Note 2										Note 4	Note 3								0.0	0.00 0.00	0.00 0.0				
	JAN	0.00	0.00	4.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	FEB	0.00	0.00	3.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAR	0.00	0.00	2.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	APR	0.00	0.00	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAY	0.00	0.00	1.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	4.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
1964	JUN	0.00	0.00	2.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JUL	0.00	0.00	3.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	AUG	0.00	0.00	3.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	SEP	0.00	0.00	2.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	OCT	0.00	0.00	1.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	NOV	0.00	0.00	2.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	DEC	0.00	0.00	4.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JAN	0.00	0.00	3.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	FEB	0.00	0.00	4.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAR	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	APR	0.00	0.00	2.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAY	0.00	0.00	1.97	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	4.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
1965	JUN	0.00	0.00	1.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JUL	0.00	0.00	4.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	AUG	0.00	0.00	2.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	SEP	0.00	0.00	2.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	OCT	0.00	0.00	3.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	NOV	0.00	0.00	2.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	DEC	0.00	0.00	1.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JAN	0.00	0.00	2.77	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	FEB	0.00	0.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAR	0.00	0.00	3.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	APR	0.00	0.00	1.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAY	0.00	0.00	3.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	4.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
1966	JUN	0.00	0.00	1.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JUL	0.00	0.00	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	AUG	0.00	0.00	1.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	SEP	0.00	0.00	6.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	OCT	0.00	0.00	4.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	NOV	0.00	0.00	4.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	DEC	0.00	0.00	3.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JAN	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	FEB	0.00	0.00	2.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAR	0.00	0.00	5.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	APR	0.00	0.00	4.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAY	0.00	0.00	6.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	4.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
1967	JUN	0.00	0.00	2.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JUL	0.00	0.00	2.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	AUG	0.00	0.00	4.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	SEP	0.00	0.00	2.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	OCT	0.00	0.00	3.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	NOV	0.00	0.00	2.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	DEC	0.00	0.00	6.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JAN	0.00	0.00	2.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	FEB	0.00	0.00	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAR	0.00	0.00	5.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	APR	0.00	0.00	3.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAY	0.00	0.00	5.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	4.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
1968	JUN	0.00	0.00	6.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JUL	0.00	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	AUG	0.00	0.00	2.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	5.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	SEP	0.00	0.00	3.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	3.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	OCT	0.00	0.00	2.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	NOV	0.00	0.00	6.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	DEC	0.00	0.00	6.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.00	0.00	0.00	2310.46

NOTES:
1. Based on gage data in cfs per sq mile for the Safford Brook watershed.
2. Rainfall data from the Shuttle Meadow rain gage during 1964-1968 period.
3. Evaporation is based on standard monthly values. Reservoir yield analysis, CT DOH, Jan 1989.
4. Leakage from the quarry is assumed to be zero.
5. Variation in water supply draft is based on weighted monthly demand values from 1995-2000 New Britain Water Dept records.
6. Effective drainage area = Total watershed area - reservoir surface area.
7. Minimum available storage above the water supply invert during the critical drought month.
8. First entry is the max value for the quarry. The second is the starting value.

DATE 12/7/2017

NEW BRITAIN WATER SUPPLY RESERVOIR ROUTING
SYSTEM SUMMARY
Water Mass Balance for 100% Stream Gage Inflow

PERIOD		RESERVOIRS																							
		SHUTTLE MEADOW			WASEL				WOLCOTT			WHIGVILLE			NORTH HART POND			SOUTH HART POND			QUARRY			TOTA	
YEAR	MONTH	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	Loss4 MG	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STORAGE w/o QUARRY MG	STORAGE MG
INITIAL STATUS			1359.9			1030.4				154.6			61.6			186.7			63.0			0.0		2856.1	2856.1
	JAN	25.6	1359.9	3.30	72.0	1030.4	0.81	0.00	21.8	154.6	5.7	31.0	61.6	6.3	11.3	186.7	3.3	6.5	63.0	2.5	0.0	0.0	0.0	2856.1	2856.1
	FEB	25.3	1343.2	0.00	71.8	1030.4	0.00	0.00	21.8	154.6	1.9	30.9	61.6	0.0	11.3	186.7	1.9	6.5	63.0	1.5	0.0	0.0	0.0	2839.3	2839.4
	MAR	25.6	1359.9	2.43	72.0	1030.4	0.56	0.00	21.8	154.6	5.6	31.0	61.6	9.5	11.3	186.7	4.5	6.5	63.0	3.7	0.0	0.0	0.0	2856.1	2856.1
	APR	25.6	1359.9	3.04	72.0	1030.4	0.71	0.00	21.8	154.6	5.7	31.0	61.6	8.3	11.3	186.7	4.1	6.5	63.0	3.3	0.0	0.0	0.0	2856.1	2856.1
	MAY	21.3	1090.9	0.00	72.0	1030.4	0.00	0.00	21.8	154.6	0.7	31.0	61.6	0.0	11.3	186.7	1.1	6.5	63.0	1.0	0.0	0.0	0.0	2587.1	2587.1
1964	JUN	24.5	1293.4	0.00	56.3	554.0	0.00	0.00	10.1	17.8	0.0	0.0	0.0	0.0	11.3	186.7	0.4	6.5	63.0	0.5	0.0	0.0	0.0	2114.9	2114.9
	JUL	18.1	898.0	0.00	60.0	657.8	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	10.8	176.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1732.4	1732.4
	AUG	11.0	508.5	0.00	63.0	740.6	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	7.5	104.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1353.2	1353.2
	SEP	16.3	797.9	0.00	45.5	322.1	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	3.6	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1153.4	1153.4
	OCT	12.8	599.7	0.00	48.5	376.8	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	976.5	976.5
	NOV	10.0	456.5	0.00	50.3	416.5	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	873.1	873.1
	DEC	16.3	792.3	0.00	42.5	268.8	0.00	0.00	8.8	11.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1072.6	1072.6
	JAN	13.7	650.3	0.00	48.3	374.3	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1024.6	1024.7
	FEB	16.8	824.8	0.00	55.5	535.1	0.00	0.00	17.2	82.5	0.0	31.0	61.6	0.5	2.1	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1517.0	1517.0
	MAR	18.2	902.7	0.00	61.5	696.0	0.00	0.00	19.2	111.7	0.0	31.0	61.6	3.0	2.6	18.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1790.7	1790.7
	APR	20.3	1026.9	0.00	64.0	772.0	0.00	0.00	19.6	117.7	0.0	14.4	14.7	0.0	1.3	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1936.8	1936.8
	MAY	16.0	780.8	0.00	67.5	879.6	0.00	0.00	16.8	78.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1738.7	1738.7
1965	JUN	18.6	931.1	0.00	50.3	412.3	0.00	0.00	11.8	28.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1372.3	1372.3
	JUL	13.0	616.0	0.00	53.0	471.9	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1087.9	1087.9
	AUG	15.8	763.4	0.00	13.0	20.1	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	783.5	783.6
	SEP	11.3	524.4	0.00	21.5	49.5	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	574.0	574.0
	OCT	7.9	352.4	0.00	32.5	115.6	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	468.0	468.0
	NOV	5.8	251.5	0.00	33.3	124.5	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	376.0	376.0
	DEC	5.3	223.0	0.00	32.0	111.9	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	335.0	335.0
	JAN	0.0	0.0	0.00	5.0	2.3	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	2.4
	FEB	3.9	163.5	0.00	32.5	116.9	0.00	0.00	14.9	56.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	336.9	336.9
	MAR	7.8	347.4	0.00	44.0	293.0	0.00	0.00	21.8	154.6	0.9	31.0	61.6	4.2	3.3	28.3	0.0	3.7	24.8	0.0	0.0	0.0	0.0	909.7	909.7
	APR	11.1	514.5	0.00	43.3	279.7	0.00	0.00	20.5	133.4	0.0	0.0	0.0	0.0	2.8	22.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	950.1	950.1
	MAY	10.6	486.0	0.00	51.5	440.1	0.00	0.00	19.8	122.0	0.0	0.0	0.0	0.0	1.3	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1054.3	1054.3
1966	JUN	15.4	745.7	0.00	31.5	106.0	0.00	0.00	16.2	69.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	921.5	921.5
	JUL	8.9	401.6	0.00	37.8	189.2	0.00	0.00	5.8	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	592.9	592.9
	AUG	6.6	286.8	0.00	20.0	43.8	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	330.6	330.6
	SEP	5.3	226.1	0.00	15.0	25.8	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	251.9	251.9
	OCT	4.8	206.7	0.00	18.0	36.1	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	242.7	242.8
	NOV	6.7	290.9	0.00	38.5	200.2	0.00	0.00	8.9	11.9	0.0	13.2	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	515.5	515.5
	DEC	7.3	325.6	0.00	46.3	334.8	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	660.4	660.4
	JAN	9.7	438.4	0.00	52.3	459.7	0.00	0.00	13.2	39.3	0.0	30.8	60.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	998.1	998.1
	FEB	13.1	618.3	0.00	51.5	441.2	0.00	0.00	11.8	28.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1088.3	1088.3
	MAR	16.4	803.6	0.00	58.8	621.3	0.00	0.00	21.4	149.3	0.0	31.0	61.6	3.2	3.4	30.0	0.0	2.8	15.6	0.0	0.0	0.0	0.0	1681.4	1681.4
	APR	21.3	1087.6	0.00	63.8	767.1	0.00	0.00	21.8	154.6	6.7	31.0	61.6	8.8	5.8	72.3	0.0	6.5	63.0	0.3	0.0	0.0	0.0	2206.1	2206.1
	MAY	23.3	1216.3	0.00	69.3	943.5	0.00	0.00	21.8	154.6	4.5	31.0	61.6	4.5	7.3	101.3	0.0	6.5	63.0	0.2	0.0	0.0	0.0	2540.2	2540.2
1967	JUN	25.3	1339.5	0.00	62.6	735.0	0.00	0.00	21.8	154.6	0.1	0.0	0.0	0.0	8.1	116.9	0.0	6.5	63.0	0.4	0.0	0.0	0.0	2408.9	2409.0
	JUL	20.1	1016.5	0.00	67.5	882.7	0.00	0.00	19.3	114.1	0.0	30.5	59.9	0.0	8.2	117.6	0.0	0.6	2.0	0.0	0.0	0.0	0.0	2192.8	2192.8
	AUG	22.8	1186.5	0.00	62.5	725.8	0.00	0.00	15.9	67.5	0.0	0.0	0.0	0.0	6.8	89.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2069.2	2069.2
	SEP	19.5	986.0	0.00	67.3	872.8	0.00	0.00	10.3	19.4	0.0	0.0	0.0	0.0	3.8	36.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1914.3	1914.3
	OCT	23.3	1212.1	0.00	63.5	757.8	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	1.8	10.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1980.1	1980.1
	NOV	24.0	1262.0	0.00	67.8	890.4	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2152.4	2152.4
	DEC	25.6	1359.9	1.69	72.0	1030.4	0.00	0.00	16.3	72.2	0.0	31.0	61.6	4.8	3.5	31.7	0.0	5.8	52.9	0.0	0.0	0.0	0.0	2608.6	2608.7
	JAN	25.5	1355.3	0.00	71.8	1030.4	0.00	0.00	21.8	154.6	0.3	31.0	61.6	0.0	6.4	83.4	0.0	6.5	63.0	1.2	0.0	0.0	0.0	2748.2	2748.2
	FEB	25.6	1359.9	0.00	72.0	1030.4	0.00	0.00	21.8	154.6	2.8	31.0	61.6	1.7	9.1	138.6	0.0	6.5	63.0	1.6	0.0	0.0	0.0	2808.0	2808.1
	MAR	25.6	1359.9	8.83	72.0	1030.4	1.22	0.00	21.8	154.6	10.5	31.0	61.6	11.8	11.3	186.7	4.2	6.5	63.0	4.6	0.0	0.0	0.0	2856.1	2856.1
	APR	25.6	1359.9	0.00	72.0	1030.4	0.00	0.00	21.8	154.6	2.8	31.0	61.6	5.1	11.3	186.7	2.7	6.5	63.0	2.2	0.0	0.0	0.0	2856.1	2856.1
	MAY	25.6	1359.9	0.00	71.8	1030.4	0.00	0.00	21.8	154.6	3.2	31.0	61.6	7.6	11.3	186.7	4.5	6.5	63.0	3.6	0.0	0.0	0.0	2856.1	2856.1
1968	JUN	25.5	1359.9	0.00	71.8	1030.4	0.00	0.00	21.8	154.6	4.5	31.0	61.6	7.0	11.3	186.7	3.8	6.5	63.0	3.1	0.0	0.0	0.0	2856.1	2856.1
	JUL	19.3	975.6	0.00	71.8	1030.4	0.00	0.00	21.5	150.3	0.0	30.9	61.6	0.0	11.3	186.7	0.6	6.5	63.0	0.7	0.0	0.0	0.0	2467.6	2467.6
	AUG	22.6	1170.7	0.00	53.8	492.6	0.00	0.00	5.8	2.1	0.0	0.0	0.0	0.0	11.3	186.7	0.2	6.5	63.0	0.3	0.0	0.0	0.0	1915.0	1915.0
	SEP	20.3	1030.6	0.00	57.5	584.4	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	11.3	186.7	0.2	2.0	7.9	0.0	0.0	0.0	0.0	1809.6	1809.6
	OCT	17.1	842.3	0.00	60.8	674.0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	8.8	131.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1648.1	1648.2
	NOV	19.2	963.6	0.00	62.8	736.7	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	8.8	133.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1833.7	1833.7
	DEC	21.1	1080.0	0.00	68.0	899.5	0.00	0.00	11.8	29.2	0.0	31.0	61.6	1.9	10.0	158.9	0.0	0.8	1.8	0.0	0.0	0.0	0.0	2230.9	2231.0

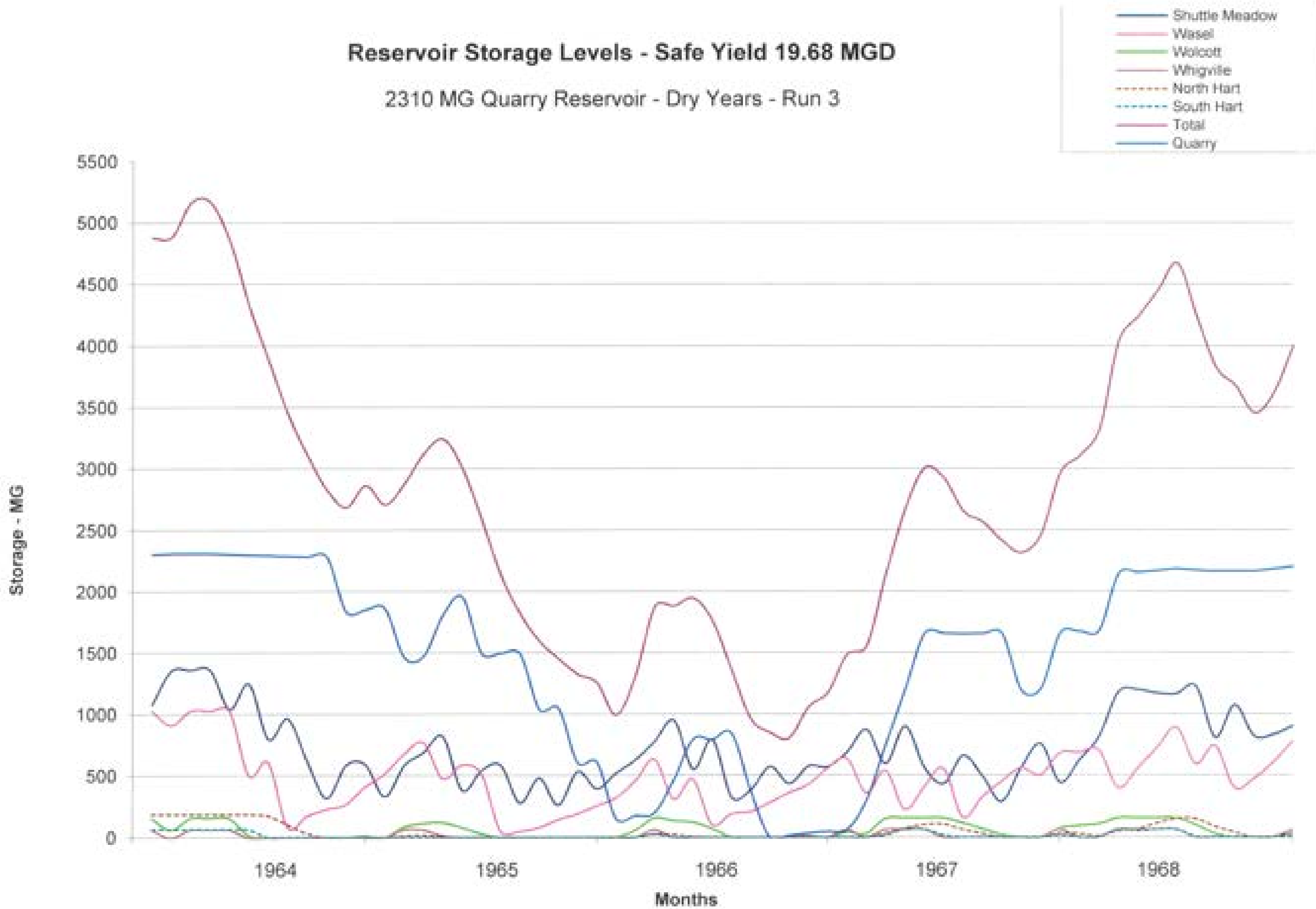
Appendix 4-3.3

Safe Yield Run # 3 Results (19.68 MGD)

Lenard Engineering, Inc.

Reservoir Storage Levels - Safe Yield 19.68 MGD

2310 MG Quarry Reservoir - Dry Years - Run 3



DATE: 12/7/17

NEW BRITAIN WATER SUPPLY ROUTING
FILTRATION PLANT
Water Mass Balance for 100% Stream Gage Inflow

SYSTEM SAFE YIELD 19.68 MGD

PERIOD		INFLOW, MGD								REQUIRED OUTFLOW, MGD	
		DIVERSIONS (Note 2)								WATER SUPPLY DRAFT	
YEAR	MONTH	WHIGVILLE	WASEL	SHUTTLE MEAD	WB POND	WB WELLS	NEPAUG	QUARRY	TOTAL	VARIATION %	DRAFT
										See Note 1	19.68
	JAN	2.59	0.81	15.64	0.00	0.00	0.00	0.00	19.05	97	19.05
	FEB	3.59	4.38	0.00	6.48	2.92	0.00	0.00	17.36	88	17.36
	MAR	0.00	0.00	4.74	10.00	3.91	0.00	0.00	18.65	95	18.65
	APR	0.00	0.00	5.15	10.00	3.91	0.00	0.00	19.05	97	19.05
	MAY	2.82	0.00	10.87	4.69	2.63	0.00	0.00	21.01	107	21.01
1964	JUN	1.28	17.56	0.00	0.89	2.02	0.00	0.00	21.75	111	21.75
	JUL	0.00	0.00	20.19	0.00	1.81	0.00	0.00	22.00	112	22.00
	AUG	0.55	19.52	0.00	0.00	1.74	0.00	0.00	21.81	111	21.81
	SEP	0.00	0.00	18.14	0.00	1.74	0.00	0.00	19.88	101	19.88
	OCT	0.00	0.00	17.59	0.00	1.74	0.00	0.00	19.34	98	19.34
	NOV	0.00	0.00	1.23	0.00	1.80	0.00	15.00	18.03	92	18.03
	DEC	0.82	0.00	10.79	4.09	2.53	0.00	0.00	18.23	93	18.23
	JAN	0.02	0.00	14.66	2.15	2.22	0.00	0.00	19.05	97	19.05
	FEB	0.00	0.00	0.00	10.00	3.63	0.00	15.00	28.63	88	17.36
	MAR	2.73	2.15	0.00	10.00	3.77	0.00	0.00	18.65	95	18.65
	APR	4.09	14.97	0.00	0.00	0.00	0.00	0.00	19.05	97	19.05
	MAY	0.47	0.00	20.54	0.00	0.00	0.00	0.00	21.01	107	21.01
1965	JUN	0.00	4.91	0.00	0.00	1.85	0.00	15.00	21.75	111	21.75
	JUL	0.59	16.87	2.80	0.00	1.74	0.00	0.00	22.00	112	22.00
	AUG	0.44	1.04	18.58	0.00	1.74	0.00	0.00	21.81	111	21.81
	SEP	0.00	0.00	3.14	0.00	1.74	0.00	15.00	19.88	101	19.88
	OCT	0.97	0.00	16.33	0.15	1.90	0.00	0.00	19.34	98	19.34
	NOV	0.00	0.00	1.18	0.00	1.85	0.00	15.00	18.03	92	18.03
	DEC	0.00	0.00	14.72	1.41	2.10	0.00	0.00	18.23	93	18.23
	JAN	0.00	0.00	1.76	0.36	1.93	0.00	15.00	19.05	97	19.05
	FEB	0.99	0.00	8.63	5.05	2.69	0.00	0.00	17.36	88	17.36
	MAR	2.59	0.00	2.15	10.00	3.91	0.00	0.00	18.65	95	18.65
	APR	3.34	15.71	0.00	0.00	0.00	0.00	0.00	19.05	97	19.05
	MAY	2.10	0.00	18.90	0.00	0.00	0.00	0.00	21.01	107	21.01
1966	JUN	1.15	15.56	0.00	2.73	2.31	0.00	0.00	21.75	111	21.75
	JUL	0.00	0.00	22.00	0.00	0.00	0.00	0.00	22.00	112	22.00
	AUG	0.00	0.00	5.07	0.00	1.74	0.00	15.00	21.81	111	21.81
	SEP	0.00	0.00	3.66	1.14	2.06	0.00	13.02	19.88	101	19.88
	OCT	0.25	0.00	14.10	2.68	2.31	0.00	0.00	19.34	98	19.34
	NOV	2.69	3.17	0.00	8.87	3.30	0.00	0.00	18.03	92	18.03
	DEC	1.36	0.00	9.33	4.88	2.66	0.00	0.00	18.23	93	18.23
	JAN	3.14	2.58	0.00	9.87	3.46	0.00	0.00	19.05	97	19.05
	FEB	3.06	14.30	0.00	0.00	0.00	0.00	0.00	17.36	88	17.36
	MAR	2.59	0.00	16.05	0.00	0.00	0.00	0.00	18.65	95	18.65
	APR	2.59	16.46	0.00	0.00	0.00	0.00	0.00	19.05	97	19.05
	MAY	2.59	0.00	18.41	0.00	0.00	0.00	0.00	21.01	107	21.01
1967	JUN	2.85	0.00	11.53	4.74	2.64	0.00	0.00	21.75	111	21.75
	JUL	0.06	17.52	0.00	2.19	2.23	0.00	0.00	22.00	112	22.00
	AUG	1.12	0.00	13.23	4.81	2.65	0.00	0.00	21.81	111	21.81
	SEP	0.00	0.00	16.70	1.13	2.06	0.00	0.00	19.88	101	19.88
	OCT	0.00	0.00	0.00	5.72	2.79	0.00	15.00	23.52	98	19.34
	NOV	1.95	6.01	0.00	7.06	3.01	0.00	0.00	18.03	92	18.03
	DEC	2.59	0.00	15.63	0.00	0.00	0.00	0.00	18.23	93	18.23
	JAN	3.83	5.12	0.00	7.09	3.01	0.00	0.00	19.05	97	19.05
	FEB	2.11	4.43	0.00	7.70	3.11	0.00	0.00	17.36	88	17.36
	MAR	2.59	16.05	0.00	0.00	0.00	0.00	0.00	18.65	95	18.65
	APR	2.78	0.00	2.55	10.00	3.72	0.00	0.00	19.05	97	19.05
	MAY	2.59	0.00	4.51	10.00	3.91	0.00	0.00	21.01	107	21.01
1968	JUN	2.59	0.00	5.25	10.00	3.91	0.00	0.00	21.75	111	21.75
	JUL	2.23	14.09	0.00	3.27	2.40	0.00	0.00	22.00	112	22.00
	AUG	0.00	0.00	19.94	0.00	1.87	0.00	0.00	21.81	111	21.81
	SEP	0.05	15.25	0.00	2.33	2.25	0.00	0.00	19.88	101	19.88
	OCT	0.00	0.00	17.05	0.36	1.93	0.00	0.00	19.34	98	19.34
	NOV	2.55	0.00	3.75	8.49	3.24	0.00	0.00	18.03	92	18.03
	DEC	2.59	0.00	1.73	10.00	3.91	0.00	0.00	18.23	93	18.23

Notes:

1. Variation in water supply draft is based on weighted monthly demand values from 1995-2000 New Britain Water Dept records.
2. All these inflows to the Filter Plant in reality, flow through Shuttle Meadow. (They are presented this way as a convenient math construct)

DATE 12/7/17 TOTAL DRAINAGE AREA 0.34 SQ MI
RESERVOIR QUARRY EFFECTIVE DRAINAGE AREA (Note 6) 0.17 SQ MI
WATERSHED QUARRY MIN REQ. DOWNSTREAM FLOW 0 MGD

NEW BRITAIN WATER SUPPLY ROUTING
QUARRY RESERVOIR
Water Mass Balance for 100% Stream Gage Inflow

Pump Rate(MGD) 15
%SM 50

SYSTEM SAFE YIELD 19.68 MGD
MINIMUM STORAGE (Note 7) 0.01 MG
PERCENT OF CAPACITY 0.00 (WATER REMAINING)

PERIOD		INFLOW MGD										TOTAL MONTHLY	OUTFLOW MGD										TOTAL MONTHLY	RESERVOIR STATUS (MONTH END)			WATER MANAGEMENT			
		STREAM FLOW		DIRECT PRECIPITATION		NATURAL	DIVERSION				NET	INFLOW	NATURAL OUTFLOW				NATURAL	DIVERSION OUT			NET	OUTFLOW	STAGE	SURFACE	TOTAL	DIVERSION		OVER	MONTH-END
													STREAMFLOW		EVAPORATION		LOSS	TO	TO					AREA	STORAGE	OUT	STORAGE	SPILLWAY	AVAIL STORAGE
YEAR	MONTH	AVG (CFS)	INFLOW	RAIN ("/MO)	DAILY VOL	TOTAL	WB			TOTAL	INFLOW	MG	OUT(MIN)	LEAKAGE	RATE ("/MO)	DAILY VOL	TOTAL	SM	FLT PLANT	TOTAL	OUTFLOW	MG	FT	AC (Note 8)	MG (Note 8)	MGD	MGD	MGD	MG
																								111.04	2310.47				
INITIAL STATUS		Note 1		Note 2										Note 4	Note 3								124.0	97.80	1848.4				
	JAN	0.62	0.40	4.60	0.45	0.85	13.91	0.00	0.00	13.91	14.76	457.43	0	0	0.85	0.07	0.07	0.00	0.00	0.00	0.07	2.26	138.0	109.3	2303.5	0.00	14.68	0.00	6.93
	FEB	0.19	0.12	3.14	0.33	0.45	0.00	0.00	0.00	0.00	0.45	13.08	0	0	0.93	0.10	0.10	0.00	0.00	0.00	0.10	2.76	140.0	111.0	2310.5	0.00	0.24	0.12	0.00
	MAR	0.63	0.40	2.45	0.24	0.64	0.00	0.00	0.00	0.00	0.64	19.93	0	0	1.51	0.15	0.15	0.00	0.00	0.00	0.15	4.56	140.0	111.0	2310.5	0.00	0.00	0.50	0.00
	APR	0.63	0.40	4.70	0.47	0.88	0.00	0.00	0.00	0.00	0.88	26.32	0	0	2.15	0.22	0.22	0.00	0.00	0.00	0.22	6.49	140.0	111.0	2310.5	0.00	0.00	0.66	0.00
	MAY	0.11	0.07	1.64	0.16	0.23	0.00	0.00	0.00	0.00	0.23	7.22	0	0	4.15	0.40	0.40	0.00	0.00	0.00	0.40	12.53	138.0	109.3	2305.2	0.00	-0.17	0.00	5.31
1964	JUN	0.04	0.03	2.86	0.29	0.32	0.00	0.00	0.00	0.00	0.32	9.50	0	0	5.1	0.51	0.51	0.00	0.00	0.00	0.51	15.16	138.0	109.3	2299.5	0.00	-0.19	0.00	10.97
	JUL	0.01	0.01	3.98	0.39	0.40	0.00	0.00	0.00	0.00	0.40	12.31	0	0	5.61	0.54	0.54	0.00	0.00	0.00	0.54	16.68	138.0	109.3	2295.1	0.00	-0.14	0.00	15.34
	AUG	0.01	0.01	3.14	0.31	0.31	0.00	0.00	0.00	0.00	0.31	9.68	0	0	5.25	0.50	0.50	0.00	0.00	0.00	0.50	15.61	138.0	109.3	2289.2	0.00	-0.19	0.00	21.26
	SEP	0.01	0.00	2.11	0.21	0.22	0.00	0.00	0.00	0.00	0.22	6.48	0	0	3.64	0.36	0.36	0.00	0.00	0.00	0.36	10.82	138.0	109.3	2284.9	0.00	-0.14	0.00	25.60
	OCT	0.02	0.01	1.89	0.18	0.19	0.00	0.00	0.00	0.00	0.19	6.02	0	0	2.6	0.25	0.25	0.00	0.00	0.00	0.25	7.73	138.0	109.3	2283.2	0.00	-0.06	0.00	27.31
	NOV	0.05	0.03	2.11	0.21	0.24	0.00	0.00	0.00	0.00	0.24	7.25	0	0	1.66	0.16	0.16	0.00	15.00	15.00	15.16	454.93	124.0	97.8	1835.5	0.00	-14.92	0.00	474.99
	DEC	0.27	0.17	4.87	0.47	0.65	0.00	0.00	0.00	0.00	0.65	20.09	0	0	1.34	0.11	0.11	0.00	0.00	0.00	0.11	3.56	124.0	97.8	1852.0	0.00	0.53	0.00	458.47
	JAN	0.15	0.10	3.02	0.29	0.39	0.00	0.00	0.00	0.00	0.39	12.12	0	0	0.85	0.07	0.07	0.00	0.00	0.00	0.07	2.26	124.0	97.8	1861.9	0.00	0.32	0.00	448.61
	FEB	0.56	0.36	4.87	0.53	0.89	0.00	0.00	0.00	0.00	0.89	24.84	0	0	0.93	0.09	0.09	0.00	15.00	15.00	15.09	422.47	112.0	88.4	1464.2	0.00	-14.20	0.00	846.24
	MAR	0.36	0.23	1.66	0.16	0.39	0.00	0.00	0.00	0.00	0.39	12.18	0	0	1.51	0.12	0.12	0.00	0.00	0.00	0.12	3.63	112.0	88.4	1472.8	0.00	0.28	0.00	837.71
	APR	0.27	0.18	2.91	0.29	0.47	10.85	0.00	0.00	10.85	11.32	339.62	0	0	2.15	0.17	0.17	0.00	0.00	0.00	0.17	5.17	124.0	97.8	1807.2	0.00	11.15	0.00	503.26
	MAY	0.13	0.08	1.97	0.19	0.27	4.84	0.00	0.00	4.84	5.11	158.43	0	0	4.15	0.36	0.36	0.00	0.00	0.00	0.36	11.04	128.0	100.9	1954.6	0.00	4.75	0.00	355.88
1965	JUN	0.08	0.05	1.48	0.15	0.20	0.00	0.00	0.00	0.00	0.20	6.11	0	0	5.1	0.47	0.47	0.00	15.00	15.00	15.47	464.00	112.0	88.4	1496.7	0.00	-15.26	0.00	813.76
	JUL	0.02	0.01	4.24	0.41	0.42	0.00	0.00	0.00	0.00	0.42	13.11	0	0	5.61	0.44	0.44	0.00	0.00	0.00	0.44	13.49	112.0	88.4	1496.3	0.00	-0.01	0.00	814.14
	AUG	0.01	0.00	2.59	0.25	0.26	0.00	0.00	0.00	0.00	0.26	7.93	0	0	5.25	0.41	0.41	0.00	0.00	0.00	0.41	12.62	112.0	88.4	1491.6	0.00	-0.15	0.00	818.84
	SEP	0.01	0.01	2.57	0.26	0.26	0.00	0.00	0.00	0.00	0.26	7.94	0	0	3.64	0.29	0.29	0.00	15.00	15.00	15.29	458.75	96.0	68.3	1040.5	0.00	-15.03	0.00	1269.65
	OCT	0.07	0.04	3.72	0.36	0.40	0.00	0.00	0.00	0.00	0.40	12.54	0	0	2.6	0.16	0.16	0.00	0.00	0.00	0.16	4.80	96.0	68.3	1048.5	0.00	0.25	0.00	1261.94
	NOV	0.06	0.04	2.21	0.22	0.26	0.00	0.00	0.00	0.00	0.26	7.84	0	0	1.66	0.10	0.10	0.00	15.00	15.00	15.10	453.08	74.0	51.8	603.3	0.00	-14.84	0.00	1707.16
	DEC	0.09	0.06	1.94	0.19	0.25	0.00	0.00	0.00	0.00	0.25	7.75	0	0	1.34	0.06	0.06	0.00	0.00	0.00	0.06	1.89	74.0	51.8	609.1	0.00	0.19	0.00	1701.33
	JAN	0.09	0.06	2.77	0.27	0.33	0.00	0.00	0.00	0.00	0.33	10.19	0	0	0.85	0.04	0.04	0.00	15.00	15.00	15.04	466.20	38.0	21.9	153.1	0.00	-14.71	0.00	2157.33
	FEB	0.46	0.30	4.00	0.43	0.73	0.00	0.00	0.00	0.00	0.73	20.42	0	0	0.93	0.02	0.02	0.00	0.00	0.00	0.02	0.55	40.0	23.1	173.0	0.00	0.71	0.00	2137.46
	MAR	0.70	0.45	3.47	0.34	0.79	0.00	0.00	0.00	0.00	0.79	24.52	0	0	1.51	0.03	0.03	0.00	0.00	0.00	0.03	0.95	44.0	25.8	196.6	0.00	0.76	0.00	2113.89
	APR	0.18	0.12	1.43	0.14	0.26	8.76	0.00	0.00	8.76	9.03	270.76	0	0	2.15	0.05	0.05	0.00	0.00	0.00	0.05	1.51	66.0	46.5	465.8	0.00	8.98	0.00	1844.63
	MAY	0.22	0.14	5.66	0.36	0.50	10.32	0.00	0.00	10.32	10.82	335.40	0	0	4.15	0.17	0.17	0.00	0.00	0.00	0.17	5.25	84.0	58.9	796.0	0.00	10.65	0.00	1514.44
1966	JUN	0.08	0.05	1.47	0.15	0.20	0.00	0.00	0.00	0.00	0.20	5.98	0	0	5.1	0.27	0.27	0.00	0.00	0.00	0.27	8.17	84.0	58.9	793.8	0.00	-0.07	0.00	1516.63
	JUL	0.02	0.01	1.66	0.16	0.18	1.74	0.00	0.00	1.74	1.92	59.48	0	0	5.61	0.29	0.29	0.00	0.00	0.00	0.29	8.99	86.0	60.4	844.3	0.00	1.63	0.00	1466.14
	AUG	0.01	0.01	1.60	0.16	0.16	0.00	0.00	0.00	0.00	0.16	5.10	0	0	5.25	0.28	0.28	0.00	15.00	15.00	15.28	473.63	50.0	41.8	375.8	0.00	-15.11	0.00	1934.68
	SEP	0.02	0.01	6.09	0.61	0.63	0.00	0.00	0.00	0.00	0.63	18.83	0	0	3.64	0.14	0.14	0.00	13.02	13.02	13.15	394.62	0.0	0.0	0.0	0.00	-12.53	0.00	2310.46
	OCT	0.07	0.05	4.07	0.40	0.44	0.00	0.00	0.00	0.00	0.44	13.71	0	0	2.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.0	6.7	13.7	0.00	0.44	0.00	2296.75
	NOV	0.27	0.17	4.35	0.44	0.61	0.00	0.00	0.00	0.00	0.61	18.36	0	0	1.66	0.01	0.01	0.00	0.00	0.00	0.01	0.30	14.0	9.3	31.8	0.00	0.60	0.00	2279.69
	DEC	0.18	0.11	3.80	0.37	0.48	0.00	0.00	0.00	0.00	0.48	15.02	0	0	1.34	0.01	0.01	0.00	0.00	0.00	0.01	0.34	18.0	11.2	46.5	0.00	0.47	0.00	2264.01
	JAN	0.39	0.25	1.56	0.15	0.40	0.00	0.00	0.00	0.00	0.40	12.51	0	0	0.85	0.01	0.01	0.00	0.00	0.00	0.01	0.26	22.0	13.1	58.7	0.00	0.40	0.00	2251.76
	FEB	0.20	0.13	2.40	0.26	0.39	7.96	0.00	0.00	7.96	8.35	233.69	0	0	0.93	0.01	0.01	0.00	0.00	0.00	0.01	0.33	52.0	36.3	292.1	0.00	8.33	0.00	2018.40
	MAR	0.67	0.43	5.47	0.53	0.97	13.91	0.00	0.00	13.91	14.87	461.06	0	0	1.51	0.05	0.05	0.00	0.00	0.00	0.05	1.49	82.0	57.4	751.6	0.00	14.82	0.00	1558.83
	APR	1.01	0.65	4.79	0.48	1.13	13.91	0.00	0.00	13.91	15.04	451.20	0	0	2.15	0.11	0.11	0.00	0.00	0.00	0.11	3.36	102.0	80.1	1199.5	0.00	14.93	0.00	1110.98
	MAY	0.75	0.48	6.21	0.61	1.09	13.91	0.00	0.00	13.91	15.00	464.86	0	0	4.15	0.29	0.29	0.00	0.00	0.00	0.29	9.04	118.0	93.0	1655.3	0.00	14.70	0.00	655.17
1967	JUN	0.28	0.18	2.64	0.27	0.45	0.00	0.00	0.00	0.00	0.45	13.37	0	0	5.1	0.43	0.43	0.00	0.00	0.00	0.43	12.91	118.0	93.0	1655.8	0.00	0.02	0.00	654.70
	JUL	0.12	0.08	2.73	0.27	0.35	0.00	0.00	0.00	0.00	0.35	10.72	0	0	5.61	0.46	0.46	0.00	0.00	0.00	0.46	14.20	118.0	93.0	1652.5	0.00	-0.11	0.00	658.18
	AUG	0.09	0.06	4.39	0.43	0.49	0.00	0.00	0.00	0.00	0.49	15.07	0	0	5.25	0.43	0.43	0.00	0.00	0.00	0.43	13.29	118.0	93.0	1654.1	0.00	0.06	0.00	656.40
	SEP	0.07	0.04	2.94	0.30	0.34	0.00	0.00	0.00	0.00	0.34	10.22	0	0	3.64	0.31	0.31	0.00	0.00	0.00	0.31	9.21	118.0	93.0	1655.1	0.00	0.03	0.00	655.40
	OCT	0.08	0.05	3.08	0.30	0.35	0.00	0.00	0.00	0.00	0.35	10.82	0	0	2.6	0.21	0.21	0.00	15.00	15.00	15.21	471.56	102.0	80.1	1194.0	0.00	-14.86	0.00	1116.16
	NOV	0.18	0.11	2.99	0.30	0.41	0.00	0.00	0.00	0.00	0.41	12.44	0	0	1.66	0.12	0.12	0.00	0.00	0.00	0.12	3.62	102.0	80.1	1203.1	0.00	0.26	0.00	1107.34
	DEC	0.49	0.31	6.37	0.62	0.93	13.91	0.00	0.00	13.91	14.84	460.05	0	0	1.34	0.09	0.09	0.00	0.00	0.00	0.09	2.92	118.0	93.0	1660.3	0.00	14.75	0.00	650.20
	JAN	0.32	0.20	2.59	0.25	0.46	0.00	0.00	0.00	0.00	0.46	14.17	0	0	0.85	0.07	0.07	0.00	0.00	0.00	0.07	2.15	118.0	93.0	1672.3	0.00	0.39	0.00	638.15
	FEB	0.31	0.20	0.85	0.09	0.29	0.00	0.00	0.00	0.00	0.29	8.42	0	0	0.93	0.08	0.08	0.00	0.00	0.00	0.08	2.35	120.0	94.6	1678.3	0.00	0.21	0.00	632.12
	MAR	1.16	0.75	5.08	0.49	1.24	13.91	0.00	0.00	13.61	15.15	469.67	0	0	1.51	0.13	0.13	0.00	0.00	0.00	0.13	3.89	134.0	105.9	2144.1	0.00	15.03	0.00	166.34
	APR	0.31	0.20	3.42	0.34	0.55	0.00	0.00	0.00	0.00	0.55	16.37	0	0	2.15	0.21	0.21	0.00	0.00	0.00	0.21	6.19	134.0	105.9	2154.3	0.00	0.34	0.00	156.16
	MAY	0.34	0.22	5.91	0.58	0.80	0.00	0.00	0.00	0.00	0.80	24.73	0	0	4.15	0.39	0.39	0.00	0.00	0.00	0.39	11.95	134.0	105.9	2167.1	0.00	0.41	0.00	143.39
1968	JUN	0.50	0.32	6.90	0.69	1.02	0.00	0.00	0.00	0.00	1.02	30.54	0	0	5.1	0.49	0.49	0.00	0.00	0.00	0.49	14.69	134.0	105.9	2182.9	0.00	0.53	0.00	127.53
	JUL	0.07	0.05	0.88	0.09	0.13	0.00	0.00	0.00	0.00	0.13	4.07	0	0	5.61	0.52	0.52	0.00	0.00	0.00	0.52	16.16	134.0	105.9	2170.9	0.00	-0.39	0.00	139.62
	AUG	0.02	0.01	2.56	0.25	0.26	0.00	0.00	0.00	0.00	0.26	8.11	0	0	5.25	0.49	0.49	0.00	0.00	0.00	0.49	15.12	134.0	105.9	2163.8	0.00	-0.23	0.00	146.63
	SEP	0.01	0.01	3.67	0.37	0.38	0.00	0.00	0.00	0.00	0.38	11.33	0	0	3.64	0.35	0.35	0.00	0.00	0.00	0.35	10.48	134.0	105.9	2164.7	0.00	0.03	0.00	145.79
	OCT	0.02	0.01	2.32	0.23	0.24	0.00	0.00	0.00	0.00	0.24	7.31	0	0	2.6	0.24	0.24	0.00	0.00	0.00	0.24	7.49	134.0	105.9	2164.5	0.00	-0.01	0.00	145.96
	NOV	0.11	0.07	6.39	0.64	0.71	0.00	0.00	0.00	0.00	0.71	21.40	0	0	1.66	0.16	0.16	0.00	0.00	0.00	0.16	4.78	134.0	105.9	2181.1	0.00	0.55	0.00	129.35
	DEC	0.33	0.21	6.02	0.59	0.80	0.00	0.00	0.00	0.00	0.80	24.81	0	0	1.34	0.12	0.12	0.00	0.00	0.00	0.12	3.86	134.0	105.9	2202.1	0.00	0.68	0.00	108.39

NOTES:
1. Based on gage data in cfs per sq mile for the Safford Brook watershed.
2. Rainfall data from the Shuttle Meadow rain gage during 1964-1968 period.
3. Evaporation is based on standard monthly values. Reservoir yield analysis, CT DOH, Jan 1989.
4. Leakage from the quarry is assumed to be zero.
5. Variation in water supply draft is based on weighted monthly demand values from 1995-2000 New Britain Water Dept records.
6. Effective drainage area = Total watershed area - reservoir surface area.
7. Minimum available storage above the water supply invert during the critical drought month.
8. First entry is the max value for the quarry. The second is the starting value.

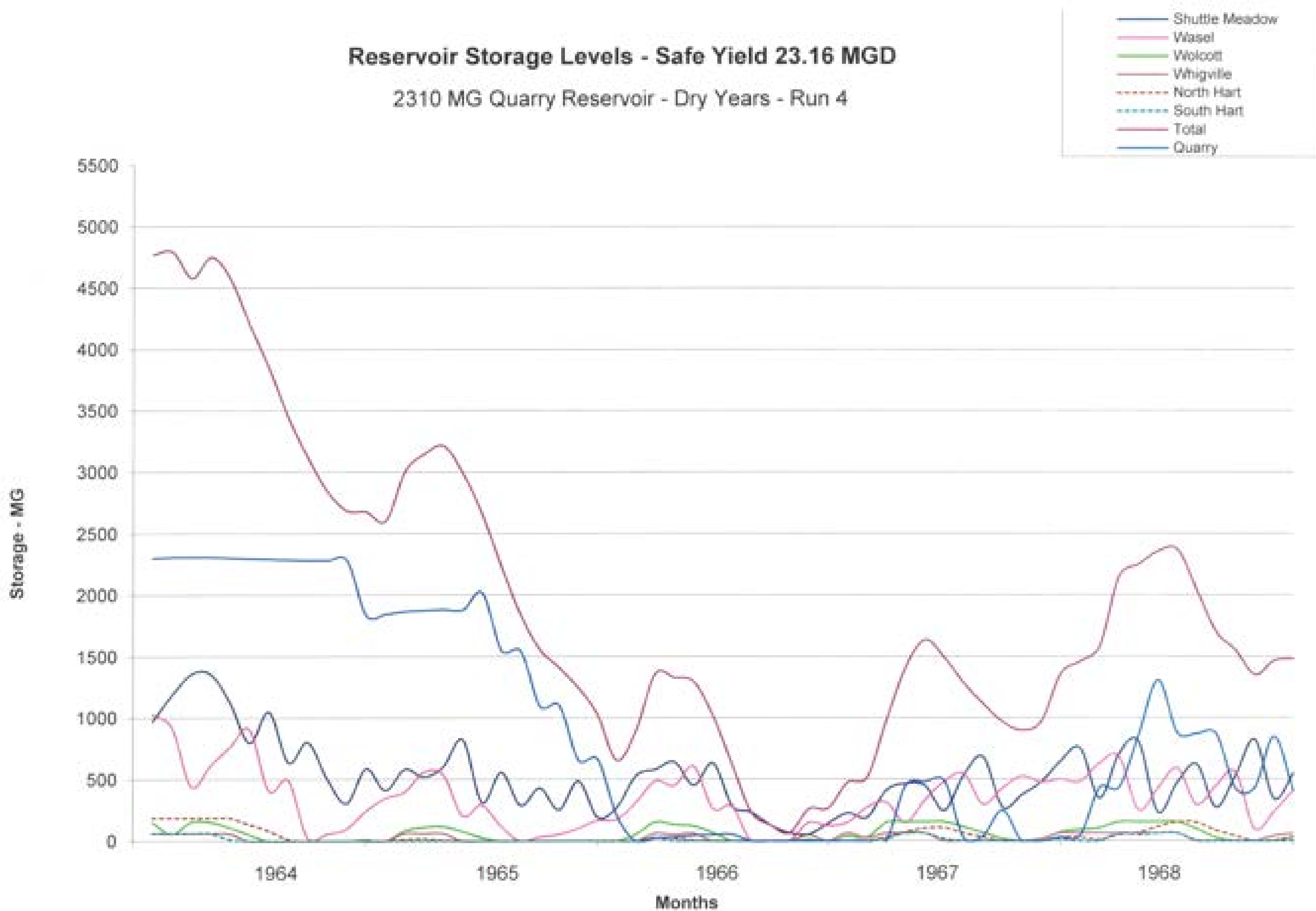
DATE 12/7/2017

NEW BRITAIN WATER SUPPLY RESERVOIR ROUTING
SYSTEM SUMMARY
Water Mass Balance for 100% Stream Gage Inflow

PERIOD		RESERVOIRS																						
		SHUTTLE MEADOW			WASEL				WOLCOTT			WHIGVILLE			NORTH HART POND			SOUTH HART POND			QUARRY			TOTA
YEAR	MONTH	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	Loss4 MG	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STORAGE w/o QUARRY MG	STORAGE MG
INITIAL STATUS			1359.9			1030.4				154.6			61.6			186.7			63.0			1848.4		2856.1	4704.5
	JAN	21.1	1078.2	0.00	71.8	1030.4	0.00	0.00	21.8	154.6	5.7	31.0	61.6	3.7	11.3	186.7	3.3	6.5	63.0	2.5	138.0	2303.5	0.0	2574.4	4878.0
	FEB	25.4	1353.2	0.00	68.5	913.7	0.00	0.00	15.3	59.8	0.0	0.0	0.0	0.0	11.3	186.7	1.9	6.5	63.0	1.5	140.0	2310.5	0.1	2576.3	4886.8
	MAR	25.6	1359.9	1.16	72.0	1030.4	0.00	0.00	21.8	154.6	0.3	31.0	61.6	7.7	11.3	186.7	3.5	6.5	63.0	2.7	140.0	2310.5	0.5	2856.1	5166.6
	APR	25.6	1359.9	1.98	72.0	1030.4	0.71	0.00	21.8	154.6	5.7	31.0	61.6	8.3	11.3	186.7	4.1	6.5	63.0	3.3	140.0	2310.5	0.7	2856.1	5166.6
	MAY	20.5	1042.9	0.00	72.0	1030.4	0.00	0.00	21.8	154.6	0.7	31.0	61.6	0.0	11.3	186.7	1.1	6.5	63.0	1.0	138.0	2305.2	0.0	2539.1	4844.3
1964	JUN	23.8	1246.5	0.00	54.3	503.6	0.00	0.00	10.1	17.8	0.0	0.0	0.0	0.0	11.3	186.7	0.4	6.5	63.0	0.5	138.0	2299.5	0.0	2017.5	4317.0
	JUL	16.3	798.9	0.00	58.3	608.5	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	10.8	176.5	0.0	0.0	0.0	0.0	138.0	2295.1	0.0	1583.9	3879.1
	AUG	19.2	963.3	0.00	29.3	86.4	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	7.5	104.1	0.0	0.0	0.0	0.0	138.0	2289.2	0.0	1153.9	3443.1
	SEP	13.1	617.3	0.00	36.5	173.0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	3.6	33.3	0.0	0.0	0.0	0.0	138.0	2284.9	0.0	823.7	3108.5
	OCT	7.2	316.9	0.00	40.3	228.5	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	138.0	2283.2	0.0	545.5	2828.6
	NOV	12.4	583.6	0.00	42.5	268.7	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	124.0	1835.5	0.0	852.3	2687.8
	DEC	12.6	590.1	0.00	50.3	412.1	0.00	0.00	8.8	11.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	124.0	1852.0	0.0	1013.8	2865.8
	JAN	7.4	329.7	0.00	54.8	517.4	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	124.0	1861.9	0.0	847.1	2709.0
	FEB	12.4	581.6	0.00	60.8	677.9	0.00	0.00	17.2	82.5	0.0	31.0	61.6	0.5	2.1	13.0	0.0	0.0	0.0	0.0	112.0	1464.2	0.0	1416.6	2880.8
	MAR	14.3	689.0	0.00	64.0	771.9	0.00	0.00	19.2	111.7	0.0	31.0	61.6	3.0	2.6	18.8	0.0	0.0	0.0	0.0	112.0	1472.8	0.0	1652.9	3125.7
	APR	16.7	819.2	0.00	53.3	478.0	0.00	0.00	19.6	117.7	0.0	14.4	14.7	0.0	1.3	5.5	0.0	0.0	0.0	0.0	124.0	1807.2	0.0	1435.0	3242.2
	MAY	8.5	381.3	0.00	57.5	588.2	0.00	0.00	16.8	78.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	128.0	1954.6	0.0	1047.9	3002.5
1965	JUN	11.7	541.3	0.00	55.0	522.7	0.00	0.00	11.8	28.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	112.0	1496.7	0.0	1092.9	2589.6
	JUL	12.4	584.0	0.00	23.5	57.3	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	112.0	1496.3	0.0	641.4	2137.7
	AUG	6.4	279.1	0.00	21.8	50.1	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	112.0	1491.6	0.0	329.3	1820.9
	SEP	10.4	478.3	0.00	28.0	79.2	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	96.0	1040.8	0.0	557.5	1598.3
	OCT	6.0	261.5	0.00	34.8	144.9	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	96.0	1048.5	0.0	406.4	1454.9
	NOV	11.5	532.5	0.00	37.8	191.3	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	74.0	603.3	0.0	723.8	1327.1
	DEC	8.8	392.5	0.00	41.8	256.1	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	74.0	609.1	0.0	648.7	1257.8
	JAN	11.3	521.1	0.00	45.5	321.2	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.0	153.1	0.0	842.2	995.4
	FEB	13.3	628.0	0.00	52.3	457.7	0.00	0.00	14.9	56.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.0	173.0	0.0	1142.1	1315.1
	MAR	16.0	780.2	0.00	59.3	632.6	0.00	0.00	21.8	154.6	0.9	31.0	61.6	4.2	3.3	28.3	0.0	3.7	24.8	0.0	44.0	196.6	0.0	1682.0	1878.6
	APR	18.9	949.6	0.00	45.0	310.4	0.00	0.00	20.5	133.4	0.0	0.0	0.0	0.0	2.8	22.5	0.0	0.0	0.0	0.0	66.0	465.8	0.0	1415.9	1881.7
	MAY	11.8	552.4	0.00	52.8	470.6	0.00	0.00	19.8	122.0	0.0	0.0	0.0	0.0	1.3	6.2	0.0	0.0	0.0	0.0	84.0	796.0	0.0	1151.1	1947.2
1966	JUN	16.3	793.0	0.00	31.5	106.0	0.00	0.00	16.2	69.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	84.0	793.8	0.0	968.8	1762.6
	JUL	7.3	324.7	0.00	37.8	189.2	0.00	0.00	5.8	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	86.0	844.3	0.0	516.0	1360.3
	AUG	8.5	382.5	0.00	38.8	206.4	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.0	375.8	0.0	588.9	964.7
	SEP	12.2	571.9	0.00	43.3	279.0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	850.9	850.9
	OCT	9.6	434.0	0.00	47.5	358.5	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	13.7	0.0	792.5	806.2
	NOV	12.3	576.1	0.00	50.8	425.4	0.00	0.00	8.9	11.9	0.0	13.2	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.0	31.8	0.0	1025.8	1057.6
	DEC	12.2	570.1	0.00	56.5	559.3	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.0	46.5	0.0	1129.5	1176.0
	JAN	14.4	690.5	0.00	59.3	638.1	0.00	0.00	13.2	39.3	0.0	30.8	60.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.0	58.7	0.0	1428.6	1487.3
	FEB	17.7	873.6	0.00	47.5	358.8	0.00	0.00	11.8	28.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	52.0	292.1	0.0	1261.2	1553.2
	MAR	12.7	596.1	0.00	55.8	539.1	0.00	0.00	21.4	149.3	0.0	31.0	61.6	3.2	3.4	30.0	0.0	2.8	15.6	0.0	82.0	751.6	0.0	1391.7	2143.3
	APR	18.1	900.3	0.00	40.0	223.9	0.00	0.00	21.8	154.6	6.7	31.0	61.6	8.8	5.8	72.3	0.0	6.5	63.0	0.3	102.0	1199.5	0.0	1475.6	2675.1
	MAY	12.1	563.7	0.00	49.8	405.1	0.00	0.00	21.8	154.6	4.5	31.0	61.6	4.5	7.3	101.3	0.0	6.5	63.0	0.2	118.0	1655.3	0.0	1349.2	3004.5
1967	JUN	9.5	431.0	0.00	56.3	556.3	0.00	0.00	21.8	154.6	0.1	0.0	0.0	0.0	7.5	105.1	0.0	2.8	15.9	0.0	118.0	1655.8	0.0	1262.9	2918.7
	JUL	13.8	660.3	0.00	36.0	162.6	0.00	0.00	19.3	114.1	0.0	0.0	0.0	0.0	5.3	62.8	0.0	0.0	0.0	0.0	116.0	1652.3	0.0	999.8	2652.1
	AUG	10.7	492.4	0.00	45.5	321.8	0.00	0.00	15.9	67.5	0.0	0.0	0.0	0.0	3.5	31.3	0.0	0.0	0.0	0.0	116.0	1654.1	0.0	913.0	2567.0
	SEP	6.6	287.5	0.00	52.0	451.7	0.00	0.00	10.3	19.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	116.0	1655.1	0.0	758.6	2413.7
	OCT	12.1	563.3	0.00	56.5	560.1	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	102.0	1194.3	0.0	1123.4	2317.8
	NOV	15.6	756.4	0.00	54.3	504.4	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	102.0	1203.1	0.0	1260.8	2463.9
	DEC	9.8	442.6	0.00	61.0	682.5	0.00	0.00	16.3	72.2	0.0	31.0	61.6	3.1	3.5	31.7	0.0	2.8	15.6	0.0	118.0	1660.3	0.0	1306.3	2966.5
	JAN	13.3	625.7	0.00	61.0	687.7	0.00	0.00	17.9	92.2	0.0	0.0	0.0	0.0	3.3	28.8	0.0	0.0	0.0	0.0	118.0	1672.3	0.0	1434.4	3106.7
	FEB	16.7	816.0	0.00	61.8	707.3	0.00	0.00	18.9	106.8	0.0	0.0	0.0	0.0	1.8	10.3	0.0	0.0	0.0	0.0	120.0	1678.3	0.0	1640.4	3318.8
	MAR	22.7	1178.5	0.00	49.5	399.5	0.00	0.00	21.8	154.6	6.7	31.0	61.6	7.4	4.6	48.8	0.0	6.5	63.0	0.0	134.0	2144.1	0.0	1905.9	4050.1
	APR	23.0	1197.9	0.00	56.5	558.8	0.00	0.00	21.8	154.6	0.5	31.0	61.6	2.8	5.5	66.1	0.0	5.6	50.8	0.0	134.0	2154.3	0.0	2089.8	4244.1
	MAY	22.5	1169.4	0.00	62.5	725.8	0.00	0.00	21.8	154.6	0.9	31.0	61.6	6.7	7.9	113.9	0.0	6.5	63.0	0.6	134.0	2167.1	0.0	2288.2	4455.3
1968	JUN	22.5	1165.2	0.00	67.8	890.8	0.00	0.00	21.8	154.6	2.2	31.0	61.6	5.3	9.8	151.8	0.0	6.5	63.0	0.5	134.0	2182.9	0.0	2486.9	4669.9
	JUL	23.4	1223.3	0.00	57.8	593.5	0.00	0.00	18.3	98.0	0.0	0.0	0.0	0.0	9.6	149.0	0.0	1.5	5.0	0.0	134.0	2170.9	0.0	2068.7	4239.5
	AUG	16.5	808.0	0.00	63.0	740.2	0.00	0.00	11.9	29.2	0.0	0.0	0.0	0.0	6.5	85.3	0.0	0.0	0.0	0.0	134.0	2163.8	0.0	1662.8	3826.6
	SEP	21.0	1074.0	0.00	49.5	397.9	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	4.1	41.2	0.0	0.0	0.0	0.0	134.0	2164.7	0.0	1513.2	3677.9
	OCT	16.8	820.4	0.00	52.8	470.8	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	134.0	2164.5	0.0	1291.3	3455.8
	NOV	16.9	831.4	0.00	58.3	605.0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	1.1	4.6	0.0	0.0	0.0	0.0	134.0	2181.1	0.0	1441.0	3622.1
	DEC	18.1	901.1	0.00	64.3	778.0	0.00	0.00	11.9	29.4	0.0	31.0	61.6	1.9	3.5	31.7	0.0	0.8	1.8	0.0	134.0	2202.1	0.0	1803.6	4005.7

Appendix 4-3.4

Safe Yield Run # 4 Results (23.16 MGD)


Reservoir Storage Levels - Safe Yield 23.16 MGD
2310 MG Quarry Reservoir - Dry Years - Run 4
Shuttle Meadow
Wasel
Wolcott
Whigville
North Hart
South Hart
Total
Quarry
Storage - MG
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1964
1965
1966
1967
1968
Months

DATE: 12/7/17

NEW BRITAIN WATER SUPPLY ROUTING
FILTRATION PLANT

SYSTEM SAFE YIELD 23.16 MGD

Water Mass Balance for 100% Stream Gage Inflow

PERIOD		INFLOW, MGD								REQUIRED OUTFLOW, MGD	
		DIVERSIONS (Note 2)								WATER SUPPLY DRAFT	
YEAR	MONTH	WHIGVILLE	WASEL	SHUTTLE MEAD	WB POND	WB WELLS	NEPAUG	QUARRY	TOTAL	VARIATION %	DRAFT
										See Note 1	23.16
	JAN	2.59	0.81	19.01	0.00	0.00	0.00	0.00	22.42	97	22.42
	FEB	3.58	3.93	0.00	10.00	2.92	0.00	0.00	20.43	88	20.43
	MAR	2.59	18.79	0.56	0.00	0.00	0.00	0.00	21.94	95	21.94
	APR	2.11	0.00	6.41	10.00	3.91	0.00	0.00	22.42	97	22.42
	MAY	2.82	0.00	10.53	8.75	2.63	0.00	0.00	24.72	107	24.72
1964	JUN	1.28	0.00	18.02	4.28	2.02	0.00	0.00	25.60	111	25.60
	JUL	0.98	20.00	0.37	2.73	1.81	0.00	0.00	25.89	112	25.89
	AUG	0.00	0.00	22.19	1.74	1.74	0.00	0.00	25.67	111	25.67
	SEP	0.51	16.49	3.26	1.39	1.74	0.00	0.00	23.39	101	23.39
	OCT	0.00	0.00	18.96	2.05	1.74	0.00	0.00	22.76	98	22.76
	NOV	0.00	0.00	16.74	2.68	1.80	0.00	0.00	21.22	92	21.22
	DEC	0.00	0.00	0.00	8.04	2.53	0.00	15.00	25.57	93	21.45
	JAN	0.02	0.00	14.42	5.76	2.22	0.00	0.00	22.42	97	22.42
	FEB	2.87	3.93	0.00	10.00	3.63	0.00	0.00	20.43	88	20.43
	MAR	2.73	0.00	5.44	10.00	3.77	0.00	0.00	21.94	95	21.94
	APR	3.38	5.92	0.00	10.00	3.12	0.00	0.00	22.42	97	22.42
	MAY	1.96	14.24	0.00	6.23	2.29	0.00	0.00	24.72	107	24.72
1965	JUN	0.00	0.00	25.60	0.00	0.00	0.00	0.00	25.60	111	25.60
	JUL	0.00	7.53	0.00	1.62	1.74	0.00	15.00	25.89	112	25.89
	AUG	0.44	4.51	17.77	1.20	1.74	0.00	0.00	25.67	111	25.67
	SEP	0.00	0.00	5.09	1.56	1.74	0.00	15.00	23.39	101	23.39
	OCT	1.22	1.46	14.77	3.40	1.90	0.00	0.00	22.76	98	22.76
	NOV	0.00	0.00	1.28	3.08	1.85	0.00	15.00	21.22	92	21.22
	DEC	0.00	0.00	14.46	4.89	2.10	0.00	0.00	21.45	93	21.45
	JAN	0.00	1.84	0.00	3.65	1.93	0.00	15.00	22.42	97	22.42
	FEB	0.40	0.00	0.00	9.17	2.69	0.00	8.16	20.43	88	20.43
	MAR	2.59	0.00	5.44	10.00	3.91	0.00	0.00	21.94	95	21.94
	APR	3.34	6.25	0.00	10.00	2.83	0.00	0.00	22.42	97	22.42
	MAY	3.46	0.00	8.22	10.00	3.05	0.00	0.00	24.72	107	24.72
1966	JUN	2.03	14.81	0.00	6.45	2.31	0.00	0.00	25.60	111	25.60
	JUL	0.52	2.11	20.06	1.45	1.74	0.00	0.00	25.89	112	25.89
	AUG	0.50	9.51	8.94	1.37	1.74	1.74	1.86	25.67	111	25.67
	SEP	1.65	2.60	8.58	4.58	2.06	3.30	0.63	23.39	101	23.39
	OCT	2.23	2.71	5.16	6.39	2.31	3.52	0.44	22.76	98	22.76
	NOV	3.20	0.63	3.48	10.00	3.30	0.00	0.61	21.22	92	21.22
	DEC	4.19	5.14	0.00	8.97	2.66	0.00	0.48	21.45	93	21.45
	JAN	3.04	4.32	1.19	10.00	3.46	0.00	0.40	22.42	97	22.42
	FEB	3.09	0.00	4.84	9.40	2.72	0.00	0.39	20.43	88	20.43
	MAR	2.59	4.48	0.00	10.00	3.91	0.00	0.97	21.94	95	21.94
	APR	2.59	11.50	8.33	0.00	0.00	0.00	0.00	22.42	97	22.42
	MAY	2.59	0.00	8.22	10.00	3.91	0.00	0.00	24.72	107	24.72
1967	JUN	2.85	0.00	11.31	8.80	2.64	0.00	0.00	25.60	111	25.60
	JUL	0.06	2.79	0.00	5.81	2.23	0.00	15.00	25.89	112	25.89
	AUG	1.12	13.01	0.00	8.89	2.65	0.00	0.00	25.67	111	25.67
	SEP	0.06	0.00	23.33	0.00	0.00	0.00	0.00	23.39	101	23.39
	OCT	1.47	0.28	0.00	9.96	2.79	0.00	8.25	22.76	98	22.76
	NOV	1.95	5.85	0.00	10.00	3.01	0.00	0.41	21.22	92	21.22
	DEC	2.59	4.95	0.00	10.00	3.91	0.00	0.00	21.45	93	21.45
	JAN	3.49	5.92	0.00	10.00	3.01	0.00	0.00	22.42	97	22.42
	FEB	3.39	0.00	17.04	0.00	0.00	0.00	0.00	20.43	88	20.43
	MAR	2.59	4.35	0.00	0.00	0.00	0.00	15.00	21.94	95	21.94
	APR	2.78	19.64	0.00	0.00	0.00	0.00	0.00	22.42	97	22.42
	MAY	2.59	0.00	22.13	0.00	0.00	0.00	0.00	24.72	107	24.72
1968	JUN	0.00	0.00	0.00	10.00	3.91	0.00	15.00	28.91	111	25.60
	JUL	2.23	14.16	0.00	7.08	2.40	0.00	0.00	25.89	112	25.89
	AUG	0.68	0.00	19.91	3.21	1.87	0.00	0.00	25.67	111	25.67
	SEP	0.05	0.12	0.00	5.97	2.25	0.00	15.00	23.39	101	23.39
	OCT	0.00	17.17	0.00	3.65	1.93	0.00	0.00	22.76	98	22.76
	NOV	2.55	0.00	18.67	0.00	0.00	0.00	0.00	21.22	92	21.22
	DEC	0.00	0.00	0.00	10.00	3.91	0.00	15.00	28.91	93	21.45

Notes

1. Variation in water supply draft is based on weighted monthly demand values from 1995-2000 New Britain Water Dept records.
2. All these inflows to the Filter Plant,in reality, flow through Shuttle Meadow. (They are presented this way as a convenient math construct)

DATE 12/7/17 | TOTAL DRAINAGE AREA 0.34 SQ MI
RESERVOIR QUARRY | EFFECTIVE DRAINAGE AREA (Note 6) 0.17 SQ MI
WATERSHED QUARRY | MIN REQ DOWNSTREAM FLOW 0 MGD

NEW BRITAIN WATER SUPPLY ROUTING
QUARRY RESERVOIR
Water Mass Balance for 100% Stream Gage Inflow

Pump Rate(MGD) 15
%SM 50

SYSTEM SAFE YIELD 23.16 MGD
MINIMUM STORAGE (Note 7) 0.00 MG
PERCENT OF CAPACITY 0.00 (WATER REMAINING)

PERIOD		INFLOW MGD										TOTAL MONTHLY	OUTFLOW MGD									TOTAL MONTHLY	RESERVOIR STATUS (MONTH END)			WATER MANAGEMENT			
		STREAM FLOW		DIRECT PRECIPITATION		NATURAL	DIVERSION				NET	INFLOW	NATURAL OUTFLOW				NATURAL	DIVERSION OUT			NET	OUTFLOW	STAGE	SURFACE	TOTAL	DIVERSION	STORAGE	OVER	MONTH-END
													STREAMFLOW		EVAPORATION		LOSS	TO	TO					AREA	STORAGE	OUT		SPILLWAY	AVAIL STORAGE
YEAR	MONTH	AVG (CFS)	INFLOW	RAIN ("/MO)	DAILY VOL	TOTAL	WB			TOTAL	INFLOW	MG	OUT(MIN)	LEAKAGE	RATE ("/MO)	DAILY VOL	TOTAL	SM	FLT PLANT	TOTAL	OUTFLOW	MG	FT	AC (Note 6)	MG (Note 8)	MGD	MGD	MGD	MG
																								111.04	2310.47				
INITIAL STATUS		Note 1		Note 2										Note 4	Note 3								124.0	97.83	1848.4				
	JAN	0.62	0.40	4.60	0.45	0.85	13.91	0.00	0.00	13.91	14.76	457.43	0	0	0.85	0.07	0.07	0.00	0.00	0.00	0.07	2.26	138.0	109.3	2303.5	0.00	14.68	0.00	6.93
	FEB	0.19	0.12	3.14	0.33	0.45	0.00	0.00	0.00	0.00	0.45	13.08	0	0	0.93	0.10	0.10	0.00	0.00	0.00	0.10	2.78	140.0	111.0	2310.5	0.00	0.24	0.12	0.00
	MAR	0.63	0.40	2.45	0.24	0.64	13.91	0.00	0.00	13.91	14.55	451.02	0	0	1.51	0.15	0.15	0.00	0.00	0.00	0.15	4.56	140.0	111.0	2310.5	0.00	0.00	14.40	0.00
	APR	0.63	0.40	4.70	0.47	0.88	0.00	0.00	0.00	0.00	0.88	26.32	0	0	2.15	0.22	0.22	0.00	0.00	0.00	0.22	6.49	140.0	111.0	2310.5	0.00	0.00	0.66	0.00
	MAY	0.11	0.07	1.64	0.16	0.23	0.00	0.00	0.00	0.00	0.23	7.22	0	0	4.15	0.40	0.40	0.00	0.00	0.00	0.40	12.53	138.0	109.3	2305.2	0.00	-0.17	0.00	5.31
1964	JUN	0.04	0.03	2.86	0.29	0.32	0.00	0.00	0.00	0.00	0.32	9.50	0	0	5.1	0.51	0.51	0.00	0.00	0.00	0.51	15.16	138.0	109.3	2299.5	0.00	-0.19	0.00	10.97
	JUL	0.01	0.01	3.98	0.39	0.40	0.00	0.00	0.00	0.00	0.40	12.31	0	0	5.61	0.54	0.54	0.00	0.00	0.00	0.54	16.68	138.0	109.3	2295.1	0.00	-0.14	0.00	15.34
	AUG	0.01	0.01	3.14	0.31	0.31	0.00	0.00	0.00	0.00	0.31	9.68	0	0	5.25	0.50	0.50	0.00	0.00	0.00	0.50	15.61	138.0	109.3	2289.2	0.00	-0.19	0.00	21.26
	SEP	0.01	0.00	2.11	0.21	0.22	0.00	0.00	0.00	0.00	0.22	6.48	0	0	3.64	0.36	0.36	0.00	0.00	0.00	0.36	10.82	138.0	109.3	2284.9	0.00	-0.14	0.00	25.60
	OCT	0.02	0.01	1.89	0.18	0.19	0.00	0.00	0.00	0.00	0.19	6.02	0	0	2.6	0.25	0.25	0.00	0.00	0.00	0.25	7.73	138.0	109.3	2283.2	0.00	-0.06	0.00	27.31
	NOV	0.05	0.03	2.11	0.21	0.24	0.00	0.00	0.00	0.00	0.24	7.25	0	0	1.66	0.16	0.16	0.00	0.00	0.00	0.16	4.93	138.0	109.3	2285.5	0.00	0.08	0.00	24.99
	DEC	0.27	0.17	4.87	0.47	0.65	0.00	0.00	0.00	0.00	0.65	20.09	0	0	1.34	0.13	0.13	0.00	15.00	15.00	15.13	468.98	124.0	97.8	1836.6	0.00	-14.48	0.00	473.88
	JAN	0.15	0.10	3.02	0.29	0.39	0.00	0.00	0.00	0.00	0.39	12.12	0	0	0.85	0.07	0.07	0.00	0.00	0.00	0.07	2.26	124.0	97.8	1846.4	0.00	0.32	0.00	464.03
	FEB	0.56	0.36	4.87	0.53	0.89	0.00	0.00	0.00	0.00	0.89	24.84	0	0	0.93	0.09	0.09	0.00	0.00	0.00	0.09	2.47	126.0	99.4	1868.8	0.00	0.80	0.00	441.66
	MAR	0.36	0.23	1.66	0.16	0.39	0.00	0.00	0.00	0.00	0.39	12.16	0	0	1.51	0.13	0.13	0.00	0.00	0.00	0.13	4.08	126.0	99.4	1876.9	0.00	0.26	0.00	433.58
	APR	0.27	0.18	2.91	0.29	0.47	0.00	0.00	0.00	0.00	0.47	14.06	0	0	2.15	0.19	0.19	0.00	0.00	0.00	0.19	5.61	126.0	99.4	1885.1	0.00	0.27	0.00	425.33
	MAY	0.13	0.08	1.97	0.19	0.27	0.00	0.00	0.00	0.00	0.27	8.48	0	0	4.15	0.36	0.36	0.00	0.00	0.00	0.36	11.21	126.0	99.4	1882.4	0.00	-0.09	0.00	428.07
1965	JUN	0.08	0.05	1.48	0.15	0.20	4.86	0.00	0.00	4.86	5.07	151.98	0	0	5.1	0.46	0.46	0.00	0.00	0.00	0.46	13.78	130.0	102.6	2020.6	0.00	4.61	0.00	289.87
	JUL	0.02	0.01	4.24	0.41	0.42	0.00	0.00	0.00	0.00	0.42	13.11	0	0	5.61	0.50	0.50	0.00	15.00	15.00	15.50	480.65	114.0	89.9	1553.1	0.00	-15.08	0.00	757.41
	AUG	0.01	0.00	2.59	0.25	0.26	0.00	0.00	0.00	0.00	0.26	7.93	0	0	5.25	0.41	0.41	0.00	0.00	0.00	0.41	12.84	114.0	89.9	1548.1	0.00	-0.16	0.00	762.33
	SEP	0.01	0.01	2.57	0.26	0.26	0.00	0.00	0.00	0.00	0.26	7.94	0	0	3.64	0.30	0.30	0.00	15.00	15.00	15.30	458.90	98.0	73.4	1097.2	0.00	-15.03	0.00	1213.29
	OCT	0.07	0.04	3.72	0.36	0.40	0.00	0.00	0.00	0.00	0.40	12.54	0	0	2.6	0.17	0.17	0.00	0.00	0.00	0.17	5.19	98.0	73.4	1104.5	0.00	0.24	0.00	1205.94
	NOV	0.06	0.04	2.21	0.22	0.26	0.00	0.00	0.00	0.00	0.26	7.84	0	0	1.66	0.11	0.11	0.00	15.00	15.00	15.11	453.32	78.0	54.5	659.0	0.00	-14.85	0.00	1651.42
	DEC	0.09	0.06	1.94	0.19	0.25	0.00	0.00	0.00	0.00	0.25	7.75	0	0	1.34	0.06	0.06	0.00	0.00	0.00	0.06	1.99	78.0	54.5	664.8	0.00	0.19	0.00	1645.66
	JAN	0.09	0.06	2.77	0.27	0.33	0.00	0.00	0.00	0.00	0.33	10.19	0	0	0.85	0.04	0.04	0.00	15.00	15.00	15.04	466.26	44.0	25.8	208.7	0.00	-14.71	0.00	2101.73
	FEB	0.46	0.30	4.00	0.43	0.73	0.00	0.00	0.00	0.00	0.73	20.42	0	0	0.93	0.02	0.02	0.00	8.16	8.16	8.16	229.16	0.0	0.0	0.0	0.00	-7.45	0.00	2310.46
	MAR	0.70	0.45	3.47	0.34	0.79	0.00	0.00	0.00	0.00	0.79	24.52	0	0	1.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.0	8.4	24.5	0.00	0.79	0.00	2285.94
	APR	0.18	0.12	1.43	0.14	0.26	0.00	0.00	0.00	0.00	0.26	7.84	0	0	2.15	0.02	0.02	0.00	0.00	0.00	0.02	0.49	14.0	9.3	31.9	0.00	0.24	0.00	2278.59
	MAY	0.22	0.14	3.66	0.36	0.50	0.00	0.00	0.00	0.00	0.50	15.38	0	0	4.15	0.03	0.03	0.00	0.00	0.00	0.03	1.05	18.0	11.2	46.2	0.00	0.46	0.00	2264.26
1966	JUN	0.08	0.05	1.47	0.15	0.20	0.00	0.00	0.00	0.00	0.20	5.98	0	0	5.1	0.05	0.05	0.00	0.00	0.00	0.05	1.55	20.0	12.1	50.6	0.00	0.15	0.00	2259.83
	JUL	0.02	0.01	1.68	0.16	0.18	0.00	0.00	0.00	0.00	0.18	5.47	0	0	5.61	0.06	0.06	0.00	0.00	0.00	0.06	1.85	20.0	12.1	54.3	0.00	0.12	0.00	2256.22
	AUG	0.01	0.01	1.60	0.16	0.16	0.00	0.00	0.00	0.00	0.16	5.10	0	0	5.25	0.06	0.06	0.00	1.86	1.86	1.91	59.35	0.0	0.0	0.0	0.00	-1.75	0.00	2310.46
	SEP	0.02	0.01	6.09	0.61	0.63	0.00	0.00	0.00	0.00	0.63	18.83	0	0	3.64	0.00	0.00	0.00	0.63	0.63	0.63	18.84	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	OCT	0.07	0.05	4.07	0.40	0.44	0.00	0.00	0.00	0.00	0.44	13.71	0	0	2.6	0.00	0.00	0.00	0.44	0.44	0.44	13.72	0.0	0.0	0.0	0.00	0.00	0.00	2310.47
	NOV	0.27	0.17	4.35	0.44	0.61	0.00	0.00	0.00	0.00	0.61	18.36	0	0	1.66	0.00	0.00	0.00	0.61	0.61	0.61	18.36	0.0	0.0	0.0	0.00	0.00	0.00	2310.47
	DEC	0.18	0.11	3.80	0.37	0.48	0.00	0.00	0.00	0.00	0.48	15.02	0	0	1.34	0.00	0.00	0.00	0.48	0.48	0.48	15.02	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JAN	0.39	0.25	1.56	0.15	0.40	0.00	0.00	0.00	0.00	0.40	12.51	0	0	0.85	0.00	0.00	0.00	0.40	0.40	0.40	12.52	0.0	0.0	0.0	0.00	0.00	0.00	2310.47
	FEB	0.20	0.13	2.40	0.26	0.39	0.00	0.00	0.00	0.00	0.39	10.83	0	0	0.93	0.00	0.00	0.00	0.39	0.39	0.39	10.83	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAR	0.67	0.43	5.47	0.53	0.97	0.00	0.00	0.00	0.00	0.97	29.97	0	0	1.51	0.00	0.00	0.00	0.97	0.97	0.97	29.98	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	APR	1.01	0.65	4.79	0.48	1.13	13.91	0.00	0.00	13.91	15.04	451.20	0	0	2.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	64.0	45.0	451.2	0.00	15.04	0.00	1859.26
	MAY	0.75	0.48	6.21	0.61	1.09	0.00	0.00	0.00	0.00	1.09	33.77	0	0	4.15	0.16	0.16	0.00	0.00	0.00	0.16	5.08	66.0	46.5	479.9	0.00	0.93	0.00	1830.57
1967	JUN	0.28	0.18	2.64	0.27	0.45	0.00	0.00	0.00	0.00	0.45	13.37	0	0	5.1	0.21	0.21	0.00	0.00	0.00	0.21	6.45	66.0	46.5	486.8	0.00	0.23	0.00	1823.64
	JUL	0.12	0.08	2.73	0.27	0.35	0.00	0.00	0.00	0.00	0.35	10.72	0	0	5.61	0.23	0.23	0.00	15.00	15.00	15.23	472.09	12.0	8.4	25.5	0.00	-14.88	0.00	2285.02
	AUG	0.09	0.06	4.39	0.43	0.49	0.00	0.00	0.00	0.00	0.49	15.07	0	0	5.25	0.04	0.04	0.00	0.00	0.00	0.04	1.20	16.0	10.2	39.3	0.00	0.45	0.00	2271.15
	SEP	0.07	0.04	2.94	0.30	0.34	6.61	0.00	0.00	6.61	6.95	208.60	0	0	3.64	0.03	0.03	0.00	0.00	0.00	0.03	1.01	48.0	28.4	246.9	0.00	6.92	0.00	2063.56
	OCT	0.08	0.05	3.08	0.30	0.35	0.00	0.00	0.00	0.00	0.35	10.82	0	0	2.6	0.06	0.06	0.00	8.25	8.25	8.31	257.74	0.0	0.0	0.0	0.00	-7.96	0.00	2310.46
	NOV	0.16	0.11	2.99	0.30	0.41	0.00	0.00	0.00	0.00	0.41	12.44	0	0	1.66	0.00	0.00	0.00	0.41	0.41	0.41	12.45	0.0	0.0	0.0	0.00	0.00	0.00	2310.47
	DEC	0.46	0.31	6.37	0.62	0.93	0.00	0.00	0.00	0.00	0.93	28.86	0	0	1.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.0	8.4	29.0	0.00	0.93	0.00	2281.51
	JAN	0.32	0.20	2.59	0.25	0.46	0.00	0.00	0.00	0.00	0.46	14.17	0	0	0.85	0.01	0.01	0.00	0.00	0.00	0.01	0.19	18.0	11.2	42.9	0.00	0.45	0.00	2267.53
	FEB	0.31	0.20	0.85	0.09	0.29	13.11	0.00	0.00	13.11	13.40	388.68	0	0	0.93	0.01	0.01	0.00	0.00	0.00	0.01	0.28	64.0	45.0	431.3	0.00	13.39	0.00	1879.14
	MAR	1.16	0.75	5.08	0.49	1.24	13.91	0.00	0.00	13.91	15.15	469.67	0	0	1.51	0.06	0.06	0.00	15.00	15.00	15.06	466.85	64.0	45.0	434.1	0.00	0.09	0.00	1876.32
	APR	0.31	0.20	3.42	0.34	0.55	13.72	0.00	0.00	13.72	14.26	427.87	0	0	2.15	0.09	0.09	0.00	0.00	0.00	0.09	2.63	88.0	62.0	859.4	0.00	14.17	0.00	1451.08
	MAY	0.34	0.22	5.91	0.58	0.80	13.91	0.00	0.00	13.91	14.70	455.82	0	0	4.15	0.23	0.23	0.00	0.00	0.00	0.23	7.00	106.0	80.4	1308.2	0.00	14.48	0.00	1002.26
1968	JUN	0.50	0.32	6.90	0.69	1.02	0.00	0.00	0.00	0.00	1.02	30.54	0	0	5.1	0.39	0.39	0.00	15.00	15.00	15.39	461.56	88.0	62.0	877.2	0.00	-14.37	0.00	1433.28
	JUL	0.07	0.05	0.88	0.09	0.13	0.00	0.00	0.00	0.00	0.13	4.07	0	0	5.61	0.31	0.31	0.00	0.00	0.00	0.31	9.46	88.0	62.0	871.8	0.00	-0.17	0.00	1438.67
	AUG	0.02	0.01	2.56	0.25	0.26	0.00	0.00	0.00	0.00	0.26	8.11	0	0	5.25	0.29	0.29	0.00	0.00	0.00	0.29	8.85	88.0	62.0	871.1	0.00	-0.02	0.00	1439.41
	SEP	0.01	0.01	3.67	0.37	0.38	0.00	0.00	0.00	0.00	0.38	11.33	0	0	3.64	0.20	0.20	0.00	15.00	15.00	15.20	456.14	62.0	43.4	426.3	0.00	-14.80	0.00	1884.21
	OCT	0.02	0.01	2.32	0.23	0.24	0.00	0.00	0.00	0.00	0.24	7.31	0	0	2.6	0.10	0.10	0.00	0.00	0.00	0.10	3.07	62.0	43.4	430.5	0.00	0.14	0.00	1879.97
	NOV	0.11	0.07	6.39	0.64	0.71	13.24	0.00	0.00	13.24	13.95	418.60	0	0	1.66	0.07	0.07	0.00	0.00	0.00	0.07	1.96	86.0	60.4	847.1	0.00	13.89	0.00	1463.33
	DEC	0.33	0.21	6.02	0.59	0.80	0.00	0.00	0.00	0.00	0.80	24.81	0	0	1.34	0.07	0.07	0.00	15.00	15.00	15.07	467.20	62.0	43.4	404.7	0.00	-14.27	0.00	1905.73

NOTES
1. Based on gage data in cfs per sq mile for the Safford Brook watershed.
2. Rainfall data from the Shuttle Meadow rain gage during 1964-1968 period.
3. Evaporation is based on standard monthly values. Reservoir yield analysis, CT DOH, Jan 1989.
4. Leakage from the quarry is assumed to be zero.
5. Variation in water supply draft is based on weighted monthly demand values from 1995-2000 New Britain Water Dept records.
6. Effective drainage area = Total watershed area - reservoir surface area.
7. Minimum available storage above the water supply invert during the critical drought month.
8. First entry is the max value for the quarry. The second is the starting value.

DATE 12/7/2017

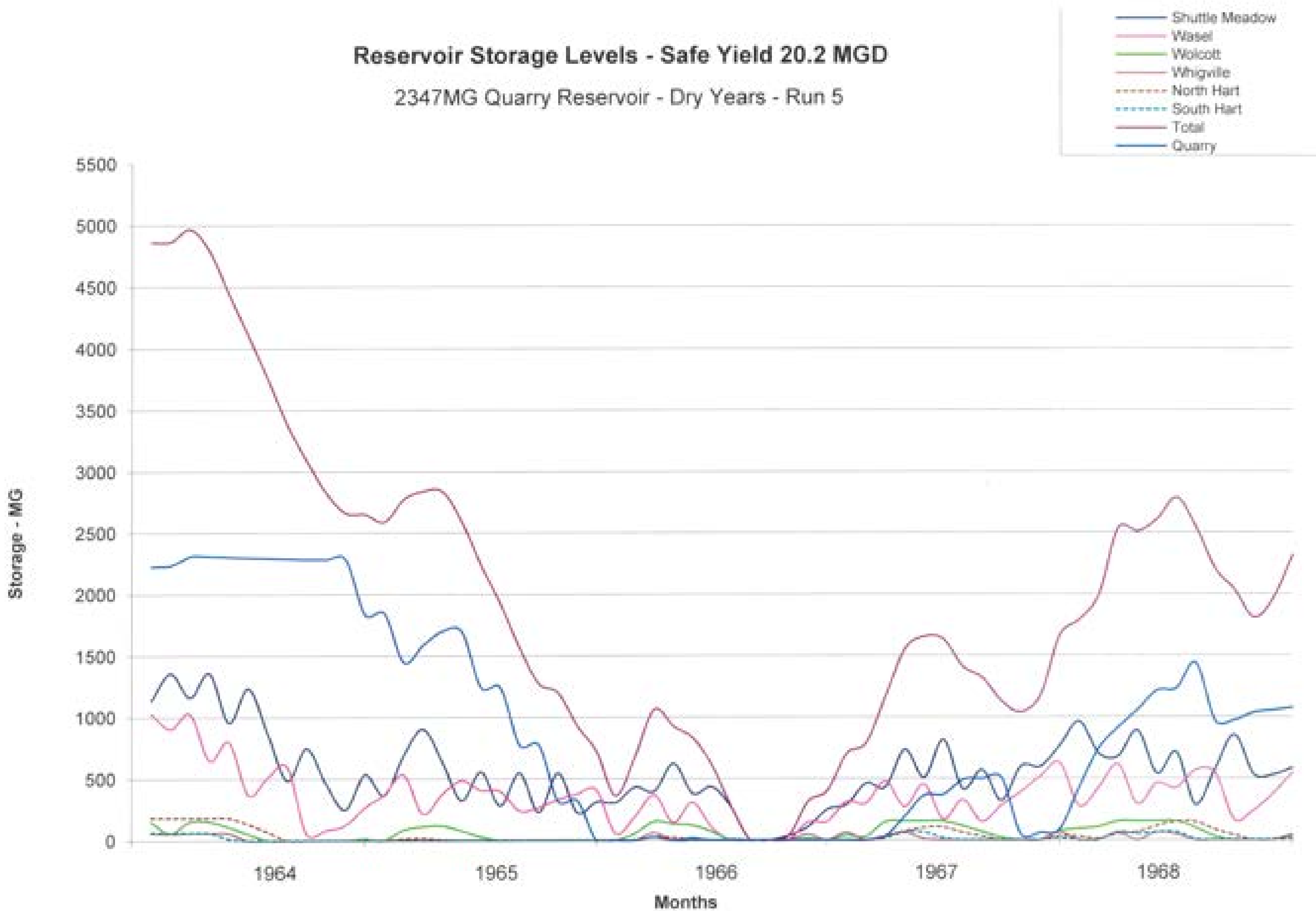
NEW BRITAIN WATER SUPPLY RESERVOIR ROUTING
SYSTEM SUMMARY
Water Mass Balance for 100% Stream Gage Inflow

PERIOD		RESERVOIRS: SHUTTLE MEADOW			WASEL				WOLCOTT			WHIGVILLE			NORTH HART POND			SOUTH HART POND			QUARRY			TOTAL	
YEAR	MONTH	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	Loss4 MG	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STORAGE w/o QUARRY MG	STORAGE MG
INITIAL STATUS			1359.9			1030.4				154.6			61.6			186.7			63.0			1848.4		2856.1	4704.5
	JAN	19.3	973.8	0.00	71.8	1030.4	0.00	0.00	21.8	154.6	5.7	31.0	61.6	3.7	11.3	186.7	3.3	6.5	63.0	2.5	138.0	2303.5	0.0	2470.0	4773.5
	FEB	22.8	1187.4	0.00	68.8	926.7	0.00	0.00	15.3	59.8	0.0	31.0	61.6	0.0	11.3	186.7	1.9	6.5	63.0	1.5	140.0	2310.5	0.1	2485.0	4795.5
	MAR	25.6	1359.9	0.00	51.8	448.0	0.00	0.00	21.8	154.6	0.3	31.0	61.6	6.9	11.3	186.7	4.0	6.5	63.0	3.2	140.0	2310.5	14.4	2273.6	4584.1
	APR	25.6	1359.9	0.49	58.8	618.1	0.00	0.00	21.8	154.6	3.4	31.0	61.6	6.2	11.3	186.7	1.5	6.5	63.0	0.7	140.0	2310.5	0.7	2443.8	4754.3
	MAY	21.8	1125.0	0.00	63.8	766.7	0.00	0.00	19.2	111.2	0.0	31.0	61.6	0.0	11.3	186.7	0.1	2.7	14.1	0.0	138.0	2305.2	0.0	2265.3	4570.5
1964	JUN	16.3	798.4	0.00	68.3	909.1	0.00	0.00	14.6	52.9	0.0	0.0	0.0	0.0	9.0	137.0	0.0	0.0	0.0	0.0	138.0	2299.5	0.0	1897.4	4196.9
	JUL	20.6	1050.6	0.00	50.0	410.4	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	6.5	84.8	0.0	0.0	0.0	0.0	138.0	2295.1	0.0	1545.9	3841.0
	AUG	13.5	639.7	0.00	54.0	496.2	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	2.2	14.4	0.0	0.0	0.0	0.0	138.0	2289.2	0.0	1150.4	3439.6
	SEP	16.4	803.0	0.00	16.0	29.1	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	138.0	2284.9	0.0	832.1	3117.0
	OCT	10.9	504.7	0.00	23.3	56.9	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	138.0	2283.2	0.0	561.7	2844.9
	NOV	6.9	305.6	0.00	30.8	98.5	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	138.0	2285.5	0.0	404.1	2689.6
	DEC	12.5	589.1	0.00	41.0	242.9	0.00	0.00	8.8	11.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	124.0	1836.5	0.0	843.5	2680.1
	JAN	9.1	412.2	0.00	47.0	348.5	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	124.0	1846.4	0.0	760.7	2607.2
	FEB	12.4	583.6	0.00	49.5	399.4	0.00	0.00	17.2	82.5	0.0	31.0	61.6	0.5	2.1	13.0	0.0	0.0	0.0	0.0	126.0	1868.8	0.0	1140.1	3008.9
	MAR	11.3	522.3	0.00	56.5	560.9	0.00	0.00	19.2	111.7	0.0	31.0	61.6	3.0	2.6	18.8	0.0	0.0	0.0	0.0	126.0	1876.9	0.0	1275.2	3152.1
	APR	12.8	606.1	0.00	55.8	539.1	0.00	0.00	19.6	117.7	0.0	31.0	61.6	0.7	1.3	5.5	0.0	0.0	0.0	0.0	126.0	1885.1	0.0	1329.9	3215.0
	MAY	16.8	822.0	0.00	38.8	206.6	0.00	0.00	16.8	78.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	126.0	1882.4	0.0	1106.9	2989.3
1965	JUN	7.2	314.8	0.00	44.0	293.1	0.00	0.00	11.8	28.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	130.0	2020.6	0.0	636.8	2657.4
	JUL	11.9	558.6	0.00	32.8	120.8	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	114.0	1553.1	0.0	679.4	2232.5
	AUG	6.7	289.5	0.00	5.5	2.7	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	114.0	1548.1	0.0	292.2	1840.3
	SEP	9.5	430.0	0.00	17.0	32.7	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.0	1097.2	0.0	462.7	1559.9
	OCT	5.8	253.7	0.00	22.5	53.5	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.0	1104.5	0.0	307.2	1411.7
	NOV	10.6	486.2	0.00	31.0	101.3	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	78.0	659.0	0.0	587.5	1246.5
	DEC	4.6	194.9	0.00	36.3	166.7	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	78.0	664.8	0.0	361.6	1026.4
	JAN	6.3	272.7	0.00	36.8	175.0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.0	208.7	0.0	447.7	656.5
	FEB	11.4	531.8	0.00	45.0	311.8	0.00	0.00	14.9	56.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	900.0	900.1
	MAR	12.4	582.0	0.00	53.5	487.1	0.00	0.00	21.8	154.6	0.9	31.0	61.6	4.2	3.3	28.3	0.0	3.7	24.8	0.0	12.0	24.5	0.0	1338.4	1363.0
	APR	13.5	641.8	0.00	52.0	449.7	0.00	0.00	20.5	133.4	0.0	28.2	51.7	0.0	2.8	22.5	0.0	0.0	0.0	0.0	14.0	31.9	0.0	1299.0	1330.9
	MAY	9.9	451.4	0.00	58.3	608.6	0.00	0.00	19.8	122.0	0.0	31.0	61.6	0.1	1.3	6.2	0.0	0.0	0.0	0.0	18.0	46.2	0.0	1249.7	1295.9
1966	JUN	13.3	631.7	0.00	42.3	264.2	0.00	0.00	16.2	69.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	50.6	0.0	965.7	1016.3
	JUL	6.6	285.7	0.00	43.3	278.7	0.00	0.00	5.8	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	54.3	0.0	566.5	620.8
	AUG	5.4	232.8	0.00	0.0	0.0	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	232.9	232.9
	SEP	3.1	127.0	0.00	0.0	0.0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	127.1	127.1
	OCT	1.7	63.7	0.00	0.0	0.0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	63.7	63.7
	NOV	1.4	53.7	0.00	34.8	146.4	0.00	0.00	8.9	11.9	0.0	26.7	46.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	258.3	258.3
	DEC	3.5	142.7	0.00	33.0	121.7	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	264.3	264.4
	JAN	5.3	225.7	0.00	34.8	147.3	0.00	0.00	13.2	39.3	0.0	31.0	61.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	473.9	473.9
	FEB	4.5	188.4	0.00	42.5	269.5	0.00	0.00	11.8	28.8	0.0	19.4	25.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	511.9	511.9
	MAR	9.1	410.0	0.00	45.0	311.4	0.00	0.00	21.4	149.3	0.0	31.0	61.6	3.8	3.4	30.0	0.0	2.8	15.6	0.0	0.0	0.0	0.0	977.9	977.9
	APR	10.2	464.8	0.00	34.8	146.4	0.00	0.00	21.8	154.6	6.7	31.0	61.6	8.8	5.8	72.3	0.0	6.5	63.0	0.3	64.0	451.2	0.0	962.6	1413.8
	MAY	9.8	446.6	0.00	46.0	328.4	0.00	0.00	21.8	154.6	4.5	31.0	61.6	4.5	7.3	101.3	0.0	6.5	63.0	0.2	66.0	479.9	0.0	1155.4	1635.3
1967	JUN	5.7	245.7	0.00	53.3	480.4	0.00	0.00	21.8	154.6	0.1	0.0	0.0	0.0	7.5	105.1	0.0	2.8	15.9	0.0	66.0	486.8	0.0	1001.7	1488.5
	JUL	11.5	535.2	0.00	56.0	545.0	0.00	0.00	19.3	114.1	0.0	0.0	0.0	0.0	5.3	62.8	0.0	0.0	0.0	0.0	12.0	25.5	0.0	1257.1	1282.5
	AUG	14.3	681.3	0.00	44.0	296.0	0.00	0.00	15.9	67.5	0.0	0.0	0.0	0.0	3.5	31.3	0.0	0.0	0.0	0.0	16.0	39.3	0.0	1076.0	1115.4
	SEP	6.3	274.5	0.00	50.8	426.1	0.00	0.00	10.3	19.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	48.0	246.9	0.0	720.0	966.9
	OCT	8.3	373.3	0.00	55.3	525.9	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	899.3	899.3
	NOV	10.4	478.8	0.00	53.0	475.2	0.00	0.00	0.0	0.0	0.0	14.8	15.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	969.3	969.3
	DEC	13.7	650.2	0.00	54.3	500.1	0.00	0.00	16.3	72.2	0.0	31.0	61.6	3.4	3.5	31.7	0.0	2.8	15.6	0.0	12.0	29.0	0.0	1331.4	1360.3
	JAN	15.5	753.6	0.00	53.3	480.6	0.00	0.00	17.9	92.2	0.0	31.0	61.6	0.3	3.3	28.8	0.0	0.0	0.0	0.0	18.0	42.9	0.0	1416.7	1459.7
	FEB	7.8	345.9	0.00	59.0	629.3	0.00	0.00	18.9	106.8	0.0	31.0	61.6	0.7	1.8	10.3	0.0	0.0	0.0	0.0	64.0	431.3	0.0	1153.8	1585.1
	MAR	14.8	709.3	0.00	61.0	684.4	0.00	0.00	21.8	154.6	6.7	31.0	61.6	9.2	4.6	48.6	0.0	6.5	63.0	0.0	64.0	434.1	0.0	1721.7	2155.8
	APR	16.5	806.7	0.00	41.8	253.1	0.00	0.00	21.8	154.6	0.5	31.0	61.6	2.8	5.5	66.1	0.0	5.6	50.8	0.0	88.0	859.4	0.0	1392.8	2252.2
	MAY	5.4	233.8	0.00	50.8	423.3	0.00	0.00	21.8	154.6	0.9	31.0	61.6	6.7	7.9	113.9	0.0	6.5	63.0	0.6	106.0	1308.2	0.0	1050.1	2358.3
1968	JUN	10.3	471.5	0.00	57.8	591.9	0.00	0.00	21.8	154.6	2.2	31.0	61.6	5.3	9.8	151.8	0.0	6.5	63.0	0.5	88.0	877.2	0.0	1494.3	2371.5
	JUL	13.2	621.5	0.00	44.0	294.7	0.00	0.00	18.3	98.0	0.0	0.0	0.0	0.0	9.6	149.0	0.0	1.5	4.8	0.0	88.0	871.8	0.0	1167.9	2039.7
	AUG	6.3	271.9	0.00	51.8	445.4	0.00	0.00	11.9	29.2	0.0	0.0	0.0	0.0	6.5	85.1	0.0	0.0	0.0	0.0	88.0	871.1	0.0	831.6	1702.7
	SEP	11.3	527.2	0.00	56.5	559.5	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	4.1	41.0	0.0	0.0	0.0	0.0	62.0	426.3	0.0	1127.7	1554.0
	OCT	16.8	823.2	0.00	30.8	98.6	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	62.0	430.5	0.0	921.8	1352.2
	NOV	7.7	341.3	0.00	40.5	234.5	0.00	0.00	0.0	0.0	0.0	24.8	40.2	0.0	1.1	4.6	0.0	0.0	0.0	0.0	86.0	847.1	0.0	620.6	1467.8
	DEC	11.8	546.0	0.00	50.0	408.8	0.00	0.00	11.9	29.4	0.0	31.0	61.6	3.1	3.5	31.7	0.0	0.8	1.8	0.0	62.0	404.7	0.0	1079.2	1484.0

Appendix 4-3.5

Safe Yield Run # 5 Results (20.20 MGD)

LEi Lenard Engineering, Inc.



Reservoir Storage Levels - Safe Yield 20.2 MGD
2347MG Quarry Reservoir - Dry Years - Run 5
Shuttle Meadow
Wasel
Wolcott
Whigville
North Hart
South Hart
Total
Quarry
Storage - MG
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1964
1965
1966
1967
1968
Months

DATE: 12/7/17

NEW BRITAIN WATER SUPPLY ROUTING
FILTRATION PLANT

SYSTEM SAFE YIELD 20.20 MGD

Water Mass Balance for 100% Stream Gage Inflow

PERIOD		INFLOW, MGD								REQUIRED OUTFLOW, MGD	
		DIVERSIONS (Note 2)								WATER SUPPLY DRAFT	
YEAR	MONTH	WHIGVILLE	WASEL	SHUTTLE MEAD	WB POND	WB WELLS	NEPAUG	QUARRY	TOTAL	VARIATION %	DRAFT
										See Note 1	20.20
	JAN	5.10	0.81	13.64	0.00	0.00	0.00	0.00	19.56	97	19.56
	FEB	2.72	4.56	0.00	7.50	3.03	0.00	0.00	17.82	88	17.82
	MAR	6.70	0.00	12.44	0.00	0.00	0.00	0.00	19.14	95	19.14
	APR	6.28	13.28	0.00	0.00	0.00	0.00	0.00	19.56	97	19.56
	MAY	0.83	0.00	17.24	0.59	2.90	0.00	0.00	21.56	107	21.56
1964	JUN	0.00	18.91	0.00	1.17	2.24	0.00	0.00	22.33	111	22.33
	JUL	0.00	0.00	20.77	0.00	1.81	0.00	0.00	22.58	112	22.58
	AUG	0.00	0.00	20.65	0.00	1.74	0.00	0.00	22.39	111	22.39
	SEP	0.00	18.66	0.00	0.00	1.74	0.00	0.00	20.40	101	20.40
	OCT	0.00	0.00	18.11	0.00	1.74	0.00	0.00	19.85	98	19.85
	NOV	0.79	0.00	15.92	0.00	1.80	0.00	0.00	18.51	92	18.51
	DEC	0.00	0.00	0.00	8.04	2.53	0.00	15.00	25.57	93	18.71
	JAN	0.02	0.00	14.06	3.26	2.22	0.00	0.00	19.56	97	19.56
	FEB	0.00	0.00	0.00	7.50	3.63	0.00	15.00	26.12	88	17.82
	MAR	3.75	15.39	0.00	0.00	0.00	0.00	0.00	19.14	95	19.14
	APR	2.22	0.00	17.34	0.00	0.00	0.00	0.00	19.56	97	19.56
	MAY	0.18	0.00	19.10	0.00	2.29	0.00	0.00	21.56	107	21.56
1965	JUN	0.00	5.48	0.00	0.00	1.85	0.00	15.00	22.33	111	22.33
	JUL	0.59	2.13	18.12	0.00	1.74	0.00	0.00	22.58	112	22.58
	AUG	0.00	5.65	0.00	0.00	1.74	0.00	15.00	22.39	111	22.39
	SEP	0.38	0.00	18.28	0.00	1.74	0.00	0.00	20.40	101	20.40
	OCT	0.00	0.00	0.00	3.40	1.90	0.00	15.00	20.30	98	19.85
	NOV	0.00	0.00	16.65	0.00	1.85	0.00	0.00	18.51	92	18.51
	DEC	0.00	1.03	0.00	4.89	2.10	0.00	10.69	18.71	93	18.71
	JAN	1.28	13.51	1.36	1.15	1.93	0.00	0.33	19.56	97	19.56
	FEB	0.99	0.00	6.74	6.67	2.69	0.00	0.73	17.82	88	17.82
	MAR	6.70	0.00	8.14	0.39	3.91	0.00	0.00	19.14	95	19.14
	APR	2.52	12.48	0.00	0.39	3.11	0.00	1.06	19.56	97	19.56
	MAY	2.10	0.00	15.82	0.59	3.05	0.00	0.00	21.56	107	21.56
1966	JUN	2.24	10.20	5.18	1.71	2.31	0.00	0.68	22.33	111	22.33
	JUL	0.52	6.10	13.75	0.00	1.74	0.46	0.00	22.58	112	22.58
	AUG	0.50	0.79	8.49	1.37	1.74	9.17	0.32	22.39	111	22.39
	SEP	1.65	2.60	1.37	4.58	2.06	7.52	0.63	20.40	101	20.40
	OCT	2.23	2.71	1.39	6.39	2.31	4.38	0.44	19.85	98	19.85
	NOV	3.20	0.63	0.77	10.00	3.30	0.00	0.61	18.51	92	18.51
	DEC	2.44	4.15	0.00	8.97	2.66	0.00	0.48	18.71	93	18.71
	JAN	3.04	0.00	2.65	10.00	3.46	0.00	0.40	19.56	97	19.56
	FEB	2.22	4.88	0.00	7.50	2.84	0.00	0.39	17.82	88	17.82
	MAR	5.77	0.00	9.07	0.39	3.91	0.00	0.00	19.14	95	19.14
	APR	6.70	12.86	0.00	0.00	0.00	0.00	0.00	19.56	97	19.56
	MAY	5.07	0.00	16.50	0.00	0.00	0.00	0.00	21.56	107	21.56
1967	JUN	0.83	14.38	0.00	4.43	2.69	0.00	0.00	22.33	111	22.33
	JUL	0.06	0.00	22.52	0.00	0.00	0.00	0.00	22.58	112	22.58
	AUG	3.11	10.72	1.33	4.58	2.65	0.00	0.00	22.39	111	22.39
	SEP	0.00	0.00	18.10	0.25	2.06	0.00	0.00	20.40	101	20.40
	OCT	0.00	0.00	0.00	5.65	2.79	0.00	15.00	23.45	98	19.85
	NOV	1.95	0.00	7.03	6.52	3.01	0.00	0.00	18.51	92	18.51
	DEC	5.10	2.21	0.00	7.50	3.91	0.00	0.00	18.71	93	18.71
	JAN	2.97	16.59	0.00	0.00	0.00	0.00	0.00	19.56	97	19.56
	FEB	2.11	0.00	15.70	0.00	0.00	0.00	0.00	17.82	88	17.82
	MAR	6.70	0.00	12.44	0.00	0.00	0.00	0.00	19.14	95	19.14
	APR	3.54	16.02	0.00	0.00	0.00	0.00	0.00	19.56	97	19.56
	MAY	6.70	0.00	14.86	0.00	0.00	0.00	0.00	21.56	107	21.56
1968	JUN	6.22	6.94	0.00	5.26	3.91	0.00	0.00	22.33	111	22.33
	JUL	0.29	0.00	22.29	0.00	0.00	0.00	0.00	22.58	112	22.58
	AUG	0.00	5.52	0.00	0.00	1.87	0.00	15.00	22.39	111	22.39
	SEP	0.05	16.44	0.00	1.66	2.25	0.00	0.00	20.40	101	20.40
	OCT	0.00	0.00	19.85	0.00	0.00	0.00	0.00	19.85	98	19.85
	NOV	2.55	0.00	6.20	6.52	3.24	0.00	0.00	18.51	92	18.51
	DEC	4.53	0.00	2.77	7.50	3.91	0.00	0.00	18.71	93	18.71

Notes 26.123

1. Variation in water supply draft is based on weighted monthly demand values from 1995-2000 New Britain Water Dept records.
2. All these inflows to the Filter Plant in reality, flow through Shuttle Meadow. (They are presented this way as a convenient math construct)

DATE 12/7/17 | RESERVOIR QUARRY | WATERSHED QUARRY

TOTAL DRAINAGE AREA 0.34 SQ MI | EFFECTIVE DRAINAGE AREA (Note 6) 0.17 SQ MI | MIN REQ. DOWNSTREAM FLOW 0 MGD

NEW BRITAIN WATER SUPPLY ROUTING
QUARRY RESERVOIR
Water Mass Balance for 100% Stream Gage Inflow

Pump Rate(MGD) 15 | %SM 50

SYSTEM SAFE YIELD 20.20 MGD | MINIMUM STORAGE (Note 7) 0.00 MG | PERCENT OF CAPACITY 0.00 (WATER REMAINING)

PERIOD		INFLOW MGD										TOTAL MONTHLY	OUTFLOW MGD									TOTAL MONTHLY	RESERVOIR STATUS (MONTH END)			WATER MANAGEMENT			
		STREAM FLOW		DIRECT PRECIPITATION		NATURAL	DIVERSION				NET	INFLOW	NATURAL OUTFLOW				NATURAL LOSS	DIVERSION OUT			NET	OUTFLOW	STAGE	SURFACE AREA	TOTAL STORAGE	DIVERSION OUT	STORAGE	OVER SPILLWAY	MONTH-END AVAIL STORAGE
													STREAMFLOW		EVAPORATION			TO	TO										
YEAR	MONTH	AVG (CFS)	INFLOW	RAIN ("/MO)	DAILY VOL	TOTAL	WB			TOTAL	INFLOW	MG	OUT(MIN)	LEAKAGE	RATE ("/MO)	DAILY VOL	TOTAL	SM	FLT PLANT	TOTAL	OUTFLOW	MG	FT	AC (Note 8)	MG (Note 8)	MGD	MGD	MGD	MG
																								111.04	2310.47				
INITIAL STATUS		Note 1		Note 2										Note 4	Note 3								124.0	97.80	1848.4				
	JAN	0.62	0.40	4.60	0.45	0.85	11.40	0.00	0.00	11.40	12.25	379.79	0	0	0.85	0.07	0.07	0.00	0.00	0.00	0.07	2.26	136.0	107.5	2225.9	0.00	12.18	0.00	84.56
	FEB	0.19	0.12	3.14	0.33	0.45	0.00	0.00	0.00	0.00	0.45	13.08	0	0	0.93	0.09	0.09	0.00	0.00	0.00	0.09	2.72	136.0	107.5	2236.3	0.00	0.36	0.00	74.20
	MAR	0.63	0.40	2.45	0.24	0.64	4.29	0.00	0.00	4.29	4.94	153.04	0	0	1.51	0.14	0.14	0.00	0.00	0.00	0.14	4.42	140.0	111.0	2310.5	0.00	2.39	2.40	0.00
	APR	0.63	0.40	4.70	0.47	0.88	4.29	0.00	0.00	4.29	5.17	155.14	0	0	2.15	0.22	0.22	0.00	0.00	0.00	0.22	6.49	140.0	111.0	2310.5	0.00	0.00	4.95	0.00
	MAY	0.11	0.07	1.84	0.16	0.23	0.00	0.00	0.00	0.00	0.23	7.22	0	0	4.15	0.40	0.40	0.00	0.00	0.00	0.40	12.53	138.0	109.3	2305.2	0.00	-0.17	0.00	5.31
1964	JUN	0.04	0.03	2.86	0.29	0.32	0.00	0.00	0.00	0.00	0.32	9.50	0	0	5.1	0.51	0.51	0.00	0.00	0.00	0.51	15.16	138.0	109.3	2299.5	0.00	-0.19	0.00	10.97
	JUL	0.01	0.01	3.98	0.39	0.40	0.00	0.00	0.00	0.00	0.40	12.31	0	0	5.61	0.54	0.54	0.00	0.00	0.00	0.54	16.68	138.0	109.3	2295.1	0.00	-0.14	0.00	15.34
	AUG	0.01	0.01	3.14	0.31	0.31	0.00	0.00	0.00	0.00	0.31	9.66	0	0	5.25	0.50	0.50	0.00	0.00	0.00	0.50	15.61	138.0	109.3	2289.2	0.00	-0.19	0.00	21.26
	SEP	0.01	0.00	2.11	0.21	0.22	0.00	0.00	0.00	0.00	0.22	6.48	0	0	3.64	0.36	0.36	0.00	0.00	0.00	0.36	10.82	138.0	109.3	2284.9	0.00	-0.14	0.00	25.60
	OCT	0.02	0.01	1.89	0.18	0.19	0.00	0.00	0.00	0.00	0.19	6.02	0	0	2.6	0.25	0.25	0.00	0.00	0.00	0.25	7.73	138.0	109.3	2283.2	0.00	-0.06	0.00	27.31
	NOV	0.05	0.03	2.11	0.21	0.24	0.00	0.00	0.00	0.00	0.24	7.25	0	0	1.66	0.16	0.16	0.00	0.00	0.00	0.16	4.93	138.0	109.3	2285.5	0.00	0.08	0.00	24.99
	DEC	0.27	0.17	4.87	0.47	0.65	0.00	0.00	0.00	0.00	0.65	20.09	0	0	1.34	0.13	0.13	0.00	15.00	15.00	15.13	468.98	124.0	97.8	1836.6	0.00	-14.48	0.00	473.88
	JAN	0.15	0.10	3.02	0.29	0.39	0.00	0.00	0.00	0.00	0.39	12.12	0	0	0.85	0.07	0.07	0.00	0.00	0.00	0.07	2.26	124.0	97.8	1846.4	0.00	0.32	0.00	464.03
	FEB	0.56	0.36	4.87	0.53	0.89	0.00	0.00	0.00	0.00	0.89	24.84	0	0	0.93	0.09	0.09	0.00	15.00	15.00	15.09	422.47	112.0	88.4	1448.6	0.00	-14.20	0.00	861.66
	MAR	0.36	0.23	1.66	0.16	0.39	4.18	0.00	0.00	4.18	4.57	141.75	0	0	1.51	0.12	0.12	0.00	0.00	0.00	0.12	3.63	116.0	91.5	1586.9	0.00	4.46	0.00	723.54
	APR	0.27	0.18	2.91	0.29	0.47	3.51	0.00	0.00	3.51	3.97	119.23	0	0	2.15	0.18	0.18	0.00	0.00	0.00	0.18	5.35	120.0	94.6	1700.8	0.00	3.80	0.00	609.66
	MAY	0.13	0.08	1.97	0.19	0.27	0.00	0.00	0.00	0.00	0.27	8.48	0	0	4.15	0.34	0.34	0.00	0.00	0.00	0.34	10.08	120.0	94.6	1698.6	0.00	-0.07	0.00	611.86
1965	JUN	0.08	0.05	1.48	0.15	0.20	0.00	0.00	0.00	0.00	0.20	6.11	0	0	5.1	0.44	0.44	0.00	15.00	15.00	15.44	463.13	104.0	81.6	1241.6	0.00	-15.23	0.00	1068.88
	JUL	0.02	0.01	4.24	0.41	0.42	0.00	0.00	0.00	0.00	0.42	13.11	0	0	5.61	0.40	0.40	0.00	0.00	0.00	0.40	12.46	104.0	81.6	1242.2	0.00	0.02	0.00	1068.22
	AUG	0.01	0.00	2.59	0.25	0.26	0.00	0.00	0.00	0.00	0.26	7.93	0	0	5.25	0.38	0.38	0.00	15.00	15.00	15.38	476.66	84.0	58.9	773.5	0.00	-15.12	0.00	1536.95
	SEP	0.01	0.01	2.57	0.26	0.26	0.00	0.00	0.00	0.00	0.26	7.94	0	0	3.64	0.19	0.19	0.00	0.00	0.00	0.19	5.83	84.0	58.9	775.6	0.00	0.07	0.00	1534.84
	OCT	0.07	0.04	3.72	0.36	0.40	0.00	0.00	0.00	0.00	0.40	12.54	0	0	2.6	0.13	0.13	0.00	15.00	15.00	15.13	469.17	54.0	37.7	319.0	0.00	-14.73	0.00	1991.47
	NOV	0.06	0.04	2.21	0.22	0.26	0.00	0.00	0.00	0.00	0.26	7.84	0	0	1.66	0.06	0.06	0.00	0.00	0.00	0.06	1.70	56.0	39.1	325.1	0.00	0.20	0.00	1985.33
	DEC	0.09	0.06	1.94	0.19	0.25	0.00	0.00	0.00	0.00	0.25	7.75	0	0	1.34	0.05	0.05	0.00	10.69	10.69	10.74	332.89	0.0	0.0	0.0	0.00	-10.49	0.00	2310.46
	JAN	0.09	0.06	2.77	0.27	0.33	0.00	0.00	0.00	0.00	0.33	10.19	0	0	0.85	0.00	0.00	0.00	0.33	0.33	0.33	10.20	0.0	0.0	0.0	0.00	0.00	0.00	2310.47
	FEB	0.46	0.30	4.00	0.43	0.73	0.00	0.00	0.00	0.00	0.73	20.42	0	0	0.93	0.00	0.00	0.00	0.73	0.73	0.73	20.42	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAR	0.70	0.45	3.47	0.34	0.79	0.00	0.00	0.00	0.00	0.79	24.52	0	0	1.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.0	8.4	24.5	0.00	0.79	0.00	2285.94
	APR	0.18	0.12	1.43	0.14	0.26	0.00	0.00	0.00	0.00	0.26	7.84	0	0	2.15	0.02	0.02	0.00	1.06	1.06	1.08	32.37	0.0	0.0	0.0	0.00	-0.82	0.00	2310.46
	MAY	0.22	0.14	3.66	0.36	0.50	0.00	0.00	0.00	0.00	0.50	15.38	0	0	4.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.0	6.7	15.4	0.00	0.50	0.00	2295.08
1966	JUN	0.08	0.05	1.47	0.15	0.20	0.00	0.00	0.00	0.00	0.20	5.98	0	0	5.1	0.03	0.03	0.00	0.68	0.68	0.71	21.37	0.0	0.0	0.0	0.00	-0.51	0.00	2310.46
	JUL	0.02	0.01	1.66	0.16	0.18	0.00	0.00	0.00	0.00	0.18	5.47	0	0	5.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.0	4.4	5.5	0.00	0.18	0.00	2304.99
	AUG	0.01	0.01	1.60	0.16	0.16	0.00	0.00	0.00	0.00	0.16	5.10	0	0	5.25	0.02	0.02	0.00	0.32	0.32	0.34	10.67	0.0	0.0	0.0	0.00	-0.18	0.00	2310.46
	SEP	0.02	0.01	6.09	0.61	0.63	0.00	0.00	0.00	0.00	0.63	18.83	0	0	3.64	0.00	0.00	0.00	0.63	0.63	0.63	18.84	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	OCT	0.07	0.05	4.07	0.40	0.44	0.00	0.00	0.00	0.00	0.44	13.71	0	0	2.6	0.00	0.00	0.00	0.44	0.44	0.44	13.72	0.0	0.0	0.0	0.00	0.00	0.00	2310.47
	NOV	0.27	0.17	4.35	0.44	0.61	0.00	0.00	0.00	0.00	0.61	18.36	0	0	1.66	0.00	0.00	0.00	0.61	0.61	0.61	18.36	0.0	0.0	0.0	0.00	0.00	0.00	2310.47
	DEC	0.18	0.11	3.80	0.37	0.48	0.00	0.00	0.00	0.00	0.48	15.02	0	0	1.34	0.00	0.00	0.00	0.48	0.48	0.48	15.02	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	JAN	0.39	0.25	1.56	0.15	0.40	0.00	0.00	0.00	0.00	0.40	12.51	0	0	0.85	0.00	0.00	0.00	0.40	0.40	0.40	12.52	0.0	0.0	0.0	0.00	0.00	0.00	2310.47
	FEB	0.20	0.13	2.40	0.26	0.39	0.00	0.00	0.00	0.00	0.39	10.83	0	0	0.93	0.00	0.00	0.00	0.39	0.39	0.39	10.83	0.0	0.0	0.0	0.00	0.00	0.00	2310.46
	MAR	0.67	0.43	5.47	0.53	0.97	0.00	0.00	0.00	0.00	0.97	29.97	0	0	1.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.0	9.3	30.0	0.00	0.97	0.00	2280.49
	APR	1.01	0.65	4.79	0.48	1.13	4.29	0.00	0.00	4.29	5.43	162.84	0	0	2.15	0.02	0.02	0.00	0.00	0.00	0.02	0.54	42.0	24.4	192.3	0.00	5.41	0.00	2118.19
	MAY	0.75	0.48	6.21	0.61	1.09	4.50	0.00	0.00	4.50	5.59	173.16	0	0	4.15	0.09	0.09	0.00	0.00	0.00	0.09	2.76	58.0	40.4	362.7	0.00	5.50	0.00	1947.79
1967	JUN	0.28	0.18	2.64	0.27	0.45	0.00	0.00	0.00	0.00	0.45	13.37	0	0	5.1	0.19	0.19	0.00	0.00	0.00	0.19	5.61	56.0	40.4	370.4	0.00	0.26	0.00	1940.03
	JUL	0.12	0.08	2.73	0.27	0.35	3.73	0.00	0.00	3.73	4.07	126.28	0	0	5.61	0.20	0.20	0.00	0.00	0.00	0.20	6.17	66.0	46.5	490.5	0.00	3.87	0.00	1819.82
	AUG	0.09	0.06	4.39	0.43	0.49	0.00	0.00	0.00	0.00	0.49	15.07	0	0	5.25	0.21	0.21	0.00	0.00	0.00	0.21	6.64	66.0	48.0	499.0	0.00	0.27	0.00	1811.49
	SEP	0.07	0.04	2.94	0.30	0.34	0.00	0.00	0.00	0.00	0.34	10.22	0	0	3.64	0.16	0.16	0.00	0.00	0.00	0.16	4.75	66.0	48.0	504.4	0.00	0.18	0.00	1806.02
	OCT	0.08	0.05	3.08	0.30	0.35	0.00	0.00	0.00	0.00	0.35	10.82	0	0	2.6	0.11	0.11	0.00	15.00	15.00	15.11	468.39	18.0	11.2	46.9	0.00	-14.76	0.00	2263.60
	NOV	0.18	0.11	2.96	0.30	0.41	0.00	0.00	0.00	0.00	0.41	12.44	0	0	1.66	0.02	0.02	0.00	0.00	0.00	0.02	0.50	22.0	13.1	58.6	0.00	0.40	0.00	2251.66
	DEC	0.49	0.31	6.37	0.62	0.93	0.00	0.00	0.00	0.00	0.93	28.96	0	0	1.34	0.02	0.02	0.00	0.00	0.00	0.02	0.48	28.0	16.2	87.3	0.00	0.92	0.00	2223.18
	JAN	0.32	0.20	2.59	0.25	0.46	10.63	0.00	0.00	10.63	11.08	343.63	0	0	0.85	0.01	0.01	0.00	0.00	0.00	0.01	0.37	62.0	43.4	430.6	0.00	11.07	0.00	1879.92
	FEB	0.31	0.20	0.85	0.08	0.29	10.61	0.00	0.00	10.61	10.90	316.05	0	0	0.93	0.04	0.04	0.00	0.00	0.00	0.04	1.10	82.0	57.4	745.5	0.00	10.86	0.00	1564.96
	MAR	1.16	0.75	5.08	0.49	1.24	4.29	0.00	0.00	4.29	5.54	171.69	0	0	1.51	0.08	0.08	0.00	0.00	0.00	0.08	2.36	90.0	63.5	914.8	0.00	5.46	0.00	1395.63
	APR	0.31	0.20	3.42	0.34	0.55	4.29	0.00	0.00	4.29	4.84	145.19	0	0	2.15	0.12	0.12	0.00	0.00	0.00	0.12	3.71	96.0	68.3	1056.3	0.00	4.72	0.00	1254.15
	MAY	0.34	0.22	5.91	0.58	0.80	4.50	0.00	0.00	4.50	5.29	164.12	0	0	4.15	0.25	0.25	0.00	0.00	0.00	0.25	7.71	102.0	80.1	1212.7	0.00	5.05	0.00	1097.75
1968	JUN	0.50	0.32	6.90	0.69	1.02	0.00	0.00	0.00	0.00	1.02	30.54	0	0	5.1	0.37	0.37	0.00	0.00	0.00	0.37	11.11	104.0	81.6	1232.2	0.00	0.65	0.00	1078.31
	JUL	0.07	0.05	0.88	0.09	0.13	6.86	0.00	0.00	6.86	6.99	216.69	0	0	5.61	0.40	0.40	0.00	0.00	0.00	0.40	12.46	110.0	86.8	1436.4	0.00	6.59	0.00	874.08
	AUG	0.02	0.01	2.56	0.25	0.26	0.00	0.00	0.00	0.00	0.26	8.11	0	0	5.25	0.40	0.40	0.00	15.00	15.00	15.40	477.39	92.0	65.0	987.1	0.00	-15.14	0.00	1343.36
	SEP	0.01	0.01	3.67	0.37	0.38	0.00	0.00	0.00	0.00	0.38	11.30	0	0	3.64	0.21	0.21	0.00	0.00	0.00	0.21	6.44	92.0	65.0	972.0	0.00	0.16	0.00	1338.47
	OCT	0.02	0.01	2.32	0.23	0.24	1.93	0.00	0.00	1.93	2.17	67.22	0	0	2.6	0.15	0.15	0.00	0.00	0.00	0.15	4.60	96.0	68.3	1034.6	0.00	2.02	0.00	1275.85
	NOV	0.11	0.07	6.39	0.64	0.71	0.00	0.00	0.00	0.00	0.71	21.40	0	0	1.66	0.10	0.10	0.00	0.00	0.00	0.10	3.08	96.0	68.3	1052.9	0.00	0.61	0.00	1257.53
	DEC	0.33	0.21	6.02	0.59	0.80	0.00	0.00	0.00	0.00	0.80	24.81	0	0	1.34	0.08	0.08	0.00	0.00	0.00	0.08	2.49	98.0	73.4	1075.3	0.00	0.72	0.00	1235.21

NOTES:
1. Based on gage data in cfs per sq mile for the Safford Brook watershed.
2. Rainfall data from the Shuttle Meadow rain gage during 1964-1968 period.
3. Evaporation is based on standard monthly values. Reservoir yield analysis, CT DOH, Jan 1989.
4. Leakage from the quarry is assumed to be zero.
5. Variation in water supply draft is based on weighted monthly demand values from 1995-2000 New Britain Water Dept records.
6. Effective drainage area = Total watershed area - reservoir surface area.
7. Minimum available storage above the water supply invert during the critical drought month.
8. First entry is the max value for the quarry. The second is the starting value.

DATE 12/7/2017

NEW BRITAIN WATER SUPPLY RESERVOIR ROUTING
SYSTEM SUMMARY
Water Mass Balance for 100% Stream Gage Inflow

PERIOD		RESERVOIRS																							
		SHUTTLE MEADOW			WASEL				WOLCOTT			WHIGVILLE			NORTH HART POND			SOUTH HART POND			QUARRY				TOTA
YEAR	MONTH	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	Loss4 MG	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STAGE FT	STORAGE MG	OVER SPILLWAY MGD	STORAGE w/o QUARRY MG	STORAGE MG
INITIAL STATUS			1359.9			1030.4				154.6			61.6			186.7			63.0			1848.4		2856.1	4704.5
	JAN	22.1	1140.3	0.00	71.8	1030.4	0.00	0.00	21.8	154.6	5.7	31.0	61.6	0.3	11.3	186.7	3.3	6.5	63.0	2.5	136.0	2225.9	0.0	2636.5	4862.4
	FEB	25.6	1359.9	0.00	68.3	908.2	0.00	0.00	15.3	59.8	0.0	29.3	55.3	0.0	11.3	186.7	1.9	6.5	63.0	1.5	136.0	2236.3	0.0	2632.8	4869.1
	MAR	22.4	1164.0	0.00	72.0	1030.4	0.00	0.00	21.8	154.6	0.3	31.0	61.6	0.9	11.3	186.7	3.4	6.5	63.0	2.6	140.0	2310.5	2.4	2660.2	4970.6
	APR	25.5	1359.9	0.00	60.0	653.4	0.00	0.00	21.8	154.6	5.6	31.0	61.6	0.0	11.3	186.7	4.1	6.5	63.0	3.3	140.0	2310.5	5.0	2479.1	4789.5
	MAY	19.1	959.6	0.00	65.0	801.8	0.00	0.00	19.2	111.2	0.0	31.0	61.6	0.0	11.3	186.7	0.1	2.7	14.1	0.0	138.0	2305.2	0.0	2134.9	4440.1
1964	JUN	23.6	1237.0	0.00	48.5	376.6	0.00	0.00	14.6	52.9	0.0	0.0	0.0	0.0	9.0	137.0	0.0	0.0	0.0	0.0	138.0	2299.5	0.0	1803.5	4103.0
	JUL	17.5	867.2	0.00	54.8	516.2	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	5.8	72.5	0.0	0.0	0.0	0.0	138.0	2295.1	0.0	1456.0	3751.1
	AUG	10.6	488.7	0.00	58.0	600.3	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.8	2.3	0.0	0.0	0.0	0.0	138.0	2289.2	0.0	1091.3	3380.5
	SEP	15.4	748.9	0.00	23.3	56.5	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	138.0	2284.9	0.0	805.4	3090.3
	OCT	10.1	460.5	0.00	28.8	84.1	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	138.0	2283.2	0.0	544.7	2827.8
	NOV	5.8	252.3	0.00	33.3	125.5	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	138.0	2285.5	0.0	377.8	2663.3
	DEC	11.5	535.9	0.00	42.5	269.4	0.00	0.00	8.8	11.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	124.0	1836.6	0.0	816.8	2653.4
	JAN	8.3	369.3	0.00	48.3	374.9	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	124.0	1846.4	0.0	744.3	2590.8
	FEB	14.4	691.3	0.00	55.5	535.8	0.00	0.00	17.2	82.5	0.0	7.4	4.7	0.0	2.1	13.0	0.0	0.0	0.0	0.0	112.0	1448.8	0.0	1327.4	2776.2
	MAR	18.2	904.6	0.00	39.8	219.7	0.00	0.00	19.2	111.7	0.0	0.0	0.0	0.0	2.6	18.8	0.0	0.0	0.0	0.0	116.0	1586.9	0.0	1254.8	2841.7
	APR	13.4	637.4	0.00	48.5	377.4	0.00	0.00	19.6	117.7	0.0	0.0	0.0	0.0	1.3	5.5	0.0	0.0	0.0	0.0	120.0	1700.8	0.0	1138.0	2838.8
	MAY	7.4	325.9	0.00	53.8	488.5	0.00	0.00	16.8	78.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	120.0	1698.6	0.0	892.8	2591.4
1965	JUN	12.0	559.2	0.00	50.0	407.4	0.00	0.00	11.8	28.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	104.0	1241.6	0.0	995.5	2237.1
	JUL	6.5	282.8	0.00	49.5	400.9	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	104.0	1242.2	0.0	683.7	1926.0
	AUG	11.8	548.1	0.00	41.0	244.0	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	84.0	773.5	0.0	792.2	1565.7
	SEP	5.4	231.0	0.00	42.5	269.3	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	84.0	775.6	0.0	500.3	1275.9
	OCT	11.8	547.7	0.00	46.0	332.5	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.0	319.0	0.0	880.2	1199.2
	NOV	5.3	227.2	0.00	48.5	378.2	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	56.0	325.1	0.0	605.5	930.6
	DEC	7.1	312.7	0.00	50.0	410.7	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	723.4	723.4
	JAN	7.0	308.6	0.00	23.3	56.7	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	365.3	365.3
	FEB	9.5	432.6	0.00	38.0	194.3	0.00	0.00	14.9	56.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	683.4	683.4
	MAR	8.8	399.3	0.00	48.0	370.0	0.00	0.00	21.8	154.6	0.9	31.0	61.6	0.1	3.3	28.3	0.0	3.7	24.8	0.0	12.0	24.5	0.0	1038.5	1063.1
	APR	13.2	624.7	0.00	34.8	146.4	0.00	0.00	20.5	133.4	0.0	0.0	0.0	0.0	2.8	22.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	927.0	927.0
	MAY	8.5	381.0	0.00	44.8	308.1	0.00	0.00	19.8	122.0	0.0	0.0	0.0	0.0	1.3	6.2	0.0	0.0	0.0	0.0	8.0	15.4	0.0	817.3	832.7
1966	JUN	9.6	434.5	0.00	31.5	106.0	0.00	0.00	16.2	69.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	610.3	610.3
	JUL	6.3	271.6	0.00	0.0	0.0	0.00	0.00	5.8	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	5.5	0.0	273.7	279.2
	AUG	0.0	2.5	0.00	0.0	0.0	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	2.5
	SEP	0.0	0.6	0.00	0.0	0.0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6
	OCT	1.0	37.0	0.00	0.0	0.0	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	37.0	37.0
	NOV	2.7	108.6	0.00	34.8	146.4	0.00	0.00	8.9	11.9	0.0	26.7	46.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	313.2	313.2
	DEC	5.6	251.4	0.00	35.3	152.4	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	403.9	403.9
	JAN	6.6	289.1	0.00	45.0	312.1	0.00	0.00	13.2	39.3	0.0	31.0	61.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	702.0	702.0
	FEB	10.1	461.3	0.00	44.3	297.4	0.00	0.00	11.8	28.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	787.5	787.5
	MAR	9.5	429.8	0.00	53.3	477.9	0.00	0.00	21.4	149.3	0.0	22.3	32.9	0.0	3.4	30.0	0.0	2.8	15.6	0.0	14.0	30.0	0.0	1135.5	1165.4
	APR	15.2	734.5	0.00	42.8	271.4	0.00	0.00	21.8	154.6	6.7	31.0	61.6	2.7	5.8	72.3	0.0	6.5	63.0	0.3	42.0	192.3	0.0	1357.3	1549.5
	MAY	11.0	508.9	0.00	52.0	452.2	0.00	0.00	21.8	154.6	4.5	12.3	11.0	0.0	7.3	101.3	0.0	6.5	63.0	0.2	58.0	362.7	0.0	1290.9	1653.6
1967	JUN	16.6	813.1	0.00	36.5	171.5	0.00	0.00	21.8	154.6	0.1	0.0	0.0	0.0	7.5	105.1	0.0	2.8	15.9	0.0	58.0	370.4	0.0	1260.1	1630.6
	JUL	9.2	416.3	0.00	45.8	326.2	0.00	0.00	19.3	114.1	0.0	0.0	0.0	0.0	5.3	62.8	0.0	0.0	0.0	0.0	66.0	490.5	0.0	919.4	1409.9
	AUG	12.2	569.3	0.00	35.0	151.3	0.00	0.00	15.9	67.5	0.0	0.0	0.0	0.0	3.5	31.3	0.0	0.0	0.0	0.0	68.0	499.0	0.0	819.4	1318.4
	SEP	7.3	321.8	0.00	43.3	282.6	0.00	0.00	10.3	19.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	68.0	504.4	0.0	623.8	1128.2
	OCT	12.8	599.7	0.00	49.3	391.9	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.0	46.9	0.0	991.6	1038.4
	NOV	12.7	598.1	0.00	54.8	517.2	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.0	58.8	0.0	1115.3	1174.1
	DEC	15.8	769.3	0.00	59.0	626.7	0.00	0.00	16.3	72.2	0.0	31.0	61.6	0.6	3.5	31.7	0.0	2.8	15.6	0.0	28.0	87.3	0.0	1577.2	1664.5
	JAN	19.2	962.6	0.00	43.0	276.3	0.00	0.00	17.9	92.2	0.0	0.0	0.0	0.0	3.3	28.8	0.0	0.0	0.0	0.0	62.0	430.6	0.0	1359.9	1790.5
	FEB	14.7	702.9	0.00	50.8	425.4	0.00	0.00	18.9	106.8	0.0	0.0	0.0	0.0	1.8	10.3	0.0	0.0	0.0	0.0	82.0	745.5	0.0	1245.4	1990.9
	MAR	14.3	680.0	0.00	58.5	616.2	0.00	0.00	21.8	154.6	6.7	31.0	61.6	3.3	4.6	48.8	0.0	6.5	63.0	0.0	90.0	914.8	0.0	1624.2	2539.0
	APR	17.9	888.9	0.00	44.0	293.6	0.00	0.00	21.6	154.6	0.5	0.0	0.0	0.0	5.5	66.1	0.0	5.6	50.8	0.0	96.0	1056.3	0.0	1453.9	2510.2
	MAY	11.6	540.8	0.00	52.5	463.5	0.00	0.00	21.8	154.6	0.9	31.0	61.6	0.8	7.9	113.9	0.0	6.5	63.0	0.6	102.0	1212.7	0.0	1397.3	2610.0
1968	JUN	14.8	712.6	0.00	50.8	423.6	0.00	0.00	21.8	154.6	2.2	26.9	47.3	0.0	9.8	151.8	0.0	6.5	63.0	0.5	104.0	1232.2	0.0	1552.9	2785.0
	JUL	6.6	287.5	0.00	56.8	568.7	0.00	0.00	18.3	98.0	0.0	0.0	0.0	0.0	9.6	149.0	0.0	1.5	4.8	0.0	110.0	1436.4	0.0	1107.9	2544.3
	AUG	12.3	578.6	0.00	56.0	544.6	0.00	0.00	11.9	29.2	0.0	0.0	0.0	0.0	6.5	85.1	0.0	0.0	0.0	0.0	92.0	967.1	0.0	1237.5	2204.7
	SEP	17.3	852.9	0.00	36.3	167.7	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	4.1	41.0	0.0	0.0	0.0	0.0	92.0	972.0	0.0	1061.6	2033.6
	OCT	11.4	532.4	0.00	41.0	241.6	0.00	0.00	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	96.0	1034.6	0.0	774.1	1808.7
	NOV	11.4	529.8	0.00	48.5	376.5	0.00	0.00	0.0	0.0	0.0	0.0	0.0	0.0	1.1	4.6	0.0	0.0	0.0	0.0	96.0	1052.9	0.0	910.9	1963.8
	DEC	12.4	585.2	0.00	56.3	550.3	0.00	0.00	11.9	29.4	0.0	26.0	44.1	0.0	3.5	31.7	0.0	0.8	1.8	0.0	98.0	1075.3	0.0	1242.5	2317.8

Water Demand Projections for New Britain and Surrounding Communities

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Chapter 5 - Water Demand Projections for New Britain and Reasonably Connected Water Systems

Section 1(b)(2) of Public Act 16-61, requires the City of New Britain to determine the "long term water supply needs for the City of New Britain as well as interconnected, and reasonably feasible interconnected, water companies in the general geographic region surrounding the areas supplied by the city of New Britain's water reservoir system". This chapter addresses the likely, long-term interconnected water demands to New Britain's public water supply.

A) Interconnected Utilities to New Britain

New Britain has agreements with several surrounding utilities to provide water supplies through interconnections. These include, in descending order from largest to smallest water use:

1) Kensington Fire District, Berlin, CT
2) Berlin Water Control Commission, Berlin, CT
3) Bristol Water Department, Bristol, CT and
4) Valley Water Systems, Plainville, CT

New Britain also maintains two treated water emergency interconnections with the Metropolitan District Commission (MDC). As noted in Chapter 3, New Britain has a contract with the MDC to purchase raw water from Nepaug Reservoir, which has historically occurred only during severe drought conditions.

The Worthington Fire District in Berlin also utilizes at times New Britain treated water, through their interconnections with the Town of Berlin Water Control Commission. Their demands are included in Berlin's water demand projections.

The most recent common year of available data for both New Britain and the four interconnected systems is 2015; therefore, 2015 will be utilized as existing system demand in this analysis.

B) Historic and Projected Water Demands – City of New Britain

The New Britain Water Department provides water to all properties within the City limits. New Britain also directly serves customers in Newington (366 metered connections), Plainville (34 metered connections), Berlin (81 metered connections) and Farmington (377 metered connections). These total 858 metered connections, with an estimated population served of 2,070 outside of New Britain.

LEI utilized the following sources of data to develop both historic and projected future water demands for the City of New Britain, including past DPH Water Supply Plans, updated New Britain consumption and production records between 2011 and 2015, New Britain's 2010 Plan of Conservation and Development, US Census and the Connecticut State Data Center (Uconn) population projections, and others.

1) Detailed Analysis of 2016 Water Consumption - For this study, New Britain prepared a detailed breakdown of water use for calendar year 2016, divided into 32 different user groups. This raw data is provided in **Appendix 5-1. Table 5-1** provides a breakdown of 2016 water consumption by Town, and also by major user groups:

   - Residential
   - Commercial
   - Industrial
   - Other
   - Sale for Resale

   Based on an estimated service population of 75,800, LEI also broke down water use for the top four categories into gallons per capita day basis, which will be used later in the report to project future water demands in these categories. For residential customers, the calculated 51.3 gallons per capita per day is well within industry standards for water use, and indicates fairly efficient use of water. LEI will use 52 gallons per capita day for future residential water demand projections.

TABLE 5-1
WATER CONSUMPTION BREAKDOWN BY CATEGORY

CUSTOMER CATEGORY	2016 USAGE (mgd)	2016 USAGE (% of total)	PER CAPITA USAGE (gpcd)
Residential – New Britain	3.755		
Residential - Berlin	0.010		
Residential – Plainville	0.002		
Residential – Farmington	0.063		
Residential – Newington	0.063		
Sub-Total – All Residential	**3.894**	54 %	51.3
Commercial- New Britain	0.767		
Commercial – Farmington	0.061		
Commercial – Newington	0.010		
Commercial – Plainville	0.001		
Sub-Total – All Commercial	**0.841**	12 %	11.1
New Britain – Industrial	0.062		
Sub-Total- All Industrial	**0.062**	1 %	0.8
Other- New Britain + Plainville	0.623		
Sub-Total - Other Water Use	**0.623**	9 %	8.2
Total – Direct Billed Customers	**5.446**	**76 %**	
Sale for Resale Customers			
Kensington Fire District	0.760		
Berlin Water Control Comm.	0.715		
Bristol Water Department	0.231		
Total- Sale for Resale	**1.706**	**24 %**	
Total Consumption	**7.158**	**100 %**	

2) Historic Water Usage between 2011 – 2015 - **Table 5-2** provides updated water demand data, showing New Britain water production, consumption and non-revenue data between 2011 and 2015.

Table 5-2 provides the Total Direct Sales from New Britain's metered customers which include all residential, commercial, industrial, municipal and public authority metered connections in New Britain, Newington, Plainville, Berlin and Farmington. Usage for these customers has been fairly steady over the past five years, averaging **5.53 MGD**. This is a similar value to the 2016 total of 5.446 MGD from **Table 5-1.**

Table 5-2 also provides historic population projections for the City of New Britain, based on US Census data, as well as estimated service population for the customers in Newington, Plainville, Berlin and Farmington. This data was taken from the 2014 New Britain Water Supply Plan. The sum of these values provides the total estimated population served by the New Britain Water Department.

Table 5-2 also provides historic Sale for Resale totals for Kensington, Berlin and Bristol. A row is also provided for Valley Water, as they have a Sale of Excess Water Permit to purchase up to 200,000 gpd.

Table 5-2 also provides yearly totals of the Sale for Resale customers, which have averaged 1.50 mgd. Total consumptive usage has averaged **7.02 MGD** over this five year period.

Table 5-2 also breakdowns non-revenue consumption, and ultimately calculates non-revenue unaccounted-for water. For this five year period, this value has averaged **19.5 %,** which is slightly above industry standards of **15 %**. The age of New Britain's water distribution system which exceeds 100 years old in certain sections of the City may contribute to this slightly higher number.

Table 5-2 also provides the average daily, maximum daily, and maximum month average daily demands during this period. The five year averaged for these are **9.05 MGD, 12.11 MGD and 10.23 MGD**, respectively.

Table 5-2 - Historic Water Demands by User Category
City of New Britain Water Department
(Demands in MGD)

		2011	2012	2013	2014	2015	5 - Yr. Average
1	Residential						
2	Industrial						
3	Commercial						
4	Municipal/ Other Users						
5	Total Direct Sales	5.63	5.59	5.45	5.55	5.42	5.53
6	New Britain Service Population	73,200	73,200	73,200	72,878	73,733	
7	Out-of-Town Service Population	2,070	2,070	2,070	2,070	2,070	
8	Total Residential Population Served	75,270	75,270	75,270	74,948	75,803	
	Sale for Resale Customers						
9	Kensington Fire District	0.48	0.73	0.72	0.71	0.78	0.68
10	Berlin Water	0.96	0.46	0.46	0.49	0.54	0.58
11	Bristol Water	0.24	0.24	0.20	0.24	0.25	0.24
12	Valley Water						
13	Total Sale for Resale	1.68	1.43	1.38	1.44	1.57	1.50
14	Total Consumptive Use	7.31	7.02	6.83	6.99	6.99	7.02
15	Total Non-Revenue Consumption	1.77	1.66	2.06	2.23	2.40	2.02
16	Non-Revenue Consumption (% of Total)	19.4	19.1	23.1	24.2	25.5	22.3
17	Backwash water and Filter to waste usage	0.18	0.21	0.14	0.17	0.13	0.17
18	Other Non-Revenue Water (Flushing, Fires, Etc)	0.10	0.10	0.10	0.10	0.10	0.10
19	Total Non-Revenue Accounted for Water (MGD)	0.28	0.31	0.24	0.27	0.23	0.27
20	Total Unaccounted-for Non-Revenue Water MGD and %)	1.49	1.35	1.82	1.96	2.23	1.77
21		16.40%	15.50%	20.40%	21.20%	23.70%	19.50%
22	Average Day Demand	9.08	8.68	8.89	9.22	9.39	9.05
23	Maximum Day Demand	12.72	11.64	12.66	12.01	11.52	12.11
24	Maximum Month Demand	10.67	9.97	10.12	10.08	10.33	10.23

3) City of New Britain Plan of Conservation and Development - LEI reviewed New Britain's 2010 Plan of Conservation and Development, to determine development patterns and future trends. A copy of the chapter entitled "Development Patterns and Trends" is provided in **Appendix 5-2**.

Some of the major conclusions that impact future water demand are repeated below:

- The lack of a sizable inventory of vacant land in commercial and industrial zones indicate that much of New Britain's future development activity will be a combination of infill development, redevelopment and revitalization projects.
- Under existing zoning, nearly 1,500 new dwelling units could be built in the City. Due to a variety of factors, this level of development is unlikely to occur.
- Under existing zoning, there exists potential for nearly 2.9 million square feet of commercial and industrial development. However, due to the small size of many vacant commercial / industrial parcels, this level of development is unlikely to occur. Also, mixed-use is permitted in several of the non-residential zones which will most likely result in a portion of this land being developed as residential.

Based on this document, future commercial and industrial water demands growth within New Britain appears to be limited.

4) Future Population Growth in New Britain - **Table 5-3** summarizes total population in New Britain. Values between 2010 and 2016 were obtained from Census data, while projected population between 2025 and 2040 were obtained from Connecticut State Data Center projections at Uconn. LEI utilized the growth rate between the 2030 and 2040 values, and assumed a similar growth rate to estimate the 2060 population value.

TABLE 5 – 3
HISTORIC AND PROJECTED POPULATION VALUES
CITY OF NEW BRITAIN

YEAR	2010	2014	2015	2016	2025	2030	2040	2060
Population	73,202	72,878	73,733	75,277	77,176	78,909	80,989	85,149
Round-off Value					77,200	78,900	81,000	85,100

Future residential water demand projections will utilize the combined New Britain population estimates, combined with the estimated 2,070 residential service population for direct metered customers in the four other towns (Newington, Berlin, Plainville and Farmington). LEI will use the rounded off values in the future residential water demand projections.

5) Future Water Demand Projections for 2020, 2030 and 2060 – **Table 5-4** includes a portion of **Table 5-2**, and adds columns for the 2016 water consumption values by user category, and future five year (2020), twenty year (2030) and fifty year (2060) planning periods. Note that DPH guidelines require the twenty and fifty year planning periods be taken from the last ten year census date; hence, the twenty year planning period takes place in 2030, and the fifty year planning period takes place in 2060.

a) Future Residential Demands - Future residential demands are based on the combined projected New Britain population, combined with the estimated 2,070 out-of-town customers that are direct metered customers of New Britain, multiplied by the historic 52 gallons per capita per day value calculated earlier in this chapter.

Residential water demands are projected to increase from 3.89 MGD to 4.53 MGD, a total of **0.64 MGD** (640,000 gpd) by **2060**.

b) Future Commercial Demands - As noted previously in Section 3, City of New Britain Plan of Conservation and Development review, future commercial growth appears limited. LEI utilized 11.1 gallons per capita per day value from **Table 5-1** for commercial water demand, multiplied by the total estimated service population, to project future commercial water demands.

Commercial water demands are projected to increase from 0.84 MGD to 0.99 MGD, or a total of **0.15 MGD** (150,000 gpd) by **2060**.

c) Future Industrial Demands - As noted previously in Section 3, City of New Britain Plan of Conservation and Development review, future industrial growth appears limited. LEI utilized the 0.8 gallons per capita per day value from Table 5-1 for industrial water demand, multiplied by the total estimated service population, to project future industrial water demands.

Industrial water demands are projected to stay steady, and remain at **0.06 MGD** (60,000 gpd) through **2060.**

d) Other Water Demands - Other water demands include municipal, governmental, religious institutions and other miscellaneous customers not classified as residential, commercial or industrial. LEI utilized the 8.2 gallons per capita per day value for 2016, multiplied by the total estimated service population, to project future water demands for "other" users.

Other water users are projected to increase from 0.62 MGD to 0.70 MGD, or a total of **0.08 MGD** (80,000 gpd) through 2060.

Table 5 -4 Historic & Projected Demand by User Category
City of New Britain Water Department
(Demands in MGD)

							5 - Yr. Average		5-Yr. Planning Period	20-Yr. Planning Period	50-Yr. Planning Period
		2011	2012	2013	2014	2015		2016	2020	2030	2060
1	Residential							3.89	4.06	4.21	4.53
2	Industrial							0.06	0.06	0.06	0.06
3	Commercial							0.84	0.88	0.91	0.99
4	Municipal/ Other Users							0.62	0.62	0.65	0.70
5	Total Direct Sales	5.63	5.59	5.45	5.55	5.42	5.53	5.45	5.62	5.83	6.28
6	New Britain Service Population	73,200	73,200	73,200	72,878	73,733			76,100	78,900	85,100
7	Out-of-Town Service Population	2,070	2,070	2,070	2,070	2,070			2,070	2,070	2,070
8	Total Residential Population Served	75,270	75,270	75,270	74,948	75,803			78,170	80,970	87,170
	Sale for Resale Customers										
9	Kensington Fire District	0.48	0.73	0.72	0.71	0.78	0.68		0.80	0.92	0.97
10	Berlin Water	0.96	0.46	0.46	0.49	0.54	0.58		0.80	0.80	0.80
11	Bristol Water	0.24	0.24	0.20	0.24	0.25	0.24		0.50	0.50	0.50
12	Valley Water								0.20	0.20	0.20
13	Total Sale for Resale	1.68	1.43	1.38	1.44	1.57	1.50		2.30	2.42	2.47
14	Total Consumptive Use	7.31	7.02	6.83	6.99	6.99	7.02		7.92	8.25	8.75
15	Total Non-Revenue Consumption	1.77	1.66	2.06	2.23	2.40	2.02		1.98	2.06	2.19
16	Non-Revenue Consumption (% of Total)	19.4	19.1	23.1	24.2	25.5	22.3		25.00%	25.00%	25.00%
17	Backwash water and Filter to waste usage	0.18	0.21	0.14	0.17	0.13	0.17				
18	Other Non-Revenue Water (Flushing, Fires, Etc)	0.10	0.10	0.10	0.10	0.10	0.10				
19	Total Non-Revenue Accounted for Water (MGD)	0.28	0.31	0.24	0.27	0.23	0.27				
20	Total Unaccounted-for Non-Revenue Water MGD and %)	1.49	1.35	1.82	1.96	2.23	1.77				
21		16.40%	15.50%	20.40%	21.20%	23.70%	19.50%				
22	Average Day Demand	9.08	8.68	8.89	9.22	9.39	9.05		9.90	10.31	10.94
23	Maximum Day Demand	12.72	11.64	12.66	12.01	11.52	12.11		13.24	13.79	14.63
24	Maximum Month Demand	10.67	9.97	10.12	10.08	10.33	10.23		11.19	11.65	12.36

e) Sale for Resale Customers - Refer to Section C for historic and projected future demands for the four Sale for Resale customers, Kensington Fire District, Berlin Water Control Commission, Bristol Water Department and Valley Water systems.

Total Sale for Resale customer demand is projected to increase from 1.50 MGD in 2015, to 2.47 MGD by 2060, or a total of **0.97 MGD** (970,000 gpd).

f) Non-revenue Consumption - An allowance of 25 % for future non-revenue consumption is provided, which is similar to 2014 and 2015 values. Note that this value includes both a) accounted-for non-revenue water (filter backwash, filter-to-waste, hydrant flushing, fires, street department use, etc.) as well as b) un-accounted for non-revenue water. Long term reductions in non-revenue water can help lower this value to some degree.

g) Projected Average Daily Demands - Total system average daily demand is projected to increase from the 2015 value of 9.39 MGD, to approximately 10.94 MGD by 2060, an increase of **1.55 MGD**.

h) Projected Maximum Daily and Maximum Month Average Daily Demands – Utilizing the historic ratios of these values to the average daily demand, 1.34 for maximum daily demand (MDD) and 1.13 for maximum month average daily demand (MMADD), LEI estimated future demands.

The estimated 2060 maximum month average daily (MMADD) and maximum daily demands (MDD) are **12.36 MGD** and **14.63 MGD**, respectively.

i) Impacts of Increased Demands on Future Available Supply and Margins of Safety - These will be discussed later in Chapter 12.

C) Historic and Projected Water Demands - Interconnected Public Water Systems

1) Historic and Projected Water Demands - Kensington Fire District

a) System Description - The Kensington Fire District (Kensington) has no sources of its own, and purchases 100% of its water from New Britain at three treated water connections near the Berlin / New Britain town line. Kensington also maintains a treated water connection with the Berlin Water Control Commission, which is very lightly utilized, mainly to equalize pressures between both systems. Kensington has approximately 3,117 residential, commercial, industrial and public authority service connections, and serve an estimated population of 8,300.

b) Agreements - In 2001, KFD entered into a 30-year agreement with NBWD, and purchasing water exclusively from New Britain, with the exception of a very small area which is served from Berlin. The current contract between Kensington and New Britain allows an unlimited amount of purchased water.

c) Permits - New Britain has a 2012 approved DPH Sale of Excess Water Permit for sales of water to Kensington, at a rate of 0.78 mgd. In 2016, Kensington obtained a DEEP diversion permit renewal for their New Britain interconnections, which allow for up to 1,000,000 gpd flows to meet maximum monthly and maximum daily demands.

d) Historic Water Purchased From New Britain - **Table 5-5** shows the purchased water from New Britain between 2011 and 2015, along with the 5 year average.

TABLE 5-5
HISTORIC PURCHASES FROM NEW BRITAN
KENSINGTON FIRE DISTRICT

Year	2011	2012	2013	2014	2015	Five Year Average
Ave. Daily Demand (mgd)	0.48	0.73	0.72	0.71	0.81	0.68

e) Historic Water Use - Kensington recently updated its Water Supply Plan in July of 2016, which was prepared by Lenard Engineering, Inc.(LEI). Historic water demands were updated through the last full year of record (2015), which showed an average daily demand of approximately 810,000 gpd. As noted above, all of this water was purchased from New Britain.

Table 5-6 below shows the 2015 average daily demand (ADD), maximum month average daily demand (MMADD), and maximum daily demands (MDD), reproduced for Kensington's 2016 Water Supply Plan.

TABLE 5-6
HISTORIC AND PROJECTED WATER DEMANDS
KENSINGTON FIRE DISTRICT

Year	**ADD**	**MMAD**	**MDD**	**NB Water Purchased (GPD)**	**SEW Limit (GPD)**
2015	805,463	1,145,540	1,208,194	805,563	780,000
2020	800,215	1,040,279	1,200,322	800,215	-
2030	924,533	1,201,892	1,386,799	924,533	-
2060	966,690	1,256,697	1,450,035	966,690	-

f) Future Water Demand Projections - The 2016 Water Supply Plan estimates average daily water demands will drop slightly in 2020, due to anticipated reductions in non-revenue water, and then increase by approximately 161,000 gpd, or 17 % in the 45 year period between 2015 and 2060. It is assumed the Kensington will continue to purchase 100 % of its water from New Britain in the future.

The DPH Sale of Excess Water Permit and potentially the DEEP Water Diversion permit limit will have to be adjusted in future years when these permits are periodically renewed, to account for future increases in water demands.

2) Historic and Projected Water Demands - Berlin Water Control Commission

a) System Description - The Town of Berlin Water Control Commission (Berlin) utilizes both groundwater as well as interconnections with New Britain, Cromwell and MDC to meet its water demands. Berlin has approximately 2,573 residential, commercial, industrial and public authority service connections, and serves an estimated population of 7,345.

b) Agreements - In 2006, Berlin entered into an agreement with New Britain, to purchase a minimum of 400,000 gpd. This agreement has no maximum value restriction with respect to water purchases.

c) Permits - New Britain has a 2012 approved DPH Sale of Excess Water Permit for sales of water to Berlin at a rate of up to 800,000 gpd.

d) Historic Water Purchased from New Britain **Table 5-7** shows Berlin's purchased water from New Britain between 2011 and 2015, along with the five year average. As shown, these values have remained have ranged from 460,000 gpd in 2012 and 2013, to a high of 960,000 gpd in 2011.

TABLE 5-7
HISTORIC PURCHASES FROM NEW BRITAIN
BERLIN WATER CONTROL COMMISSION

Year	2011	2012	2013	2014	2015	Five Year Average
Ave. Daily Demand (mgd)	0.96	0.46	0.46	0.49	0.54	0.58

e) Historic Water Demands - Berlin Water Control Commission updated its Water Supply Plan in July of 2012, which was prepared by Lenard Engineering Inc. (LEI). Historic water demands were updated through 2015, which showed an average daily demand of approximately **1,098,000 gpd. Table 5-8** below shows the 2015 average daily demand (ADD), maximum month average daily demand (MMADD), and maximum daily demand (MDD, as well as the amount of New Britain water purchased in 2015.

TABLE 5 - 8
HISTORIC AND PROJECTED WATER DEMANDS
BERLIN WATER CONTROL COMMISSION

Year	ADD	MMAD	MDD	NB Water Purchased (GPD)	SEW Limit (GPD)
2015	1,098,000	1,647,000	1,318,000	540,000	800,000
2020	1,098,000	1,647,000	1,318,000	800,000	800,000*
2030	1,119,000	1,647,000	1,318,000	900,000	800,000*
2060	1,259,000	1,889,000	1,511,000	900,000	800,000*

*SEW permit value to be increased in future

f) Future Water Demand Projections - Average daily demands in Berlin are estimated to increase by 161,000 gpd over the next 45 years, or approximately 13 %. Future water purchases from New Britain are estimated to remain at their current 800,000 gpd Sale of Excess Water Permit value for 2020, and increase to 900,000 gpd through the year 2060, to meet a portion of the future growth in Berlin.

3) Historic and Projected Water Demands - Bristol Water Department

a) System Description - The City of Bristol Water Department (Bristol) obtains its drinking water from a combination of both surface and ground water supplies, as well as a treated water interconnection with New Britain. Detailed information on Bristol's system, as well as existing and future water demand projections were not available from Bristol for this report, so LEI utilized published information from public sources for our data.

b) Agreements - In 2011 , Bristol entered into a 10-year agreement with New Britain, which has a maximum limit of 500,000 gpd.

c) Permits - New Britain has an 2012 approved DPH Sale of Excess Water Permit for sales of water to Bristol, at a rate of up to 500,000 gpd.

d) Historic Water Purchased From New Britain - **Table 5-9** shows Bristol's purchased water from New Britain between 2011 and 2015, along with the 5 year average. As shown, these values have remained fairly steady, ranging from a low of 200,000 gpd in 2013, to a high of 250,000 gpd in 2015.

TABLE 5-9
HISTORIC PURCHASES FROM NEW BRITAIN
BRISTOL WATER DEPARTMENT

Year	2011	2012	2013	2014	2015	Five Year Average
Ave. Daily Demand (mgd)	0.24	0.24	0.20	0.24	0.25	0.24

e) Historic Water Demands - Records of historic water demands and water demand projections were not available from the Bristol Water Department; thus, LEI utilized publically available information from the Bristol Water Department website for this study. As given in Bristol's Consumer Confidence Report, the 2015 average daily demand was 5.43 mgd, with a maximum daily demand of 8.02 mgd. These are shown below in **Table 5-10.**

TABLE 5 – 10
HISTORIC AND PROJECTED WATER DEMANDS
BRISTOL WATER DEPARTMENT

Year	ADD	MMAD	MDD	NB Water Purchased (GPD)	SEW Limit (GPD)
2015	5,430,000		8,024,000	253,000	500,000
2020	-		-	500,000	500,000
2030	-	-	-	500,000	500,000
2060	-	-	-	500,000	500,000

f) Future Water Demand Projections - Due to lack of available information on future water demand projections, LEI assumed that Bristol would utilize their New Britain connection up to the current 500,000 gpd permit value, for the planning periods from 2020 through 2060. As this connection has additional hydraulic capacity, New Britain has the ability to provide additional volumes of water if requested.

4) Historic and Projected Water Demands, Valley Water Systems, Plainville, CT

a) System Description - Valley Water Systems (Valley) is a privately owned water utility serving over 18,231customers in Plainville, Southington, and Farmington, Connecticut. The Company provides approximately 1.6 million gallons per day to its customers in a region having a relatively large commercial and industrial base. Valley's relies on groundwater from two wellfields as their primary source of supply.

b) Agreements – Valley Water Systems and New Britain have no formal contract for the purchase of water; Valley is treated as a New Britain customer.

c) Permits - New Britain has an 2012 approved DPH Sale of Excess Water Permit for sales of water to Valley, at a rate of up to 200,000 gpd.

d) Historic Water Purchases from New Britain – Between 2011 and 2015, Valley has not purchased water from New Britain, with the exception of 34 metered connections in Plainville which are billed directly as New Britain customers.

e) Historic Water Demands - Valley's water demands were updated through the last full year of record (2015), which showed an average daily demand of approximately 1.55 mgd. **Table 5-11** below shows the 2015 average daily demand (ADD), maximum month average daily demand (MMADD), and maximum daily demands (MDD), obtained from their 2016 Water Supply Plan.

TABLE 5-11
HISTORIC AND PROJECTED WATER DEMANDS
VALLEY WATER SYSTEMS

Year	ADD	MMAD	MDD	NB Water Purchased (GPD)	SEW Limit (GPD)
2015	1,550,000	2,100,000	2,560,000	0	200,000
2020	1,530,000	2,250,000	3,200,000	200,000	200,000
2030	1,430,000	2,110,000	2,990.000	200,000	200,000
2060	1,190,000	1,760,000	2,490,000	200,000	200,000

Valleys' Water Supply Plan states there has been a decrease in residential per capita consumption and due to high efficiency appliances creating a decreases in water use over time. Population estimates are also noted to drop over the 50 year period.

f) Future Water Demand Projections - The average daily demand will decrease over the 45 year period by 360,000 gpd or 23%. LEI has assumed that Valley will purchase no more than their current Sale of Excess Water permitting volume, 200,000 gpd, between 2020 and 2060. The Valley interconnection has significant additional capacity to provide additional water, in the event Valley requests it in the future.

Appendix 5-1

2016 New Britain Water Consumption Breakdown Worksheet

Lenard Engineering, Inc.

Usage is in gals & ADD Table 2 revised

Municipality	Residential	Commercial	Industrial	Institutional	Other	total
New Britain	3,754,543	767,265	57,651	38,050	622,750	5,240,258
Newington	63,195	10,203				73,398
Kensington	9,800				759,728	769,528
Berlin		83			715,432	715,515
Farmington	62,951	61,710				124,660
Bristol					230,889	230,889
Plainville	2,076	1,680			110	3,867
Hartford					141	141

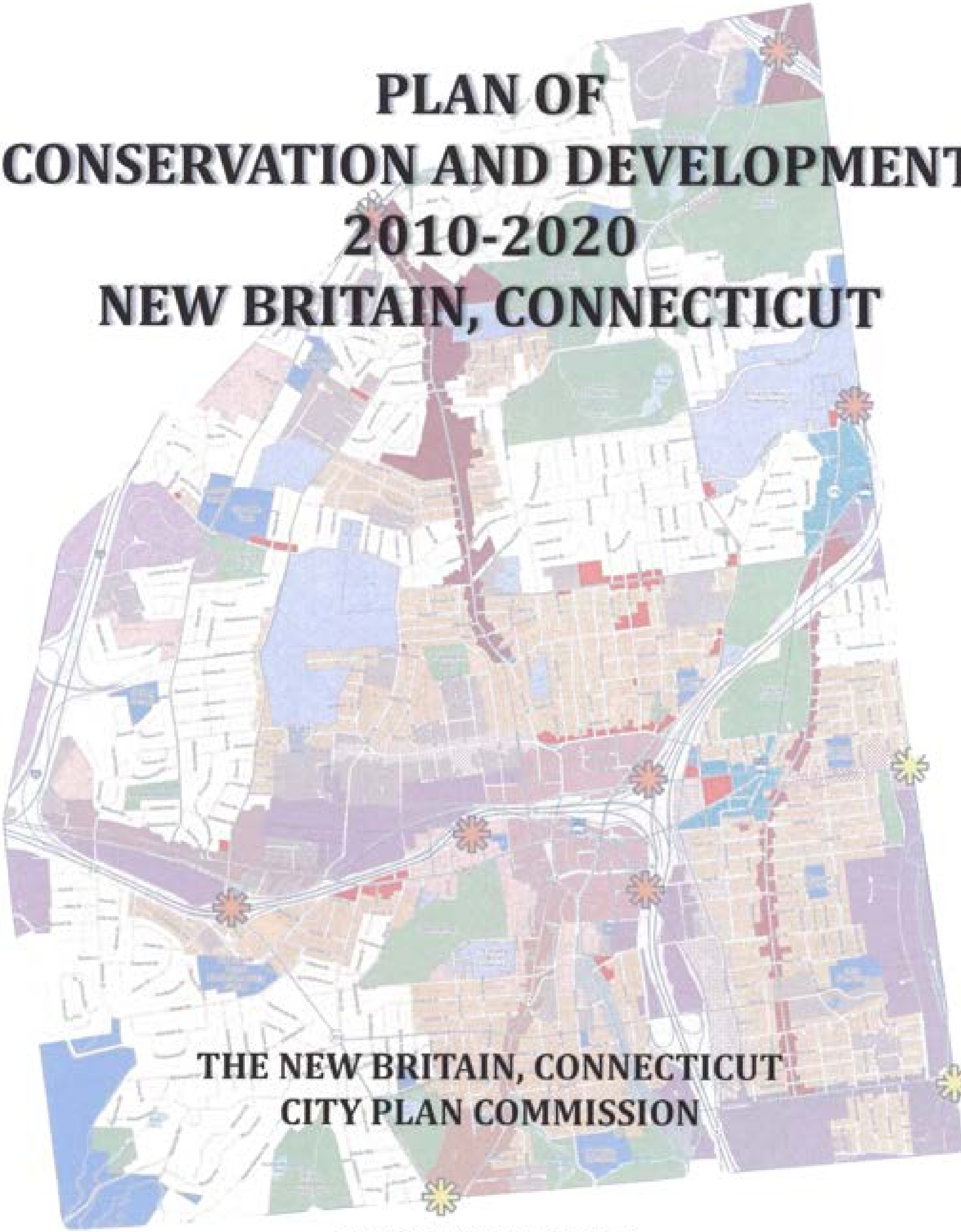
	CLASS	USAGE cuft			Gallons	ADD in gallons	
1	SINGLE	66,000,011	res-nb		493,746,082	1,349,033	
2	MULTI F	93,937,277	res-nb		702,744,769	1,920,068	
3	MULTI F	16,217,210	res-nb		121,320,948	331,478	
4	INDUSTR	2,548,441	ind-nb		19,064,887	52,090	
5	COMMERC	37,537,608	com-nb		280,818,845	767,265	
6	MUNICIP	7,347,593	oth-nb		54,967,343	150,184	
7	FEDERAL	5,705,090	oth-nb		42,679,778	116,611	
9	RESIDEN	3,079,787	res-far		23,039,887	62,951	
11	COMMERC	3,019,085	com-far		22,585,775	61,710	
12	RESALE-	5,400	oth-pl	(cancer ctr)	40,397	110	
17	RELIGIO	1,861,558	ins-nb		13,926,315	38,050	
18	SINGLE	4,554,926	res-nb		34,075,401	93,102	
19	CONDOMI	2,946,934	res-nb		22,046,013	60,235	
20	STATE G	400	oth-nb		2,992	8	
21	MUNICIP	6,900	oth-htfd	batterson pk = HTFD	51,619	141	
22	RESIDEN	3,091,772	res-new		23,129,546	63,195	
23	COMMERC	499,162	com-new		3,734,231	10,203	
24	COMPOUN	17,414,296	oth-nb		130,276,348	355,946	
25	RESIDEN	479,458	res-ken		3,586,825	9,800	
27	RESIDEN	101,568	res-pl		759,830	2,076	
28	COMMERC	82,200	com-pl		614,938	1,680	
30	COMMERC	4,080	com-be		30,522	83	
32	RES 2-1	30,700	res-nb		229,667	628	
		266,471,456			1,993,472,962	5,446,647	
13	Resale Bristol	11,296,000	oth-br	aka "Water Transfers"	84,505,376	230,889	
15	Resale Kens Fire	37,168,900	oth ken	aka "Water Transfers"	278,060,541	759,728	
16	Resale Berlin Wa	35,001,736		aka "Water Transfers"	261,847,987	715,432	
4	Industial						
	Stanley Tool	181,050	ind-nb		1,354,435	3,701	
	Stanley Wks	91,000	ind-nb		680,771	1,860	
Grand Total:		350,210,142		gals:	2,619,922,072	7,158,257	gals ADD

1 Single Fam Single Family Residential
2 Multi Fam Multifamily 2-10 units
3 Multifamil Multifamily more than 10
4 Industial Industrial
5 Commerci Commercial
6 Municipal Municipal
7 Federal Hc Federal Housing
8 State Hous State Housing
9 Res Farmir Residential Farmington
10 Indus out Industrial Out of Town
11 Comm Far Commercial Farmington
12 Resale Plai Resale Plainville
13 Resale Bris Resale Bristol
14 Resale MD Resale MDC
15 Resale Ker Resale Kens Fire District
16 Resale Ber Resale Berlin Water
17 Religious I Religious Institution
18 Single Fam Single Family Condominium
19 Condo Ass Condominium Assn Meter
20 State Gove State Government Building
21 Mun out o Municipal out of town
22 Residentia Residential Newington
23 Comm Nei Commercial Newington
24 Compounc Compound Meter
25 Res Kensin Residential Kensington
26 Com Kensi Commercial Kensington
27 Res Plainvi Residential Plainville
28 Com Plain Commercial Plainville
29 Residentia Residential Berlin
30 Commerci Commercial Berlin
31 Swr Balan Sewer Balance Housing
32 Res 2-10 U Res 2-10 U CCND

Appendix 5-2

Excerpts from 2010 New Britain Plan of Conservation and Development

PLAN OF CONSERVATION AND DEVELOPMENT 2010-2020 NEW BRITAIN, CONNECTICUT



THE NEW BRITAIN, CONNECTICUT CITY PLAN COMMISSION

DECEMBER 2010

DEVELOPMENT PATTERNS & TRENDS

INTRODUCTION

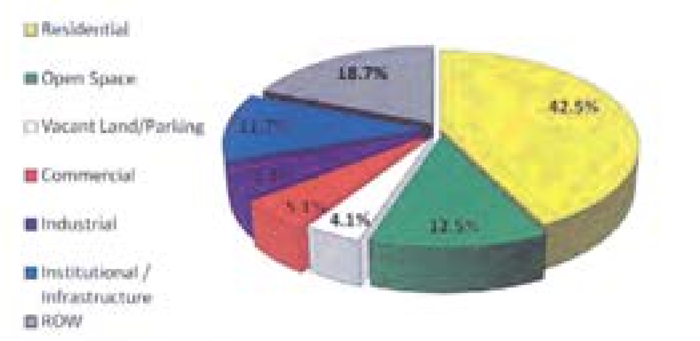
The built environment contributes greatly to the character of a community. Understanding the types, location and intensity of existing land uses enables a community to create a vision and plan for the future. Knowing the specific location of uses, on a parcel level, can help identify areas that may have potential for economic development, housing, public facilities, or open space protection. The City's zoning and land use regulations are its tools for not only controlling its land uses but also influencing future development patterns. This section describes in detail the existing land use composition of New Britain, including a series of maps showing potential development constraints, existing zoning, and other influences on land use. This chapter also provides an assessment of the City's capacity to accommodate new development.

LAND USE INVENTORY

The City's digital parcel base map, which includes land use, zoning, and assessment information, provided the basis for the following analysis. While this level of detail is useful for quantifying land use patterns and trends, it is important to recognize that this analysis intends to provide a generalized assessment of land use patterns to help indicate growth trends and potential for the future.

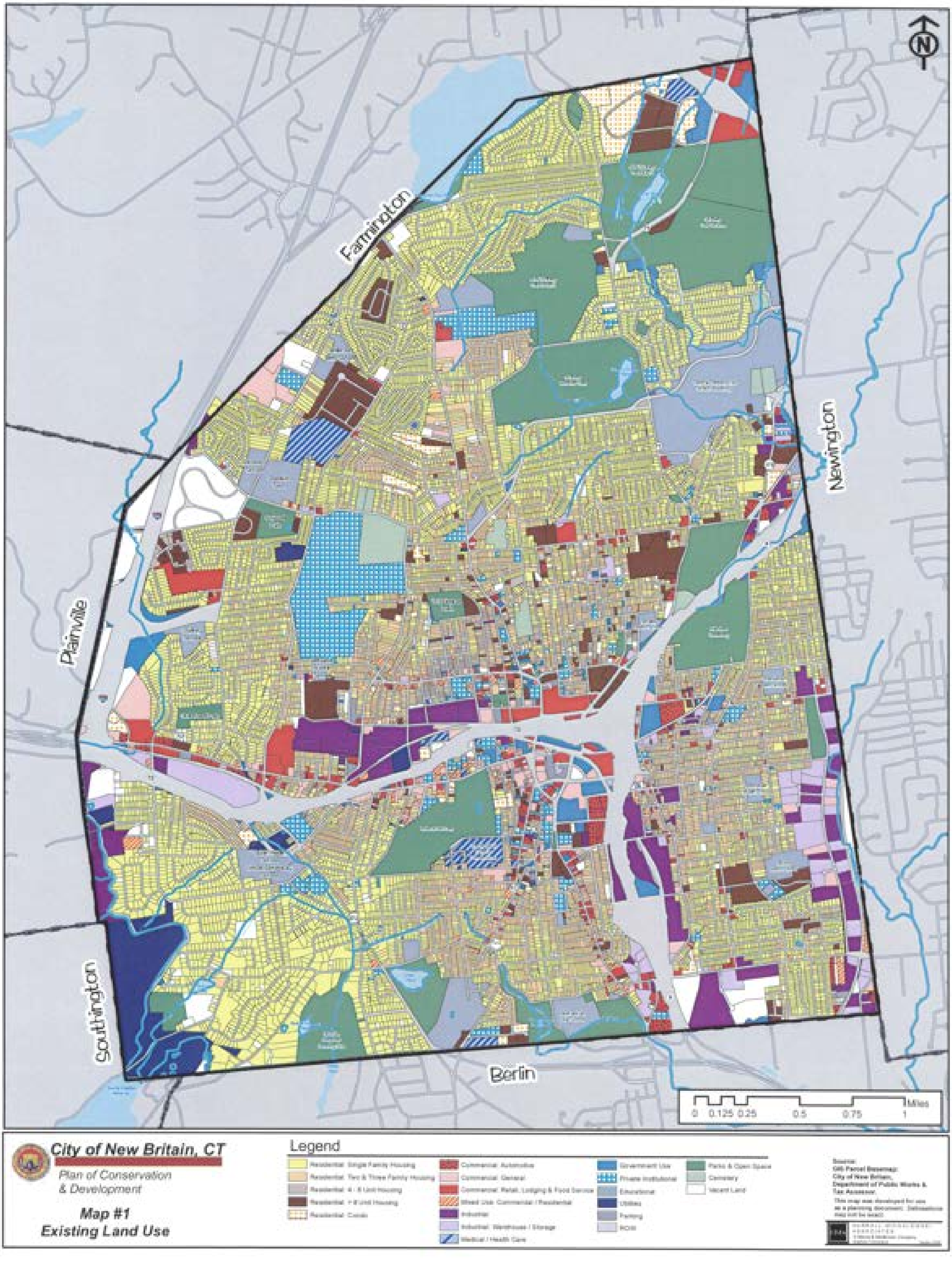
Figure 1 and Map 1 show the break-down of land use by six major categories and 21 subcategories in the City. Approximately 84% of the City's land is developed, with the largest amount of that devoted to residential use. The next largest use, in terms of land area, is right-of-way (ROW) at about 19% - predominantly within the Routes 9 and 72 corridors. **About 13% of land area in the City is considered open space, 10.5% of which represents parks and protected open space. Commercial and Institutional uses account for about 12%, while industrial land accounts for 10% of New Britain's land area. Mixed-use development, consisting of parcels that blend residential and commercial uses, accounts for less than 1% of New Britain's total land.**

Figure 1: Existing Land Use 2009



Commercial / Industrial

In comparison to New Britain's 10% of commercial and industrial land use, the percentage of land used for commercial or industrial purposes in some other larger Connecticut municipalities are: New Haven, 11%; Meriden, 10%; West Haven, 12%; and East Hartford, 13%. As pointed out in the chapter on the economy, about a third of the land zoned I-1 and I-2 is used for right-of-way, and only about 36% is actually in industrial use.



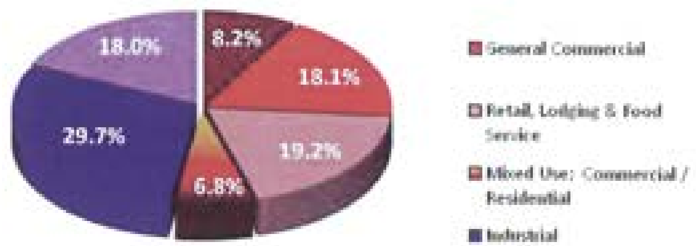
City of New Britain, CT

Plan of Conservation & Development

Map #1 Existing Land Use

Retail, automotive and general commercial uses are densely clustered in both the major east-west and north-south transportation corridors, as well as adjacent to Routes 9 and 72. Mixed-use development is clustered in and around Main Street in the Downtown and along Broad Street. Industrial uses are clustered in the John Downey Drive Industrial Park and lands adjacent to the highway and rail corridors throughout the City. Figure 2 shows a detailed summary of Commercial and Industrial Land Use Composition in the City.

Figure 2: Commercial & Industrial Land Use Composition



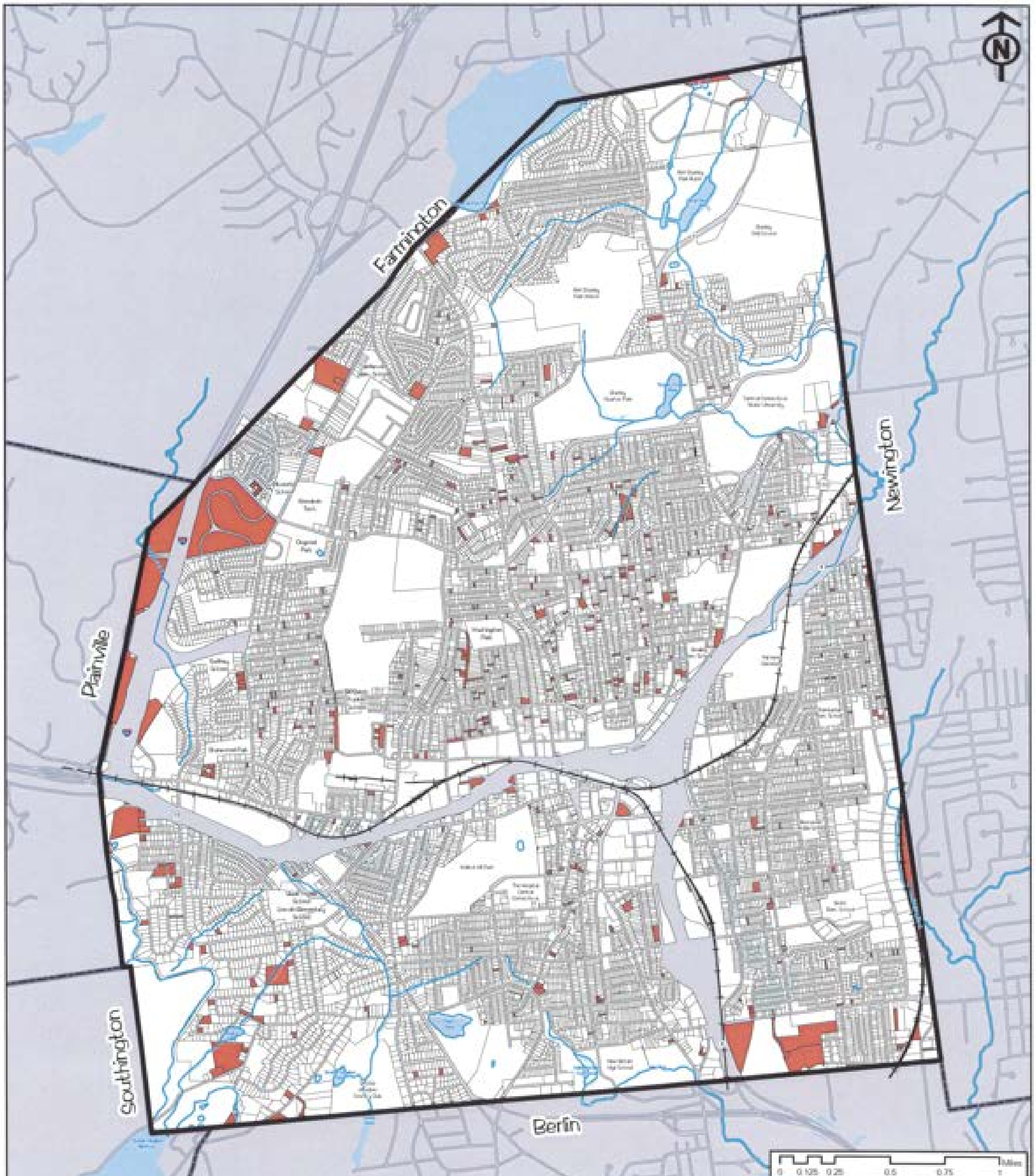
Institutional / Infrastructure & ROW

Educational uses account for a large part of the approximate 12% of land area in institutional or infrastructural use. Central Connecticut State University and New Britain Public Schools primarily account for the 353 acres (4% of all land) in educational use. The remaining 658 acres contain municipal, medical, religious, fraternal, and other non-profit institutions. As mentioned above, Routes 9 and 72 largely account for the additional 1,627 acres, 19% of all land, classified as ROW.

Open and Vacant Land

The City has 909 acres designated as open space, representing land used for active and passive recreation and generally protected from future development. The City is just short of the State's stated goal of having each municipality protect 11% of its land from development, with 10.5% of its land dedicated to parks and preserved open space. Most of the City's open space inventory is contained in a few large facilities. In fact, the Stanley Golf Course, Walnut Park, Stanley Quarter Park, and AW Stanley Park contain over 70% of the City's open space. An additional 2% of New Britain's land is classified as public and private cemeteries.

With only approximately 354 acres of vacant land, on 512 parcels, a limited amount of future development is anticipated for vacant lots. Vacant lands are mostly small lots, with a 0.2 acre median lot size. Only 16 parcels have a lot size greater than four acres and only 12 parcels contain two to four acres. Moreover, this vacant land calculation fails to account for physical development constraints such as wetlands, floodplains, and steep slopes that further reduce the effective amount of developable land. The distribution of vacant land is shown on Map 2 on the following page. Vacant land is further defined as residential and non-residential land based on current zoning and displayed on Maps 3 and 4.



City of New Britain, CT

Plan of Conservation & Development

Map #2

Vacant Land

Legend

Vacant Land

Source:
GIS Parcel Basemap:
City of New Britain,
Department of Public Works &
Tax Assessor.

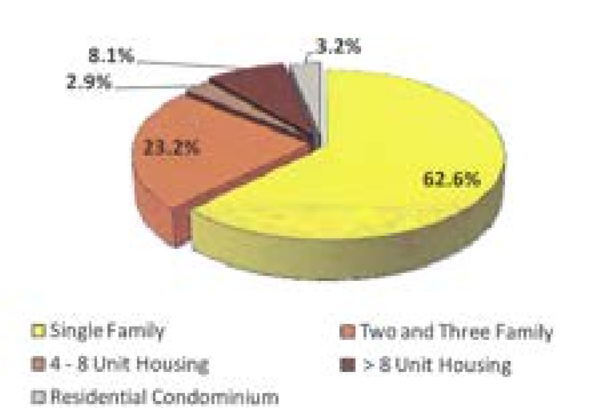
This map was developed for use as a planning document. Delineations may not be exact.

The limited amount of vacant land in the City indicates that future growth especially in core areas of the City will likely involve "infill" development projects to fill in the gaps of existing land use pattern. In addition, it is likely that many of the new commercial developments that will occur in New Britain over the next decade are likely to involve redevelopment projects, or conversion of abandoned and obsolete land uses and brownfields into new redefined development projects. Evidence of this trend is already apparent. Smart Park I, Smart Park II, and Pinnacle Heights Business Park are a few of the recently completed and ongoing redevelopment and reuse projects in New Britain.

Residential

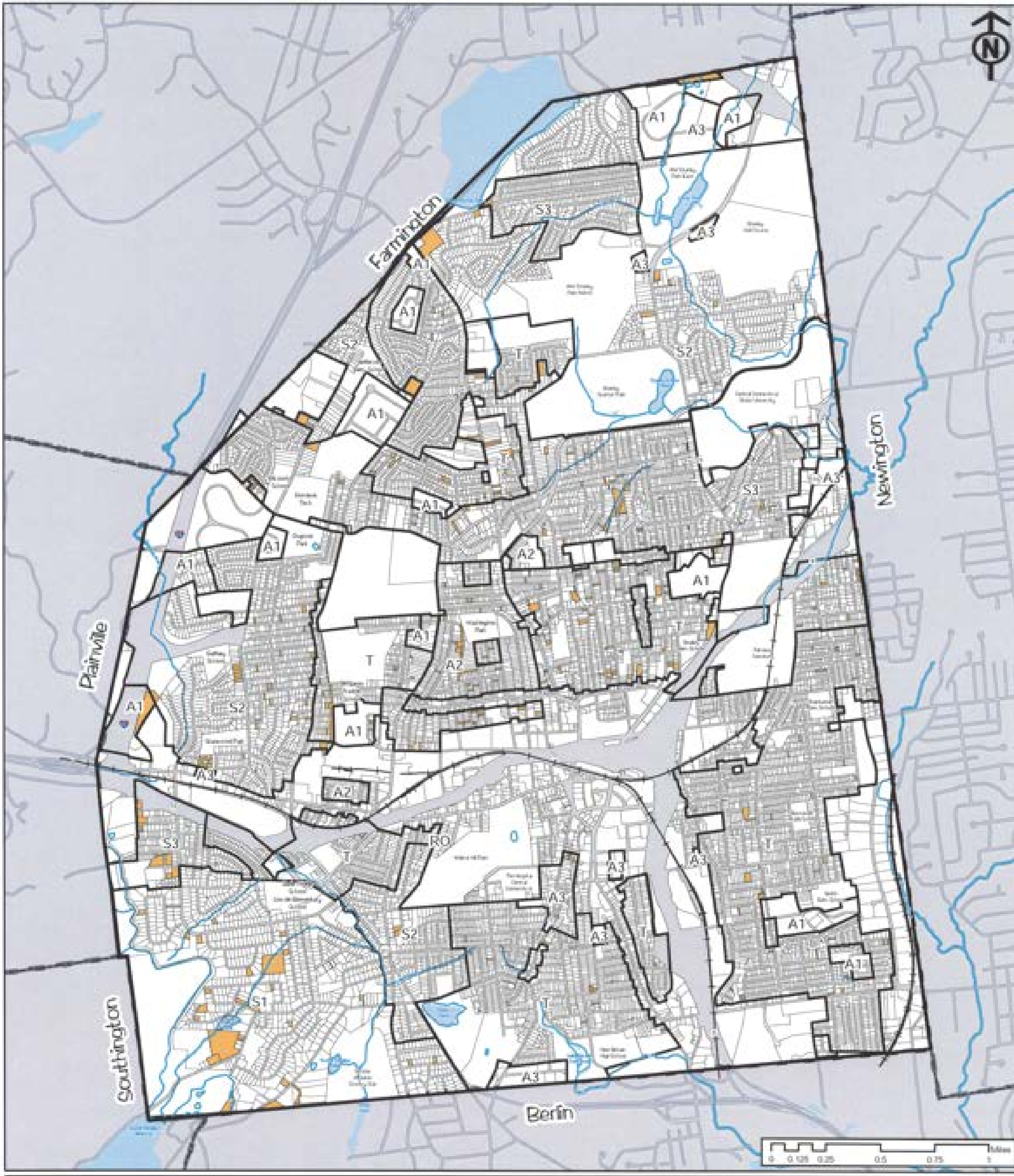
At 3,664 acres, residential use is the most prevalent land use in the City, and it is predominantly single-family, as shown in Figure 3. Nevertheless, two- and three-family residences comprise about 23% of all residential lands. Single-family developments are clustered in the southwest, the northern tier in the vicinity of Stanley Park and Central Connecticut State University, and to a lesser extent roughly west of Slater Road, and along the periphery of the City. Two- and three-family housing is densely clustered around Burritt Street, extending into the eastern side of the Broad Street NRZ, and within the Arch and East Street NRZs. Multi-Family housing, four to eight units per structure, is primarily located near the city center, particularly the Broad Street NRZ. High density multi-family housing, more than eight units per structure, is distributed throughout the City with clusters near and radiating from the Downtown.

Figure 3: Residential Land Use Composition



ANALYSIS OF DEVELOPMENT CAPACITY

Understanding where developable land is located within the City and how much development can be accommodated based on existing regulatory controls and physical constraints is the first step in establishing a plan for the future. Once this is accomplished, issues such as infrastructure limitations and natural resource protection can be factored in to properly plan for new growth. This development capacity is expressed in terms of potential dwelling units for vacant and under-utilized land zoned residential and potential square feet of development for areas zoned commercial or industrial. For this analysis, under-utilized parcels are defined as residentially zoned lots that are greater than three times the required minimum lot size by zone.



City of New Britain, CT

Plan of Conservation & Development

Map #3

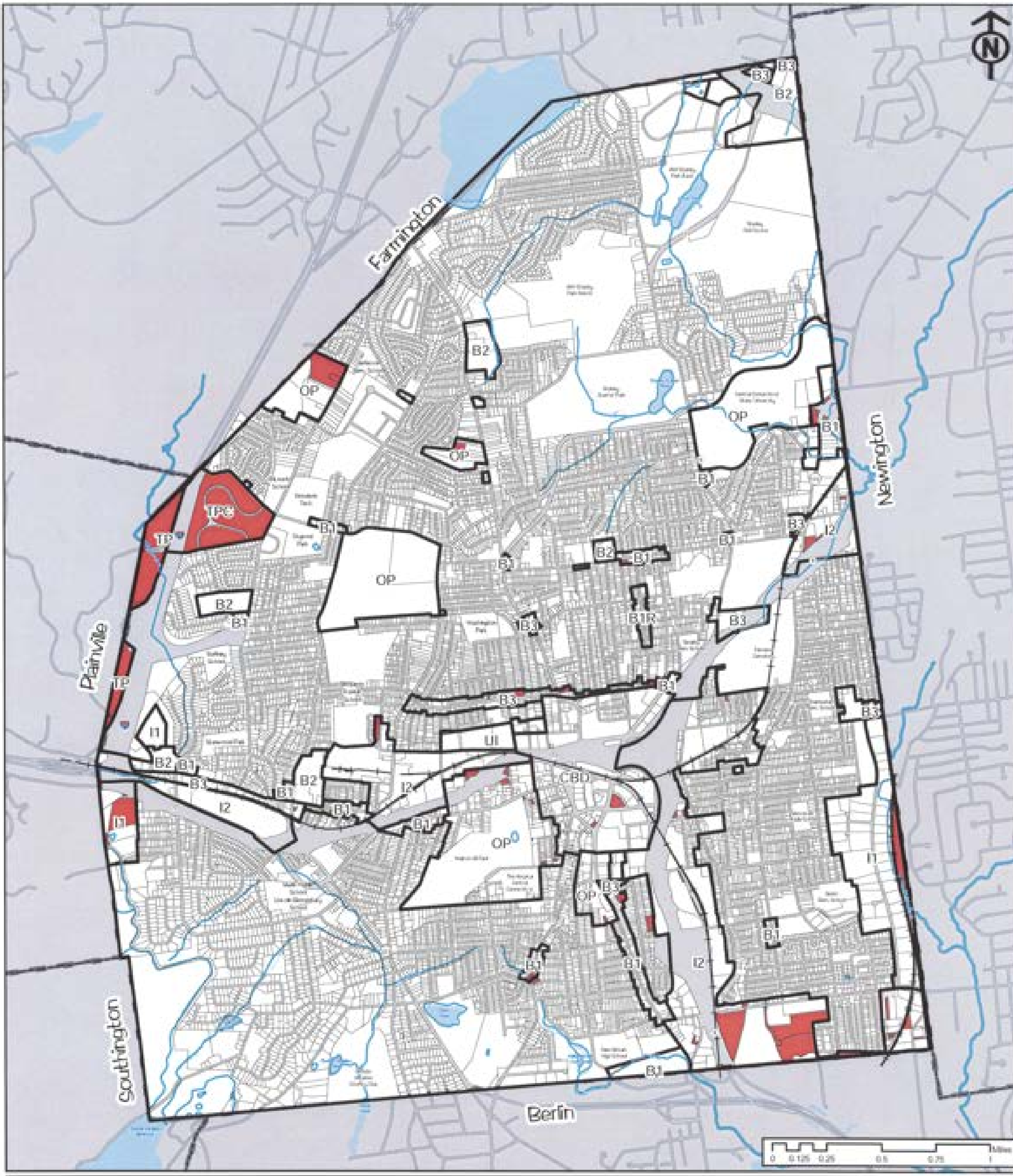
Residentially Zoned Vacant Land

Legend

- Residentially Zoned Vacant Land
- Zoning District Boundary

Source:
GIS Parcel Basemap & Zoning Map
City of New Britain,
Department of Public Works
& Tax Assessor

This map was developed for use as a planning document. Delineations may not be exact.



City of New Britain, CT

Plan of Conservation & Development

Map #4

Non-Residentially Zoned Vacant Land

Legend

Non-Residentially Zoned Vacant Land

Zoning District Boundary

Source:
GIS Parcel Basemap & Zoning Map
City of New Britain,
Department of Public Works
& Tax Assessor.

This map was developed for use as a planning document. Delineations may not be exact.

Hydrogeologic Impact Assessment, Proposed Quarry Expansion and Storage Reservoir

(Leggette, Brashears and Graham)

**HYDROGEOLOGIC-IMPACT ASSESSMENT
PROPOSED QUARRY EXPANSION AND
STORAGE RESERVOIR CREATION
CITY OF NEW BRITAIN, CONNECTICUT**

Prepared for

Lenard Engineering, Inc.

December 2017

Prepared By:

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HYDROGEOLOGIC-IMPACT ASSESSMENT
PROPOSED QUARRY EXPANSION AND STORAGE RESERVOIR CREATION
CITY OF NEW BRITAIN, CONNECTICUT

1.0 INTRODUCTION

Leggette, Brashears & Graham, Inc. (LBG) was retained by Lenard Engineering, Inc. (LEI) to conduct a hydrogeologic-impact assessment for a proposed storage reservoir both within a portion of the existing quarry operated by Tilcon Connecticut, Inc. (Tilcon) and including excavation on watershed land to the south owned by the City of New Britain (the City). This assessment is part of an environmental study and water supply planning commissioned by the City of New Britain (New Britain) under the auspices of Public Act 16-1, "An Act Concerning an Environmental Study on a Change in Use of New Britain Water Company Land." The proposed storage reservoir would be used by the NBWC to augment the water supply for the City.

This assessment was designed to make a preliminary evaluation of potential hydrogeologic impacts from the proposed quarry expansion and reservoir creation on local surface-water and groundwater resources; specifically watercourses, wetlands, potential vernal pools and nearby surface-water impoundments to the south of the existing quarry and any nearby private or public water-supply wells. For the purpose of this assessment, the Study Area has been limited to the Tilcon property, the City-owned parcel to the south and nearby environs within approximately 3,500 feet of the Tilcon and City-owned parcel (figure 1). The scope of the assessment included the following activities:

- Review of in-house and readily available hydrogeologic information for the Study Area;
- Review of relevant project drawings and documents including plans for the proposed quarry expansion and storage reservoir, wetland and watercourse delineations and studies, Tilcon water diversion permits and water use reports;
- Lineament analysis for fractured bedrock in the Study Area;
- Site inspections of the existing quarry, proposed quarry expansion/storage reservoir area including watercourses, wetlands and potential vernal pools;
- A well-inventory survey for nearby properties;

- A watershed and drainage basin analysis for nearby surface-water resources for pre- and post-expansion/storage reservoir conditions;
- Installation and measurement of groundwater piezometers in watercourses, wetlands and potential vernal pools;
- Data compilation and interpretation to make a preliminary hydrogeologic-impact assessment for the proposed quarry expansion/storage reservoir;
- Consideration of significant data gaps and evaluation of potential mitigation measures, as necessary; and
- Preparation of the Hydrogeologic-Impact Assessment Report.

This report presents a conceptual hydrogeologic model for the Study Area, an inventory of groundwater and surface-water resources, a summary of the proposed quarry expansion and storage reservoir, a qualitative assessment of potential impacts, and potential mitigation measures.

2.0 CONCEPTUAL HYDROGEOLOGIC MODEL

2.1 Setting

The Study Area encompasses approximately 6.4 square miles in Plainville, New Britain and Southington, Connecticut; centered on the subject City Parcel in Plainville (the Parcel) and the adjacent Tilcon Quarry, and extending south to the Shuttle Meadow Reservoir in Southington, east to Victoria Road in New Britain, west to Interstate 84 in Plainville and north to just beyond Route 72 (figure 1). Much of the Study Area is occupied by undeveloped forested land and the quarry. The Parcel proposed for quarry expansion for the storage reservoir and the area south to the Shuttle Meadow Reservoir is undeveloped forested land. The quarry and Parcel are surrounded to the west north and east by urban residential and commercial development.

2.2 Geomorphology

The geomorphology of the Study Area results from tectonic extension, eastward tilting, normal faulting and differential erosion of layered volcanic and sedimentary bedrock followed by glaciation, associated sediment deposition, alluvial erosion and deposition and mining activities. The topography of the Parcel generally slopes from west to east (controlled by the dip angle of the underlying volcanic and sedimentary rock); from elevation 678 ftmsl (feet above mean sea level) atop Bradley Mountain in the northwest corner of the Parcel to 430 ftmsl at the southeast corner of the Parcel. The surface-water stage in Shuttle Meadow Reservoir Meadow Reservoir is approximately 370 ftmsl; the bottom of the Tilcon Quarry is approximately 265 ftmsl; and Interstate 84 is at approximately 180 ftmsl (figure 1). The proposed storage reservoir would expand the existing quarry approximately 1,650 feet to the south with a bottom elevation of approximately 222 ftmsl.

The land surface to the east follows the general slope of the stratigraphic dip angle of 5 to 20 degrees. The land surface to the west of the Parcel and north of the quarry slopes steeply downward along a structural and erosional escarpment to the alluvial floodplain of the Quinnipiac River. The land surface to the south maintains a relatively consistent elevation until it reaches the structural/erosional escarpment along the north shore of Shuttle Meadow Reservoir.

2.3 Bedrock Geology

The bedrock geology beneath the Study Area consists of a layered sequence of sedimentary and volcanic rocks that has been tilted to the east; striking north-northeast and dipping approximately 5 to 20 degrees to the east-southeast (Rodgers, 1985 and Simpson, 1966) (figure 2 and Appendix I). From east to west (youngest to oldest) the bedrock beneath the Study Area consists of the following units:

- Holyoke Basalt (Jho): A dark-grey, orange to brown weathering basalt (Rodgers, 1985). Dark- to very dark-gray or greenish-gray hard strong tough fine- to medium-grained basalt, in part massive with columnar jointing, in part prismatically jointed, thickness about 250 feet; locally consists of as many as nine closely sequential lava flows that constitute a single stratigraphic unit (Simpson, 1966).

- Shuttle Meadow Formation (Jsm): A reddish brown silty shale (Rodgers, 1985). Pale-reddish-brown micaceous, feldspathic to arkosic interbedded medium- to fine-grained sandstone, siltstone, and silty shale and commonly in the south, highly fissile micaceous light-gray, greenish-gray, bluish-gray, and grayish-orange shale; thickness ranges from 270 to 340 feet (Simpson, 1966).

- Talcott Basalt (Jta): A dark grey, orange to brown weathering basalt (Rodgers, 1985). Dark to very dark gray hard strong tough fine grained basalt; thickness about 200 feet (Simpson, 1966).

- New Haven Arkose (TRnh): A reddish, poorly sorted arkose (Rodgers, 1985). Pale reddish brown to grayish-red micaceous, feldspathic to arkosic interbedded coarse- to fine-grained sandstone, siltstone, and silty shale; thickness unknown, but may exceed 3,000 feet (Simpson, 1966).

Extensional tectonics sometime after deposition tilted the bedrock layers to the east. During the process of tilting the rock units were fractured and displaced along high angle normal faults that primarily strike to the northeast-southwest and dip to the west-northwest. The relative rock movement is interpreted to be in a downward direction on the west side of the faults and upward on the east side (Rodgers, 1985), although older interpretations show localized horst and graben block faulting that results in downward movement on the east sides of the faults (Simpson, 1966; Appendix I).

The Tilcon Quarry is currently mining the Holyoke Basalt, which extends to the south beneath the proposed quarry expansion/reservoir area. During several site visits in 2016 and 2017 LBG inspected the bedrock exposures in the existing quarry and several outcrops at higher elevations in the proposed expansion/reservoir area. The basalt appeared as described above, with similar lithologic description and mapped orientation. The basalt appears as an extremely fine- to medium-grained, aphanitic volcanic rock that is typically grey color on fresh surfaces and orange/brown on weathered surfaces. Areas of pillow basalt that contain characteristic pillow-shaped structures attributed to subaqueous extrusion of lava are prevalent along the higher benches of the south-central pit wall. Areas of finer grained and layered basalt formed by rapid cooling of extrusive igneous rock exposed at or near the land surface are prevalent along the eastern pit wall.

The fracture density in the basalt appeared variable, increasing significantly near steep angled faults zones that were most prevalent in the southeast portion of the Tilcon pit. Many exposures in the mine area exhibit the characteristic columnar jointing nearly vertical to bedding resulting from depositional cooling, as well as low angle, eastwardly dipping flow contacts. Areas along the eastern pit wall exhibited a lower fracture density. Of note, water seeps were observed at only a few locations along the pit walls; generally in areas of steep vertical faults. Not significant flow was observed at the seep locations.

The Shuttle Meadow Formation as described above was observed in the western portion of the pit (Point A) at approximate elevation 435 ftmsl, and in the floor near the center of the pit bottom (Point B) at elevation 390 ftmsl; a separation distance of approximately 1,000 feet. Using the tangent function of trigonometry, and assuming mining was terminated at the top surface of the Shuttle Meadow Shale, the dip angle of the contact between the Holyoke Basalt and underlying shale from Point A to Point B is estimated to be 2.6 degrees; extremely shallow when compared to reported dip slopes of 5 to 20 degrees. Using the same logic, the contact dip angle from Point B to the deepest portion of the pit in basalt approximately 1,500 feet to the east (Point C) at elevation 250 ftmsl is a minimum of 5.0 degrees; indicating some steepening to the east. Of note, the relative movements of the footwall (east side) of the westward dipping normal faults that transect the quarry displace the contact to a higher elevation, resulting in in the appearance of a shallower dip angle.

LBG completed a lineament analysis using LiDAR (Light Detection and Ranging) to identify and map significant fracture and fault zones in the Study Area. LBG obtained LiDAR survey data for the Study Area from an internet source. The LiDAR data and our ArcGIS software were used to plot a digital elevation model of the project area that was examined to locate larger scale lineaments (figure 3). The LiDAR image is plotted and examined directly to locate large scale and extensive topographic flexures that may represent fracture lineaments. The term "fracture" as used here also means joints, faults and bedding-plane fissures in the otherwise fairly dense fabric of the local volcanic-sedimentary bedrock. The results of the LiDAR analysis are transposed onto the Geologic Map in figure 2.

In general, the LiDAR analysis shows a moderate fracture density with a dominant northeast-southwest set of lineament trends and a less dominant north-south lineament trends. The lineament trends show a moderate to high degree of parallelism, which is consistent with the genesis of the fracturing; and provide some validation of the lineament interpretation. The results are also very consistent with Simpson's interpretation (Simpson, 1966; appendix I) and observations made in the Tilcon Quarry.

LBG used the topography for the Study Area, Rodger's geology map with transposed LiDAR lineaments and the Reservoir Plan for the proposed storage reservoir developed by

Lenard Engineering, Inc. (LEI, 2017) to constructed two geologic cross sections to facilitate our understanding of the conceptual hydrogeologic model. Section Line A-A' and B-B' are shown on the geologic map (figure 2). The sections were developed using a vertical exaggeration of seven times, to provide greater detail of the stratigraphy over the approximately 2.5 mile long sections lines. The sections depict the bedrock geology and do not show the relatively thin surficial materials. The sections also note municipal and watershed boundaries, roadways, surface-water features and piezometer locations, the Parcel and the limit of the proposed storage reservoir.

Section A-A' is oriented in an east-west direction (looking north) and transects the width to the Study Area through the proposed quarry expansion/reservoir area (plate 1). The geologic interpretation of Section A-A' shows the stratigraphic units slope or dip to the east at approximately 7 to 9 degrees; and are offset by steeply dipping normal faults with relative upward movement of the footwall (east side) and downward movement of the kneewall (west side). The stratigraphic units are shown to range in thickness from approximately 100 to 350 feet; with the Holyoke Basalt thinning westward due to uplift and erosion. Section A-A' indicates the proposed storage reservoir within the Holyoke basalt, with the possibility of contacting the Shuttle Meadow Formation in the eastern portion of the proposed reservoir. The land surface of the Parcel and areas to the east in New Britain are entirely underlain by the Holyoke Basalt. The steep slopes to the west are underlain by the Shuttle Meadow Formation and Talcott Basalt. The Quinnipiac River Valley near Interstate 84 is underlain by the New Haven Arkose.

Section B-B' is oriented in a north-south direction (looking east) and transects the length of the Study Area, through the existing Tilcon Quarry, proposed quarry expansion/reservoir area and Shuttle Meadow Reservoir (plate 2). The geologic interpretation of Section B-B' shows the stratigraphic units dip gently to the south at less than 2 degrees; and are similarly offset by steeply dipping normal faults with relative upward movement of the footwall (east side) and downward movement of the kneewall (west side). The stratigraphic units are shown to range in thickness from approximately 100 to 250 feet. Section B-B' indicates the proposed storage reservoir within the Holyoke basalt, with the possibility of contacting the Shuttle Meadow Formation in the southern portion of the proposed reservoir. The land surface of the Tilcon Quarry, Parcel and areas south to the Shuttle Meadow Reservoir are underlain by the Holyoke

Basalt. A steep normal fault displaces the Shuttle Meadow Formation upward, beneath the Reservoir. The Quinnipiac River Valley is positioned over a steep normal fault that places the Shuttle Meadow Formation beneath the south bank and the Holyoke Basalt beneath the north bank of the river.

The bedrock geologic map in Appendix I includes geologic cross section C-C', oriented in a northwest-southeast direction (looking northeast) and transects through the southwest corner of the Parcel (Simpson, 1966). Section C-C' shows similar stratigraphy, sloping to the east and offset by normal faulting at a one to one scale with no vertical exaggeration.

2.4 Surficial Geology

The surficial geology within the Study Area consists primarily of variable thicknesses of glacial ice laid till deposits, with post glacial talus (formed by an accumulation of broken rock debris) covering the steeper west-facing slopes (Stone, 1992) (figure 4). To the north, the Quinnipiac River valley is filled with sand and gravel from undifferentiated glacial meltwater deposits. To the west, the Quinnipiac River terrace deposits are comprised of sand overlying finer grained sediments laid down by glacial meltwater streams; with a narrow channel of more recent alluvial sand deposits associated with the current Quinnipiac River. Further southwest the sediments coarsen to include sand and gravel from undifferentiated glacial meltwater deposits.

Till comprised of an unsorted mixture of clay through boulder sized material was deposited by the glaciers directly on the bedrock surface. Throughout most of the Study Area the till is mapped as being relatively thin to absent; interpreted to be generally less than 10 feet thick. Melt waters from the receding glaciers deposited sand and gravel in the lower topography of the Quinnipiac River Valley, interpreted to be up to 400 feet thick. More recently, alluvial sediments have been deposited within watercourses and erosional talus debris developed on the steeper basalt slopes.

2.5 Groundwater

Groundwater beneath the Study Area is expected to exist within the unconsolidated sediments and fractured bedrock under perched water table, phreatic water table and partially confined conditions. In the thin till, groundwater may occur seasonally and is likely perched at the bedrock surface. In the thicker portions of the till and within the sand and gravel sediments groundwater may be present within a few feet of grade and likely exists under water table conditions, but may locally be perched within the till and above less permeable materials (like swamp muck). Within the bedrock, groundwater will exist within remnant bedding planes, joints, fractures and faults and to a lesser extent in the interstitial pore spaces in the sedimentary rocks, under phreatic and confined conditions. Note that the basalt has virtually no available pore space. The groundwater surface in the bedrock is expected to be on the order of 5 to 30 ft bg (feet below grade); closer to the surface at lower elevations near potential discharge points; and with a *potentiometric surface* elevation (the elevation to which water rises in a well that taps a confined aquifer or fracture) above the bedrock surface if confined. The volcanic and sedimentary bedrock are expected to exhibit different hydraulic characteristics.

Groundwater flow is expected to somewhat mimic topography, flowing toward local and regional discharge points at lower elevations. Beneath the proposed quarry expansion/reservoir area groundwater should generally flow to the east towards the unnamed watercourses to between the West Canal and Route 372 (Corbin Avenue) in New Britain (figure 5). West of the ridgeline at the western edge of the Parcel and proposed quarry expansion/reservoir and north of the Tilcon Quarry groundwater should flow to the west and north towards the Quinnipiac River. More locally, the groundwater flow direction in thin overburden will be influenced by proximate surface-water features. Similarly, the local bedrock groundwater flow will be influenced by the head differential proximate to the Tilcon Quarry. The bedrock may also be influenced by regional discharge points, including the Farmington River to the south at elevation 100 ftmsl and east at elevation 85 ftmsl, Salmon Brook to the west at elevation 160 ftmsl, and Stony Brook to the northeast at elevation 150 ftmsl.

The Connecticut Department of Energy and Environmental Protection (CTDEEP) has classified the groundwater beneath and south of the New Britain Parcel as GAA, reflecting its contribution to Shuttle Meadow Reservoir; a public drinking water supply reservoir (CTDEEP, 2011 and 2015) (figure 6). The immediate surrounding area is classified as GA groundwater, with designated uses for existing private and potential public or private water supplies. LBG has confirmed that the potable water supply in these areas is derived from public water service and private groundwater wells (see Section 3.0 below). Areas beyond to the north and west are classified as GA impaired indicating treatment may be needed to meet potable standards and the goal is to remediate groundwater to GA standards. Areas beyond to the east in New Britain are classified as GB indicating groundwater is not suitable for consumption due to waste discharges, spills or leaks of chemicals or land use impacts. Groundwater beneath the western portion of the Study Area, in the vicinity of the Quinnipiac River Valley, is mapped as a Level A Aquifer Protection Area, indicating it is within the area of contribution to a public water supply well. The Level A zone in the northwest portion of the Study Area is associated with the Woodford Avenue Well Field operated by Valley Water Systems, Inc. The Level A zone in the west portion of the Study Area is associated with Well 9 operated by the Southington Water Department. The Level A zone to the west of Shuttle Meadow Reservoir is associated with Patton Brook Well Field operated by the Southington Water Department.

2.6 Surface Water and Drainage Basins

The surface-water features within the Parcel and immediately south and east of the Parcel have been inventoried by Davison Environmental, LLC to include intermittent watercourses and perimeter wetlands #4 and #5, other pocket wetlands #1, #2, #3, #6, #7, #8, #9 and #10, potential vernal pools (PVPs) #1, #2, #3, #4, and #5 within corresponding wetland areas and isolated PVPs #6, #7 and #8 southwest of the southern limit of the proposed storage reservoir (Davison, 2017) (Appendix II). Other mapped surface-waters bodies within the Study Area include the Quinnipiac River located 3,500 feet north and 4,000 west of the Parcel, the Plainville Reservoir (aka Crescent Lake) and unnamed outlet watercourse located 1,200 to the southwest, Patton Brook located 6,500 feet to the southwest, two intermittent watercourses located 300 feet south and 1,600 feet east, the West Canal located 800 feet to the east, the Shuttle Meadow Reservoir and unnamed outlet watercourse located 4,000 feet to the south, Shultz Pond located on the Reservoir outlet watercourse approximately 3,000 feet southeast of the Parcel, and the East Canal located 3,500 feet southeast of the Parcel (figure 1).

The CTDEEP has classified the Quinnipiac River as a B surface-water body, designated for habitat for fish, other aquatic life and wildlife; recreation, navigation; and industrial and agricultural water supply (CTDEEP, 2011) (figure 6). The Plainville and Shuttle Meadow Reservoirs, intermittent watercourses and East and West Canals are Class AA surface-water bodies, designated for existing and proposed drinking water supplies as well as Class B uses, not including navigation. Of note, the Plainville Reservoir (also known as Crescent Lake) is no longer used as a drinking water reservoir. The unnamed outlet watercourses and Shultz Pond are

Class A surface-water bodies designated for Class B uses as well as potential drinking water supplies.

The City of New Britain Parcel and the proposed quarry expansion/reservoir area exist almost entirely within the Connecticut Major Basin No. 4, Mattabesset Regional Basin No. 46, Willow Brook Subregional Basin No. 4602, Basin No. 4602-01-1 (CTDEP, 1981) (figure 7). Of note, the eastern limit of Basin No. 4602-01-1 is the constructed West Canal, which directs captured surface water and runoff to the Shuttle Meadow Reservoir. The eastern portion of the Study Area in New Britain that is developed by residential properties exists in Basin Nos. 4602-03-1 and 4602-00-1. The southern portion of the Study Area including the Shuttle Meadow Reservoir exists in Basin No. 4602-00-1-L1. The East Canal, which captures surface-water and runoff from Basin No. 4602-02-1, including overflow from the Wassel Reservoir, also discharges to the Shuttle Meadow Reservoir. The northern and western portions of the Study Area including approximately 4 acres of the northwest and western portions of the New Britain Parcel, the Quinnipiac River and Plainville Reservoir exist in the South Central Coast Major Basin No. 5, Quinnipiac Regional Basin No. 52 and Quinnipiac River Subregional Basin No. 5200; including from north to west Basins Nos. 5200-00-1-L1, 5200-00-1, 5200-02-1-L1 and 5200-02-1.

To better understand the hydrology and potential impact to the identified surface-water features on the Parcel that would remain after construction of the propose storage reservoir, LBG further subdivided Basin No. 4602-01-1 into project-area basins A through N (table 1 and figure 8). Each basin is defined by a designated outlet point (point of analysis) for a target surface-water feature and the watershed boundary determined by topography. Direct precipitation and stormwater runoff within these project-specific basins follow topography and discharge to the identified surface-water features. Some portion of the surface-water hydrology may also be supported by overburden-groundwater runoff and possibly bedrock-groundwater runoff within the drainage basins.

3.0 WELL INVENTORY SURVEY

According to the CTDEEP records the closest public water supply well is the Woodford Avenue Wellfield Well No. 7 operated by Valley Water Systems, Inc., located approximately 4,000 feet northwest of the limit for the proposed reservoir (CTDEEP, 1991) (figures 6 and 9).

The Well 9 Wellfield operated by the Southington Water Department is located approximately 4,300 feet southwest of the limit of the proposed reservoir. Both public water-supply wells are completed in the overburden glacial outwash sediments deposited in the Quinnipiac and Patton Brook valleys.

Two process water supply wells located on the Tilcon property are operated under a CTDEEP General Permit for Water Diversion (figure 9). One well supplies water to the concrete plant for the concrete mixing operation, with minor quantities used to fill concrete truck water supply tanks and rinse trucks during loading operations. Water from the other well is used for onsite dust suppression and non-contact cooling water for heat exchangers associated with recirculating bearing oil. According to information in the permit application the wells are drilled in bedrock within the Shuttle Meadow Formation. There are several other low-yield bedrock wells on the Tilcon property used to provide potable water for kitchens, bathrooms and other uses with the office buildings.

LBG completed a well inventory survey for properties located within 1,500 feet of the Tilcon and subject City-owned parcel (figure 9). Parcel maps identify 661 properties within the search area; including 176 properties in New Britain, 471 properties in Plainville and 14 properties in Southington. The lists of property addresses and owners were provided to the New Britain Health Department, New Britain Water Department, Plainville-Southington Health Department, Plainville Public Works Department and the Southington Water Department to confirm connection to the public water service and/or records for permits or completion reports for private water-supply wells. LBG also reviewed well completion reports for the search area on file at the Department of Consumer Protection in Hartford, and made a windshield tour of the search area to identify any visible evidence of well surface completions. Copies of the information obtained during the well inventory survey are included in Appendix III.

The well inventory survey confirmed that 540 of the properties in the search area are connected to public water; 143 properties in New Britain and 397 properties in Plainville. The 14 properties in Southington are not connected to public water. Fifty-four (54) properties in the search area with no record of public water service were determined by visual or research evidence to be undeveloped; 28 properties in New Britain, 16 properties in Plainville and 11 properties in Southington. For the 67 remaining properties the survey identified visual and/or documented evidence of 38 private water supply wells; including 35 wells in Plainville

(12 visual only, 4 by visual and report and 19 by reports only) and three wells in Southington (reports only) (figure 9). No evidence of private water supply wells was found for the 178 New Britain properties within the search area. Twenty-nine (29) properties in the search area with no record of public water service or visual/report evidence of a well are considered to have the potential for a private water supply well, including five properties in New Britain and 24 properties in Plainville; equating to a total of 67 properties in the search area with confirmed or potential wells.

The majority of the identified and potential private wells are located to the west and north of the existing quarry and proposed quarry expansion/reservoir area; ranging in distance from approximately 2,300 to over 5,500 feet from the limits of the proposed storage reservoir. The closest identified private well is located at 50 View Street in Plainville. The five potential wells in New Britain are located approximately 1,300 to 3,500 feet from the eastern limits of the proposed storage reservoir, with the closest potential well located at 23 Hickory Hill Road in New Britain.

According to the bedrock geologic map and the limited well completion reports, all of the wells located in Plainville are completed in the sedimentary (Shuttle Meadow Formation) or volcanic (Talcott Basalt) units that are stratigraphically below the Holyoke Basalt. Three of the wells located along Cyrenius Avenue in Plainville, approximately 5,500 feet west of the proposed storage reservoir, are completed in the shallow overburden glacial outwash sediments. The potential wells in New Britain may be completed in the Holyoke Basalt, or the underlying sedimentary rocks.

4.0 HYDROGEOLOGIC INTERPRETATION

4.1 Volcanic Bedrock

The Holyoke Basalt (and stratigraphically lower Talcott Basalt) is interpreted to have no significant primary porosity (*percentage of void space in a rock, defined as the ratio of the volume of the voids or pore space divided by the total volume*) and localized zones of low to moderate porosity in areas of primary jointing and secondary fracturing and faulting. The hydraulic conductivity (*rate of flow under a unit hydraulic gradient through a unit cross-sectional area of an aquifer, sometimes expressed as the ratio of velocity to hydraulic gradient indicating permeability*) of basalt is extremely low, except within discrete fault zones. This assessment of porosity and conductivity is supported by observations within the Tilcon Quarry and groundwater-level, permeability and pumping test data obtained by LBG as part of a hydrogeologic assessment of a similar quarry in the Holyoke Basalt in East Granby, Connecticut.

The Tilcon Quarry staff has reported that the majority of stormwater runoff from precipitation events is retained within the mine area, with the 5 to 10 foot thick residual blast zone in the pit floor or ponded in the lowermost elevations of the pit floor, and does not infiltrate significantly into the basalt. Retained stormwater either evaporates or is pumped to onsite or offsite discharge points. This provides some indication of the low porosity and conductivity of the basalt.

Inspection of the rock exposures in the Tilcon Quarry showed generally low to moderate fracture density with areas of high fracture density near faults, but very few areas of groundwater discharge along the steep pit walls; except where faulting was observed. The lack of significant drainage in the pit walls provides some evidence of the low conductivity of the basalt.

4.2 Sedimentary Bedrock

The sedimentary sandstone, siltstone and shale bedrock of the Shuttle Meadow Formation may be relatively porous and have low to moderate hydraulic conductivity; although the layered stratigraphy is expected to limit/reduce the vertical hydraulic conductivity. Well records for surrounding properties indicate that several water-supply wells are completed in the sedimentary bedrock, including a relatively high-yield process-water well at the Tilcon Quarry. The mine staff reported that the stormwater management program within the quarry includes infiltration into the Shuttle Meadow Formation where "sandstone" is exposed on the pit floor. The information concerning the well yields and infiltration capacity provide qualitative support for relatively higher porosity and conductivity of certain sedimentary rock compared to the basalt. The Shuttle Meadow Reservoir is underlain by the Shuttle Meadow Formation, which provides qualitative support the relatively low vertical hydraulic conductivity of the sedimentary rocks due to compositional variability in the stratigraphy (figure 2). Low vertical conductivity may also inhibit hydraulic connection to adjacent bedrock units, partially confining the underlying Talcott Basalt or New Haven Arkose.

The New Haven arkose is expected to have a relatively higher primary porosity and hydraulic conductivity. The cemented structure of the arkose has a plastic response to fracturing that tends to retain fracture and fault geometry that can increases the hydraulic conductivity and transmissivity (*rate of flow under a unit hydraulic gradient through a unit width of aquifer of thickness*).

4.3 Overburden Sediments

Glacial till has low to moderate porosity on the order of 10 to 25 percent and low hydraulic conductivity (Driscoll, 1986). Thin till deposits on the hillsides of the proposed quarry expansion/storage reservoir area tend to promote stormwater runoff, minimize infiltration and provide little sustained overburden-groundwater runoff. Thicker till deposits observed where the slope flattens can provide seasonal, metered runoff to support wetland functions and intermittent drainage, especially if deposited on low permeability bedrock that limits vertical leakage.

Sand deposits in the river valleys to the north and west of the proposed storage reservoir have significantly higher porosity (25 to 45 percent) and hydraulic conductivity and can store and transmit large quantities of water. Note that several public-water supply wellfields are located in these sandy deposits.

4.4 Hydrology of Intermittent Watercourses, Wetlands and Potential Vernal Pools

For the purpose of this study the conceptual model assumes the Quinnipiac River, Plainville Reservoir (also known as Crescent Lake) and unnamed outlet watercourse, Patton Brook, Shuttle Meadow Reservoir and unnamed outlet watercourse, Shultz Pond, and East Canal are located sufficiently distant and outside of the potential influence of the proposed storage reservoir to warrant more detailed evaluation of their contributing hydrology.

The intermittent watercourses, wetlands and PVPs located on and near the Parcel formed in topographic depressions in thin glacial till deposits overlying basalt bedrock, or directly on the basalt bedrock surface (Appendix II). The spatial distribution of the surface-water features suggests their geomorphology is closely associated with preferential erosion along bedrock faults/fractures, resulting in the topographic lows and isolated pockets that contain the features. Of note, PVP # 4 and #5 are located in headwater areas for watercourses #4 and #5, while the remaining pools are located in isolated pockets. Overtime, decomposed organic materials have accumulated in portions of these areas to form a low permeability layer above the till deposits or bedrock. These organic layers tend to limit or retard vertical leakage of surface water and may confine the underlying groundwater.

The hydrology of the surface-water features is principally derived from direct precipitation, stormwater runoff within the contributing drainage basins and limited, seasonal overburden-groundwater runoff from the immediately adjacent till sediments. The low permeability of the organic layer, till and/or bedrock combined with the subdued topography promotes seasonal retention of stormwater. The geomorphology of these surface-water features may also promote relatively thicker accumulations of till deposits that can support a greater thickness of groundwater saturated sediments; providing a nearby water source that may extend they hydro-period. If present, bedrock-groundwater runoff through underlying faults may also contribute to the hydrology, seasonally reversing the vertical hydraulic gradient. The converse could also be true, with seasonally lower water levels in the bedrock inducing surface-water leakage into underlying faults. The low conductivity of the organic layer and till would likely minimize the positive and negative impacts of bedrock-groundwater runoff.

Site-specific field data was developed to better our understanding of the surface-water hydrology. In November 2016 LBG installed piezometers PZ-1, 2, 4, 5, 6, and 7 in representative surface-water features (figure 10). In February 2017 PZ-6 was lost and replaced with PZ-6R. In March 2017 PZ-8 was installed in PVP #2. Each piezometer was constructed using a 1.5-foot long, 1.5-inch diameter, stainless-steel, wire-wrapped screen with drive point attached to a 5-foot long steel pipe. The piezometer was manually driven by hammering to approximately 6.5 ft bg (feet below grade); until the top of the screen was approximately 2.0 ft bg (table 2). Driving conditions dictated the final completion depths. After installation the piezometers were developed by surging and pumping to insure the screen zone was connected to groundwater in the shallow sediments.

Between November 2016 and June 2017 LBG made manual water-level measurements at each piezometer on nearly a monthly basis (table 2). Manual measurements were made of the depth to surface water (outside pipe) and depth to groundwater (inside pipe) referenced to the top of the piezometer pipe. Vertical hydraulic gradients (the vector gradient between two or more hydraulic head measurements over the length of the flow path) were computed by dividing the difference between the surface-water and groundwater levels by the depth of the midpoint of the screened interval below the ground surface (Winters, 1988). The potential for groundwater contribution to surface water is indicated when the water level inside the piezometer is higher than the surface-water level. This condition indicates the potential for the surface water to "*gain*" flow (i.e., the surface-water hydrology may be supported by groundwater discharge), and by convention, the vertical hydraulic gradient is assigned a positive value. When the groundwater level in the piezometer is lower than the surface-water level the vertical hydraulic gradient is assigned a negative value; indicating the potential for "*losing*" surface-water flow to groundwater.

The precipitation condition during the monitoring period has a direct bearing on the piezometer data and surface-water hydrology. With the exception of April and May 2017, the total monthly precipitation during the monitoring period measured at the National Oceanic and Atmospheric Administration (NOAA) station at Shuttle Meadow Reservoir was below the 30-year normal precipitation amount; ranging from 0.36 to 3.23 inches below normal (table 3). The relatively drier conditions would tend to reduce the volume of surface water derived from direct precipitation and stormwater runoff and groundwater recharge by infiltration. With the exception of November 7, 2016 and February 23, 2107, precipitation was recorded over the 7-day period preceding each piezometer measurement; ranging from 0.07 to 2.48 inches (table 2). The NOAA precipitation data is included in Appendix IV.

The piezometer data are summarized below:

- <u>**PZ-1** in Downstream Reach of Wetland/Watercourse #4:</u>

  This reach of Watercourse #4 is located at elevation 450 ft msl, approximately 150 feet east of the limit of the proposed storage reservoir; and would therefore remain after construction of the reservoir approximately 50 feet above the maximum reservoir stage height of 400 ft msl. The data document consistent negative vertical hydraulic gradients throughout the monitoring period, indicating a potential losing surface-water flow condition. No surface water was measured in 2016 or June 2017. The data confirm the intermittent nature of the watercourse and suggests the hydrology in this reach of the watercourse is principally supported by surface-water runoff.

- <u>**PZ-2** in PVP #4:</u>

  PVP #4 is located in the headwater area of wetland/watercourse #4 at approximate elevation 487 ft msl; within the limit of the proposed storage reservoir. No surface water was measured in PVP #4 in November and December 2016; reflective of the historical dry conditions. With the exception of January and early June 2017, the data show slightly positive and consistent vertical hydraulic gradients, ranging from 0.01 to 0.03 ft/ft (foot per foot). The data suggest the hydrology for PVP #4 is principally derived from stormwater runoff, with negligible support by groundwater discharge from the surrounding sediments and/or bedrock.

- **PZ-3** in Mid-Stream Reach of Wetland/Watercourse #5:

  This reach of Watercourse #5 is located at elevation 525 ft msl; within the limit of the proposed storage reservoir. PZ-3 documents a similar hydrology to PVP #4; the historical dry conditions in 2016 and a relatively neutral vertical hydraulic gradient ranging from -0.01 to 0.01 ft/ft. The data suggest the hydrology for this reach of wetland/watercourse #5 is principally derived from stormwater runoff, with negligible support by groundwater discharge from the surrounding sediments and/or bedrock. The absence of measureable surface water in late June 2017, after a week of 1.35 inches of precipitation, provided support for a losing surface-water flow condition in this reach of the watercourse. Of note, the losing condition may be promoted by an absence of a significant organic layer within a watercourse.

- **PZ-4** in PVP #5 in Upstream Reach of Wetland/Watercourse #5:

  PVP #5 and this reach of Watercourse #5 are located at elevation 545 ft msl; within the limit of the proposed storage reservoir. Following the dry conditions of late 2016, the piezometer data shows a downward vertical hydraulic gradient in January and February 2017; documenting a losing surface-water flow condition. For the balance of the monitoring period the data show a slightly positive gradient ranging from 0.01 to 0.04 ft/ft and a gaining condition. Again, the data suggest the hydrology for PVP #5 and this reach of wetland/watercourse #5 is principally derived from stormwater runoff, with the possibility of minor support by groundwater discharge from the surrounding sediments and/or bedrock. Of note, the highest surface-water level recorded in February 2017 corresponds with the most negative vertical gradient and follows a rainless 7-day period. This may indicate the low permeability organic layer or till plays a key role in maintaining the seasonal hydrology of PVP #5; more significant than any potential minor contribution from groundwater.

- **PZ-5** in PVP #1:

  PVP #1 is located at elevation 560 ft msl in an isolated pocket wetland approximately 250 feet west of the limit of the proposed storage reservoir; and would therefore remain after construction of the reservoir approximately 160 feet above the maximum reservoir stage height of 400 ft msl. Following the dry conditions of 2016 measurable surface water is maintained in PVP #1 for the balance of the monitoring period. In general, the data shows a slight positive vertical hydraulic gradient ranging from 0.01 to 0.02 ft/ft. A slightly losing surface-water flow condition is documented in February 2017 following a rainless 7-day period. The data suggest the hydrology for PVP #1 is principally derived from stormwater runoff from the approximately 9.3-acre drainage basin, with negligible support by groundwater discharge from the surrounding sediments and/or bedrock. Once again, the highest surface-water level recorded in February 2017 corresponds with the losing flow condition. This may indicate the low permeability organic layer or till plays a key role in maintaining the seasonal hydrology of PVP #1; more significant than any potential minor contribution from groundwater.

- <u>**PZ-6** in PVP #3:</u>

  PVP #3 is located at elevation 570 ft msl; within the limit of the proposed storage reservoir and approximately 100 feet south of the southern limit of the Tilcon Quarry. Following the dry conditions of 2016 measurable surface water is maintained in PVP #1 for the balance of the monitoring period. The data shows relatively more significant positive vertical hydraulic gradients compared to the other piezometers, ranging from 0.03 to 0.32 ft/ft. A significant losing surface-water flow condition (gradient of -0.54 ft/ft) is documented in February 2017 again corresponding to the highest measured surface-water level and following a rainless 7-day period. The data suggest the hydrology for PVP #1 may be more significantly supported by groundwater discharge from the surrounding sediments and/or bedrock, in addition to stormwater runoff. However, at this relatively high elevation and position within the contributing drainage basin there is unlikely to be adequate bedrock recharge area to support significant bedrock groundwater recharge into PVP #3. It is also interesting to note that the close proximity to the Tilcon Quarry pit does not appear to impact the vertical gradient and potential gaining surface-water flow condition at PVP #3. The record high surface-water level in February 2017 again corresponds with the single losing flow condition, which suggests the organic layer or till also plays a key role in maintaining the seasonal hydrology of PVP #3

- <u>**PZ-7** in Downstream Reach of Watercourse #5:</u>

  This reach of Watercourse #5 is located at elevation 480 ft msl; within the limit of the proposed storage reservoir. The data document consistent negative vertical hydraulic gradients throughout the monitoring period ranging from -0.11 to -0.33 ft/ft, indicating a potential losing surface-water flow condition. No surface water was measured in 2016 or June 2017. The data confirm the intermittent nature of the watercourse and suggests the hydrology in this reach of the watercourse is principally supported by surface-water runoff. The record high surface-water level in February 2017 following a 7-day rainless period suggests an organic layer or till may be more prevalent in this reach of the watercourse.

- <u>**PZ-8** in PVP #2:</u>

  PVP #2 is located at elevation 575 ft msl in an isolated pocket wetland approximately 250 feet west of the limit of the proposed storage reservoir and 250 feet south of the Tilcon Quarry pit; and would therefore remain after construction of the reservoir approximately 175 feet above the maximum reservoir stage height of 400 ft msl. Few data exists for PZ-8 since it was installed later in the monitoring program, but, unlike the other PVPs the data shows a consistent negative vertical hydraulic gradient, ranging from

-0.06 to -0.12 ft/ft. The data suggests the hydrology for PVP #2 is principally supported by surface-water runoff from the approximately 5.6-acre drainage basin.

The piezometer data supports or validates the conceptual model for the hydrology of the surface-water features, derived principally from direct precipitation and stormwater runoff with negligible to minor contribution by groundwater discharge from the surrounding sediments and possibly bedrock. The most positive gradients were measured in PVP #3, closest to the existing quarry; confirming the low permeability nature of the basalt bedrock or absence of significant contribution to surface-water hydrology from bedrock groundwater and suggesting that pit excavation does not significantly impact nearby surface-water hydrology. The most negative gradients were measured in the down-stream reaches of the intermittent watercourses, confirming the absence of any contribution from groundwater. Low permeability organic layers and till likely contribute to lengthening the hydro period of certain features, and where absent (mostly in watercourses) result in more significant negative hydraulic gradients and losing surface-water flow conditions. The model interpretation is qualified by the relatively drier precipitation conditions during the monitoring period, compared to normalized conditions, which could result in reduce infiltration and groundwater recharge.

5.0 PROPOSED STORAGE RESERVOIR

The proposed storage reservoir would be constructed by expanding the eastern portion of the Tilcon Quarry excavation to the south, onto the City of New Britain Parcel (LEI, 2017 and Appendix V). The propose expansion area at the maximum reservoir stage elevation of 360 ft msl is approximately 39 acres. The quarry operation is completed by blasting and excavation of the Holyoke Basalt in 40-foot lifts, leaving benches of basalt at the perimeter of each lift for a haulage road. Of note, this quarrying technique leaves behind a five to 10-foot thick zone of blast-fractured rock (rubble zone) on the quarry floor that cannot be removed by mechanical excavation. The secondary porosity and permeability of the rubble zone is significantly higher than the native basalt.

Currently the deepest point of excavation in the eastern portion of the quarry is at approximately elevation 260 ft msl. It was reported to LBG that Tilcon plans excavation of at least one more lift in this area to elevation 220 ft msl. This would be the deepest point of the proposed storage reservoir. The anticipated expansion activities would include clearing of trees and other vegetation from the proposed expansion area and removal of the till overburden followed by excavation. Excavation would be completed in a similar manner to the current quarrying operation, with the bottom elevation paralleling the eastward sloping contact between the Holyoke Basalt and Shuttle Meadow Formation. The perimeter of the final reservoir would be shaped by 40-foot basalt benches, with a bottom floor ranging in elevation from 220 to 360 ft msl; the highest elevation equaling the maximum reservoir stage height, controlled by the lowest perimeter elevation in the northeast corner of the quarry of approximately 367 ft msl. The vertical relief of the final reservoir walls on the Parcel would range from a high of approximately 600 ft msl in the southwest corner to approximately 450 ft msl at the northeast corner; comprised entirely of basalt bedrock. Some thin till deposits may remain at the top of the pit walls.

6.0 QUALITATIVE-IMPACT ASSESSMENT

The qualitative-impact assessment focuses on anticipated direct impacts and potential indirect impacts to the identified surface-water features within and nearby the Parcel and the nearby private water supply wells. The assessment considers our conceptual hydrogeologic model, our interpretation of the hydrogeology for the principal bedrock units, overburden deposits and identified surface-water features, and the mine plan for the proposed storage reservoir.

6.1 Anticipated Direct Impacts

Surface-water features within the proposed storage reservoir will be directly impacted by the proposed storage reservoir. Quarry expansion will result in removal/elimination of PVP #4 and #5, Wetland #3, #6, #8, and #9 and significant portions of Wetland # 4, #5, #7 and #10 and Watercourse #4 and #5 (Davison 2017, Appendix II).

Direct impacts include the removal/elimination of significant portions of certain drainage basins that support the hydrology of the downstream reaches of Watercourse #4 (44 %) and #5 (91 %) east of the limit of the proposed storage reservoir (table 1 and figure 7). Expansion will result in moderate losses of contributing drainage-basin area to Watercourse #4 at the outlet to the West Canal (22 %), Wetland #7 (23 %) and Wetland #10 (25 %); and lesser impacts to the drainage areas for the West Canal (18 %) and Wetland #6 (15 %).

Additional direct impacts to remnant portions of Wetlands #5 and #10 in the close proximity to the excavation limit of the proposed storage reservoir, resulting from lowering of the phreatic water table (underground surface beneath which earth materials are saturated with water) in the wetland/till sediments, steepening of the hydraulic gradient and increasing groundwater flow velocities; all contributing to potentially reducing the hydro period.

Other direct impacts to the downstream reaches of Watercourse #4 and #5, the upstream reach of Watercourse #5 and PVP #6 may result from lowering of the potentiometric surface (the elevation to which water rises in a well that taps a confined aquifer; representing the confining pressure or hydrostatic head) in the basalt bedrock within the proposed quarry expansion area if their hydrology is significantly supported by bedrock groundwater. The low permeability of the basalt bedrock is expected to mitigation or significantly limit the lateral extent of this impact.

There should be no significant direct impacts to the hydrology supporting Shuttle Meadow Reservoir (6.1 %), East Canal (0 %), intermittent Watercourse to the south of the Parcel identified in Table 1 and Figure 7 as 4B (Basin ID F) (0 %), PVP and Wetland #2 (1 %), PVP and Wetland #1 (0 %), upstream reach of Watercourse #5 (7 %) and PVP #7 and 8 (0 %). The principal hydrology for these surface-water features are direct precipitation, stormwater runoff and limited overburden-groundwater runoff. The proposed storage reservoir does not significantly reduce the size of the contributing watersheds for these features and therefore should not reduce their respective water budgets.

Any potential for direct impact to the nearby water supply wells is mitigated by the separation distance from the limit of the proposed storage reservoir and the low hydraulic conductivity of the basalt bedrock. There will be no additional consumptive water loss from the expanded quarry; which, if present, would be mitigated by surface water stored in the reservoir. Therefore, the water budgets for the larger-scale drainage basins should not be directly impacted.

6.2 Potential Indirect Impacts

Lowering the potentiometric surface in and around the proposed storage reservoir could potentially reduce the amount of bedrock groundwater discharge to PVP #1 and possible but to a lesser extent PVP #7 and #8. Note the hydrogeologic model concludes the potential gaining surface-water condition measured in PVP #1 is due to groundwater discharge from the adjacent glacial till sediments, with very limited potential for significant bedrock groundwater discharge.

If this assumption is correct, then lowering of the potentiometric surface in the bedrock would have a negligible potential to impact PVP #1; and by extrapolation PVP #7 and #8.

There should be no potential impacts to the nearby residential water supply wells. The proposed quarry should not result in any consumptive loss to the bedrock aquifers utilized by the nearby wells. The actual volume of bedrock groundwater should increase due to more efficient and direct infiltration within the quarry/reservoir limits and the water storage contained in the reservoir. The low hydraulic conductivity of the basalt bedrock should limit the extent of the groundwater-impact area (the area where lowering of the potentiometric surface could impact existing groundwater uses). This conclusion is supported, in part, by the separation distance between the nearby wells and the limit of the proposed storage reservoir, the majority of nearby wells being completed in the Shuttle Meadow Formation below the Holyoke Basalt, and the absence of any known or reported well problems near the existing Tilcon Quarry.

Construction of a water storage reservoir with a maximum stage elevation above the potentiometric surface in the surrounding rock has the potential to induce infiltration along faults/fractures and within the underlying Shuttle Meadow Formation, where in contact with the reservoir. Induced infiltration at the reservoir could raise groundwater levels within faults/fractures or the underlying sedimentary rock outside of the reservoir; specifically at elevations below 400 ft msl and decreasing with distance.

6.3 Other Considerations

The storage capacity of the proposed reservoir may be affected, to a small degree, by leakage into underlying faults/fractures in the basalt bedrock, lithologic contacts, and more permeable strata within the Shuttle Meadow Formation. Leakage rates should decrease over time as features associated with the primary and secondary porosity of the bedrock become saturated; then continued at a significantly reduced rate controlled by the resulting hydraulic gradient and transmissivity.

It follows that leakage of surface water from the proposed storage reservoir has the potential to increase the potentiometric surface within nearby faults/fractures and lithologic contacts, and the more permeable units within Shuttle Meadow Formation. An increase of the potentiometric surface has the potential to result in groundwater seepage at points where the transmitting features intersect the land surface; when the potentiometric surface is above the elevation of the subject land-surface point. The surface-water elevation in the proposed reservoir (proposed maximum stage height of 360 ft msl), hydraulic gradient within the transmissive features and proximity of the stored surface-water to the transmissive features will influence the potentiometric surface and location of potential seepage point(s). Based on the hydrogeologic model it appears that potential reservoir-induced groundwater seepage would be limited to areas northeast of the proposed storage reservoir and southwest of the Interstate 84 and Route 72 interchange; and would likely be contained within existing surface-water features or stormwater control structures.

7.0 POTENTIAL MITIGATION MEASURES

There are no potential mitigation measures for direct impacts to the identified surface-water features within the proposed storage reservoir. Compensatory mitigation by creation of offsetting wetland or potential vernal pool areas could be considered, in areas west and south of the proposed expansion area.

Potential mitigation measures for surface-water features with anticipated moderate to low direct impacts resulting from lost drainage area could include enhancements to promote stormwater runoff within the retained drainage areas and/or augmentation by newly developed groundwater sources (wells) or pumping from reservoir storage; the latter possibly being more appropriate for mitigation of potential impacts to West Canal and the Shuttle Meadow Reservoir. A simplified water-budget analysis provides some qualification of the amount of augmentation water that would be necessary to augment the potential impact to the West Canal.

Changes to drainage basin areas result in proportional changes to total runoff that contributes to the hydrology of the drainage basins and identified surface-water features. Total runoff is directly related to the amount of precipitation that falls within the drainage basin. The NOAA data for the Shuttle Meadow Reservoir station indicates the normal precipitation rate for the study area is 52.8 in/yr (inches per year).

Total runoff to wetlands, streams and water bodies is approximately equal to one half of the precipitation that falls within the contributing drainage basin (26.4 in/yr normal); the other half being consumed by evapotranspiration. On average, approximately 57% of total runoff is direct, overland stormwater runoff (15.1 in/yr normal) and 43% is groundwater runoff; divided between overburden runoff (6% of total runoff or 1.6 in/yr normal) and bedrock runoff (37% of total runoff or 9.8 in/yr normal). Surface drainage areas capture stormwater runoff and overburden-groundwater runoff, which equals 63% of total runoff (16.6 in/yr normal).

In the pre-reservoir condition, the surface drainage area for the Shuttle Meadow Reservoir (1,680.3 acres) 2.075 mgd (million gallons per day) of combined stormwater runoff. In the post-reservoir condition the losses to the drainage basin area for the West Canal result in a combined 6.1% reduction in the available runoff for the Shuttle Meadow Reservoir; equating to approximately 126,500 gpd (gallons per day). A well or reservoir pump producing approximately 88 gpm (gallon per minute) would be needed to augment the lost runoff to the West Canal and Shuttle Meadow Reservoir.

8.0 RECOMMENDED HYDROGEOLOGIC INVESTIGATION

Hydrogeologic investigation to develop site-specific data would be useful to confirm the hydrogeologic model of the study area, hydrology of the post-reservoir surface-water features and the potential indirect impacts. Monitoring points installed to obtain this data would also provide a useful network for monitoring during the proposed quarry expansion.

8.1 Proposed Investigation for Reservoir Expansion Area

- Drill bedrock test holes within the limits of the proposed storage reservoir to assess the composition of underlying bedrock. Construct the test holes as open borehole groundwater-monitoring wells in basalt and Shuttle Meadow Formation as appropriate. Conduct in-situ permeability tests to determine hydraulic conductivity of basalt and shale/sandstone and water-level monitoring to determine the elevation of the potentiometric surface.

- Drill bedrock test holes immediately west, south and east of the proposed quarry limits and construct as open borehole groundwater-monitoring wells in basalt and underlying shale/sandstone as appropriate. Conduct in-situ permeability tests in new perimeter bedrock wells to provide additional estimates of bedrock hydraulic conductivity. Monitoring groundwater levels in these well to determine the elevation of the potentiometric surface.

- Survey all monitoring points. Monitor water levels on a regular basis to evaluate seasonal changes, groundwater configuration and precipitation response to provide some indication of porosity and stormwater management.

8.2 Proposed Investigation for Post-Reservoir Surface-Water Features

- Drill test borings in the overburden sediments to bedrock refusal at locations in proximity to the surface-water features to determine lithology and thickness of sediments. Seal bottom of boring to prevent connection to bedrock aquifer and install overburden groundwater-monitoring wells in borings. At selected locations drill second test boring and install nested monitoring well in shallower sediments. Conduct in-situ permeability tests to estimate hydraulic conductivity and monitor shallow groundwater levels.

- Drill test holes into the shallow bedrock adjacent to selected overburden monitoring wells. Complete as groundwater monitoring wells in underlying bedrock. Conduct in-situ permeability tests to estimate hydraulic conductivity of underlying bedrock and monitor groundwater levels to assess vertical hydraulic gradients and potential for bedrock groundwater discharge to surface-water features.

- Install additional shallow piezometers within surface-water features, with nested installations at selected locations. Monitor water levels to estimate vertical gradients.

- Select locations to measure/gage stream flow at the discharge points in Watercourse #4 and #5 and the West Canal.

- Survey all monitoring points. Monitor water levels on a regular basis to evaluate seasonal changes. Construct groundwater-elevation contour maps to determine groundwater configuration. Evaluate vertical gradients. Use bedrock wells to evaluate potentiometric surface and bedrock-groundwater contributions. Use data to evaluate precipitation response and infiltration rates.

8.3 Drill Test Wells for Water-Supply Augmentation

- Complete more detailed lineament analysis of Parcel outside the limits of the proposed reservoir to determine locations for drilling water-supply test wells. Drill bedrock test wells targeting a combined yield of approximately 100 gpm; to be used to mitigate post-reservoir impacts to the West Canal. If successful, complete testing and permitting as necessary.

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December 13, 2017
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TABLES

TABLE 1

CITY OF NEW BRITAIN, CONNECTICUT
PROPOSED STORAGE RESERVOIR

Project-Area Basins and Qualitative Assessment of Potential Impacts to Surface-Water Resources

Project Area Basin ID	Designated Outlet Point - Point of Analysis			Drainage Basin Area (Acres)		Impact	
	Surface Water	Potential Vernal Pool	Wetland	Pre-Reservoir	Post-Reservoir	Acres	%
A	Shuttle Meadow Reservoir	--	--	728.6	728.6	0.0	0.0%
B	West Canal	--	--	562.3	459.7	102.6	18.3%
C	East Canal	--	--	389.4	389.4	0.0	0.0%
A, B, C	Shuttle Meadow Reservoir (combined)	--	--	1680.3	1577.7	102.6	6.1%
D	4	--	--	136.2	106.4	29.8	21.9%
E	4A	--	4 R	67.0	37.5	29.5	44.0%
F	4B	--	--	50.8	50.8	0.0	0.0%
G	5	--	--	67.1	5.9	61.3	91.3%
H	--	--	7	5.8	4.5	1.3	22.9%
I	--	2	2	5.6	5.5	0.1	1.3%
J	--	1	1	9.3	9.3	0.0	0.0%
K	--	--	5 R	21.0	19.4	1.6	7.4%
L	--	--	10	2.2	1.6	0.5	24.6%
M	--	6	--	3.6	3.0	0.5	15.0%
N	--	7, 8	--	2.8	2.8	0.0	0.1%

R - Remaining portion of potential vernal pool post reservoir

TABLE 2

CITY OF NEW BRITAIN
PROPOSESD STORAGE RESERVOIR

Summary of Piezometer Data for Surface-Water Features

Piezometer PZ-1: Wetland and Watercourse #4

Date	Time	Preceding 7-day Precipitation (inches)	Depth to Water (ft btp)		Compare Surface Water to Groundwater	
			Surface Water (outside pipe)	Groundwater (inside pipe)	Vertical Hydraulic Gradient 1/ (foot/foot)	Potential Surface Water Flow Condition 2/
11/7/16	8:19	0.00	Dry	Dry	--	--
12/12/16	13:03	0.92	Dry	Dry	--	--
1/25/17	13:41	1.65	2.92	3.49	-0.23	Losing
2/23/17	9:03	0.00	2.86	3.07	-0.08	Losing
3/9/17	11:23	0.20	3.12	3.32	-0.08	Losing
4/19/17	14:07	0.07	3.09	3.39	-0.12	Losing
5/12/17	11:03	2.48	2.98	3.23	-0.10	Losing
6/2/17	12:53	1.59	3.17	3.33	-0.06	Losing
6/22/17	11:05	1.35	Dry	3.78	--	--

ft btp — feet below top of pipe
ft bg — feet below grade
-- — Not calculated

Precipitation Data: NOAA USC00067432 Shuttle Meadow Reservoir

1/ Difference between surface water and groundwater levels divided by depth of screen midpoint

2/ Gaining when groundwater level higher than surface-water level (postive vertical hydraulic gradient); Losing when surface-water level higher than groundwater (negative vertical hydraulic gradient)

Install Date:	11/4/16
Grade:	3.26 ft btp
Total Depth:	3.28 ft bg
Screen Setting:	1.80 to 3.26 ft bg
Screen Mid-Point Depth (ft bg):	2.53

TABLE 2

CITY OF NEW BRITAIN
PROPOSESD STORAGE RESERVOIR

Summary of Piezometer Data for Surface-Water Features

Piezometer PZ-2: Potential Vernal Pool #4

Date	Time	Preceding 7-day Precipitation (inches)	Depth to Water (ft btp)		Compare Surface Water to Groundwater	
			Surface Water (outside pipe)	Groundwater (inside pipe)	Vertical Hydraulic Gradient 1/ (foot/foot)	Potential Surface Water Flow Condition 2/
11/7/16	8:28	0.00	Dry	Dry	--	--
12/12/16	13:08	0.92	Dry	3.12	--	--
1/25/17	14:50	1.65	1.68	1.75	-0.02	Losing
2/23/17	9:10	0.00	1.69	1.65	0.01	Gaining
3/9/17	11:37	0.20	1.84	1.75	0.03	Gaining
4/19/17	14:15	0.07	1.86	1.78	0.03	Gaining
5/12/17	11:10	2.48	1.77	1.68	0.03	Gaining
6/2/17	13:00	1.59	0.86	1.74	-0.29	Losing
6/22/17	11:12	1.35	2.00	1.90	0.03	Gaining

ft btp — feet below top of pipe
ft bg — feet below grade
-- — Not calculated
Precipitation Data: NOAA USC00067432 Shuttle Meadow Reservoir
1/ Difference between surface water and groundwater levels divided by depth of screen midpoint
2/ Gaining when groundwater level higher than surface-water level (postive vertical hydraulic gradient); Losing when surface-water level higher than groundwater (negative vertical hydraulic gradient)

Install Date:	11/4/16
Grade:	2.82 ft btp
Total Depth:	3.75 ft bg
Screen Setting:	2.31 to 3.75 ft bg
Screen Mid-Point Depth (ft bg):	3.03

TABLE 2

CITY OF NEW BRITAIN
PROPOSESD STORAGE RESERVOIR

Summary of Piezometer Data for Surface-Water Features

Piezometer PZ-3: Wetland and Watercourse #5

Date	Time	Preceding 7-day Precipitation (inches)	Depth to Water (ft btp)		Compare Surface Water to Groundwater	
			Surface Water (outside pipe)	Groundwater (inside pipe)	Vertical Hydraulic Gradient 1/ (foot/foot)	Potential Surface Water Flow Condition 2/
11/7/16	- -	0.00	Dry	Dry	--	--
12/12/16	13:16	0.92	Dry	4.18	--	--
1/25/17	13:57	1.65	2.59	2.60	0.00	Neutral
2/23/17	9:40	0.00	2.45	2.47	-0.01	Losing
3/9/17	11:55	0.20	2.77	2.78	0.00	Neutral
4/19/17	14:32	0.07	2.78	2.79	0.00	Neutral
5/12/17	11:26	2.48	2.78	2.76	0.01	Gaining
6/2/17	13:11	1.59	2.84	2.87	-0.01	Losing
6/22/17	11:20	1.35	Dry	3.11	--	--

ft btp feet below top of pipe
ft bg feet below grade
- - Not calculated

Precipitation Data: NOAA USC00067432 Shuttle Meadow Reservoir

1/ Difference between surface water and groundwater levels divided by depth of screen midpoint

2/ Gaining when groundwater level higher than surface-water level (postive vertical hydraulic gradient);
Losing when surface-water level higher than groundwater (negative vertical hydraulic gradient)

Install Date:	11/7/16
Grade:	3.02 ft btp
Total Depth:	3.56 ft bg
Screen Setting:	2.11 to 3.56 ft bg
Screen Mid-Point Depth (ft bg):	2.84

TABLE 2

CITY OF NEW BRITAIN
PROPOSESD STORAGE RESERVOIR

Summary of Piezometer Data for Surface-Water Features

Piezometer PZ-4: Potential Vernal Pool #5 and Wetland/Watercourse #5

Date	Time	Preceding 7-day Precipitation (inches)	Depth to Water (ft btp)		Compare Surface Water to Groundwater	
			Surface Water (outside pipe)	Groundwater (inside pipe)	Vertical Hydraulic Gradient 1/ (foot/foot)	Potential Surface Water Flow Condition 2/
11/7/16	8:39	0.00	Dry	Dry	--	--
12/12/16	13:25	0.92	Dry	6.22	--	--
1/25/17	14:11	1.65	2.02	2.09	-0.02	Losing
2/23/17	9:52	0.00	1.98	2.12	-0.05	Losing
3/9/17	12:24	0.20	2.17	2.14	0.01	Gaining
4/19/17	14:41	0.07	2.19	2.12	0.02	Gaining
5/12/17	11:37	2.48	2.06	1.94	0.04	Gaining
6/2/17	13:21	1.59	2.05	2.01	0.01	Gaining
6/22/17	11:30	1.35	2.39	2.29	0.04	Gaining

ft btp feet below top of pipe
ft bg feet below grade
-- Not calculated
Precipitation Data: NOAA USC00067432 Shuttle Meadow Reservoir
1/ Difference between surface water and groundwater levels divided by depth of screen midpoint
2/ Gaining when groundwater level higher than surface-water level (postive vertical hydraulic gradient); Losing when surface-water level higher than groundwater (negative vertical hydraulic gradient)

Install Date:	11/7/16
Grade:	3.00 ft btp
Total Depth:	3.58 ft bg
Screen Setting:	2.14 to 3.58 ft bg
Screen Mid-Point Depth (ft bg):	2.84

TABLE 2

CITY OF NEW BRITAIN
PROPOSESD STORAGE RESERVOIR

Summary of Piezometer Data for Surface-Water Features

Piezometer PZ-5: Potential Vernal Pool #1

Date	Time	Preceding 7-day Precipitation (inches)	Depth to Water (ft btp)		Compare Surface Water to Groundwater	
			Surface Water (outside pipe)	Groundwater (inside pipe)	Vertical Hydraulic Gradient 1/ (foot/foot)	Potential Surface Water Flow Condition 2/
11/7/16	8:45	0.00	Dry	Dry	--	--
12/12/16	13:30	0.92	Dry	5.78	--	--
1/25/17	14:17	1.65	2.81	2.79	0.01	Gaining
2/23/17	9:59	0.00	2.72	2.74	-0.01	Losing
3/9/17	12:41	0.20	2.77	2.70	0.02	Gaining
4/19/17	14:47	0.07	2.83	2.78	0.02	Gaining
5/12/17	11:44	2.48	2.73	2.66	0.02	Gaining
6/2/17	13:26	1.59	2.78	2.73	0.02	Gaining
6/22/17	11:35	1.35	3.04	3.01	0.01	Gaining

ft btp — feet below top of pipe
ft bg — feet below grade
-- — Not calculated
Precipitation Data: NOAA USC00067432 Shuttle Meadow Reservoir
1/ Difference between surface water and groundwater levels divided by depth of screen midpoint
2/ Gaining when groundwater level higher than surface-water level (postive vertical hydraulic gradient); Losing when surface-water level higher than groundwater (negative vertical hydraulic gradient)

Install Date:	11/7/16
Grade:	3.34 ft btp
Total Depth:	3.25 ft bg
Screen Setting:	1.80 to 3.25 ft bg
Screen Mid-Point Depth (ft bg):	2.84

TABLE 2

CITY OF NEW BRITAIN
PROPOSESD STORAGE RESERVOIR

Summary of Piezometer Data for Surface-Water Features

Piezometer PZ-6/6R: Potential Vernal Pool #3

Date	Time	Preceding 7-day Precipitation (inches)	Depth to Water (ft btp)		Compare Surface Water to Groundwater	
			Surface Water (outside pipe)	Groundwater (inside pipe)	Vertical Hydraulic Gradient 1/ (foot/foot)	Potential Surface Water Flow Condition 2/
11/7/16	9:24	0.00	Dry	Dry	--	--
12/12/16	13:36	0.92	Dry	3.60	--	--
1/25/17	nm	1.65	nm	nm	--	--
2/23/17	10:25	0.00	1.93	3.14	-0.54	Losing
3/9/17	13:36	0.20	2.33	2.08	0.11	Gaining
4/19/17	14:53	0.07	2.42	1.71	0.32	Gaining
5/12/17	11:55	2.48	2.15	1.95	0.09	Gaining
6/2/17	13:41	1.59	2.28	2.21	0.03	Gaining
6/22/17	12:01	1.35	2.90	2.80	0.04	Gaining

ft btp — feet below top of pipe
ft bg — feet below grade
-- — Not calculated
nm — No measurement

Precipitation Data: NOAA USC00067432 Shuttle Meadow Reservoir

1/ Difference between surface water and groundwater levels divided by depth of screen midpoint

2/ Gaining when groundwater level higher than surface-water level (postive vertical hydraulic gradient); Losing when surface-water level higher than groundwater (negative vertical hydraulic gradient)

Install Date:	2/23/2017 (PZ-6R)
Grade:	3.74 ft btp
Total Depth:	2.98 ft bg
Screen Setting:	1.48 to 2.98 ft bg
Screen Mid-Point Depth (ft bg):	2.23

TABLE 2

CITY OF NEW BRITAIN
PROPOSESD STORAGE RESERVOIR

Summary of Piezometer Data for Surface-Water Features

Piezometer PZ-7: Potential Vernal Pool #5 and Wetland/Watercourse #5

Date	Time	Preceding 7-day Precipitation (inches)	Depth to Water (ft btp)		Compare Surface Water to Groundwater	
			Surface Water (outside pipe)	Groundwater (inside pipe)	Vertical Hydraulic Gradient 1/ (foot/foot)	Potential Surface Water Flow Condition 2/
11/7/16		0.00	Dry	Dry	--	--
12/12/16	14:02	0.92	Dry	6.35	--	--
1/25/17	14:45	1.65	2.85	3.72	-0.33	Losing
2/23/17	10:40	0.00	2.55	3.04	-0.19	Losing
3/9/17	13:55	0.20	2.99	3.58	-0.23	Losing
4/17/19	15:12	0.07	3.01	3.34	-0.13	Losing
5/12/17	12:09	2.48	2.94	3.22	-0.11	Losing
6/2/17	14:03	1.59	2.97	3.30	-0.13	Losing
6/22/17	12:20	1.35	Dry	4.63	--	--

ft btp — feet below top of pipe
ft bg — feet below grade
-- — Not calculated

Precipitation Data: NOAA USC00067432 Shuttle Meadow Reservoir

1/ Difference between surface water and groundwater levels divided by depth of screen midpoint

2/ Gaining when groundwater level higher than surface-water level (postive vertical hydraulic gradient); Losing when surface-water level higher than groundwater (negative vertical hydraulic gradient)

Install Date:	11/7/16
Grade:	3.25 ft btp
Total Depth:	3.38 ft bg
Screen Setting:	1.86 to 3.38 ft bg
Screen Mid-Point Depth (ft bg):	2.62

TABLE 2

CITY OF NEW BRITAIN
PROPOSESD STORAGE RESERVOIR

Summary of Piezometer Data for Surface-Water Features

Piezometer PZ-8: Potential Vernal Pool #2

Date	Time	Preceding 7-day Precipitation (inches)	Depth to Water (ft btp)		Compare Surface Water to Groundwater	
			Surface Water (outside pipe)	Groundwater (inside pipe)	Vertical Hydraulic Gradient 1/ (foot/foot)	Potential Surface Water Flow Condition 2/
11/7/16	nm	0.00	nm	nm	--	--
12/12/16	nm	0.92	nm	nm	--	--
1/25/17	nm	1.65	nm	nm	--	--
2/23/17	nm	0.00	nm	nm	--	--
3/9/17	13:20	0.20	2.24	2.40	-0.06	Losing
4/17/19	nm	0.07	nm	nm	--	--
5/12/17	nm	2.48	nm	nm	--	--
6/2/17	13:31	1.59	2.17	2.48	-0.11	Losing
6/22/17	11:40	1.35	2.43	2.76	-0.12	Losing

ft btp	feet below top of pipe	- -	Not calculated
ft bg	feet below grade	nm	No measurement

Precipitation Data: NOAA USC00067432 Shuttle Meadow Reservoir

1/ Difference between surface water and groundwater levels divided by depth of screen midpoint

2/ Gaining when groundwater level higher than surface-water level (postive vertical hydraulic gradient); Losing when surface-water level higher than groundwater (negative vertical hydraulic gradient)

Install Date:	3/9/17
Grade:	3.29 ft btp
Total Depth:	3.51 ft bg
Screen Setting:	2.00 to 3.51 ft bg
Screen Mid-Point Depth (ft bg):	2.76

TABLE 3

CITY OF NEW BRITAIN
PROPOSED STORAGE RESERVOIR

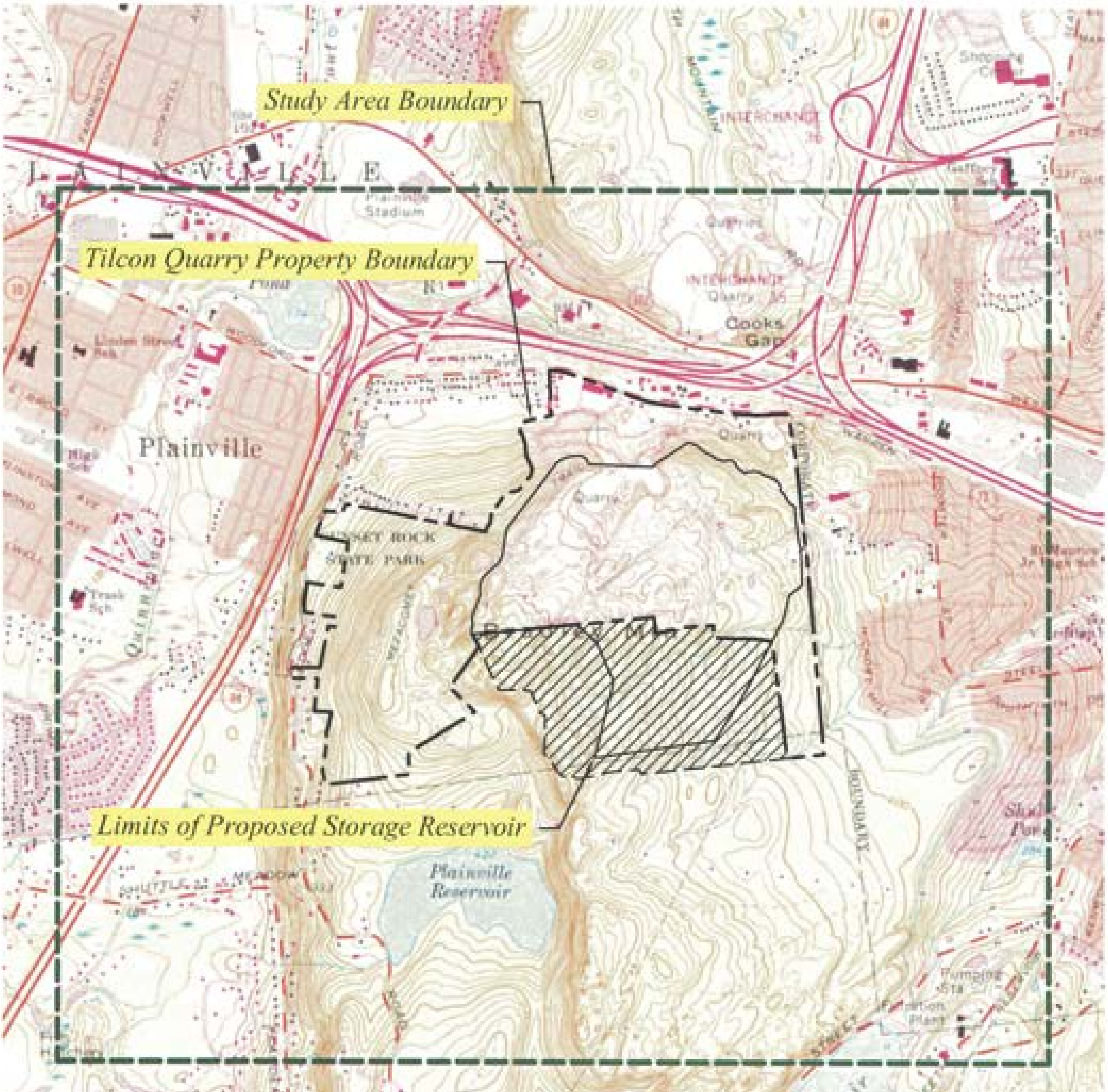
Precipitation Data for Study Area - Shuttle Meadow Reservoir NOAA Station #US00067432

Month	30-Year Normal Precipitation 1/ (inches)	Actual Precipitation During Monitoring Period		
		Year	Amount (inches)	Difference From Normal
Jan	4.07	2017	3.46	-0.61
Feb	3.69	2017	3.03	-0.66
March	4.43	2017	4.07	-0.36
April	4.43	2017	5.44	1.01
May	4.16	2017	5.44	1.28
June	4.59	2017	3.83	-0.76
July	4.82	2017	3.91	-0.91
Aug	4.11	2017	2.72	-1.39
Sept	4.4	2017	na	na
Oct	5.02	2017	na	na
Nov	5.01	2016	1.78	-3.23
Dec	4.07	2016	1.82	-2.25
Total	52.8			

na - Not available

1/ 50% probability value determined from probability graph constructed using total monthly precipitation amounts for 30-year period from 1980 to 2010

FIGURES



SOURCE: USGS TOPOGRAPHIC QUADRANGLE NEW BRITAIN, CONNECTICUT (REVISED 1992).

LEGEND

CITY OF NEW BRITAIN PARCEL

QUADRANGLE LOCATION

0 2000

SCALE IN FEET

CITY OF NEW BRITAIN PROPOSED QUARRY EXPANSION AND STORAGE RESERVOIR CREATION

STUDY AREA MAP

DATE	REVISED	PREPARED BY: LEGGETTE, BRASHEARS & GRAHAM Professional Groundwater and Environmental Engineering Services Member of WSP 6 Executive Drive Suite 109 Farmington, Connecticut 06032 (860) 678-0404
DRAWN:	RAC	CHECKED: RG · DATE: 12/11/17 · FIGURE: 1

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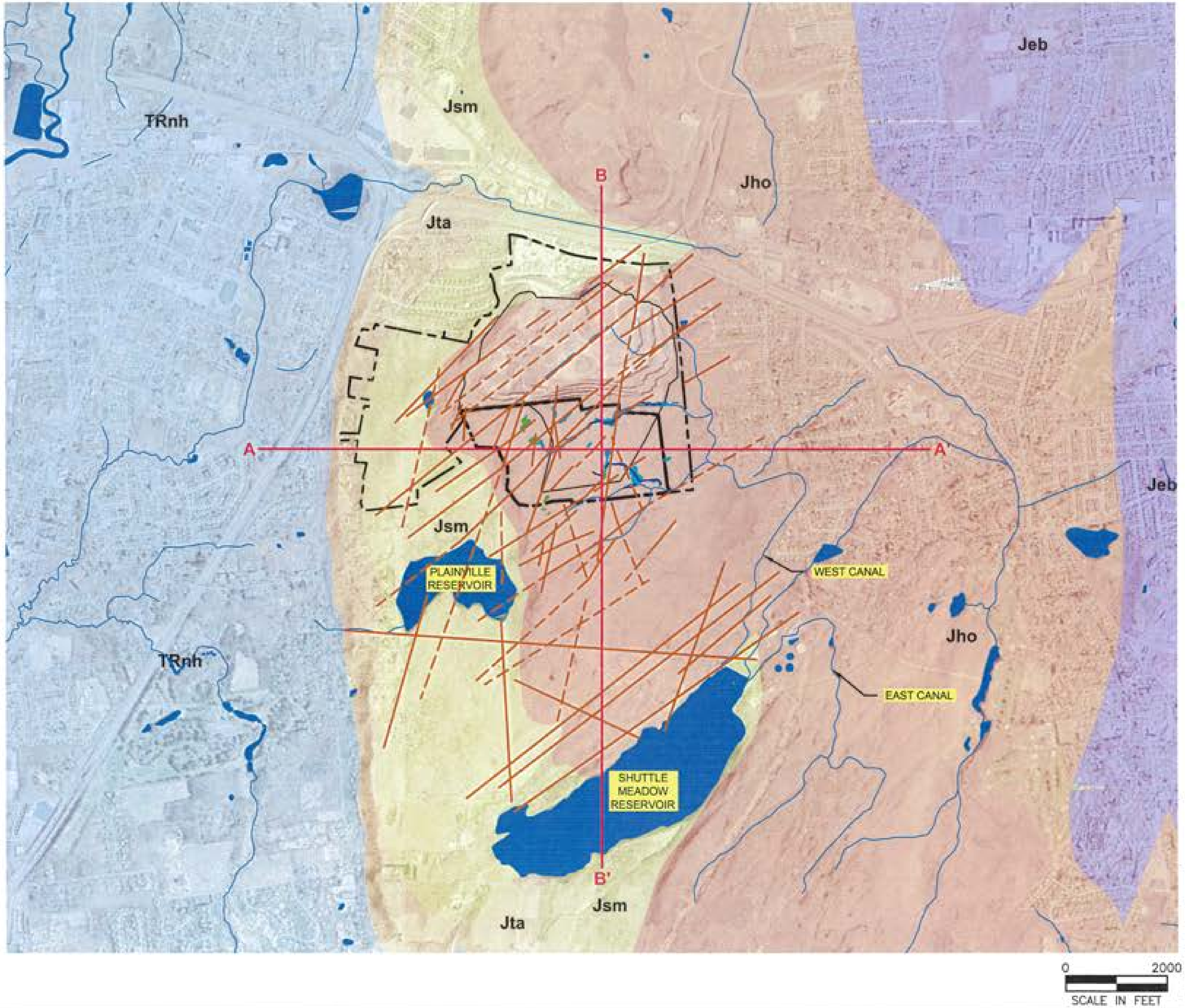


LEGEND

- CITY OF NEW BRITAIN PARCEL
- TILCON PROPERTY BOUNDARY
- LIMIT OF PROPOSED STORAGE RESERVOIR
- CROSS SECTION LOCATION
- WETLANDS
- VERNAL POOL
- HIGH PROBABILITY LIDAR LINEAMENT ANALYSIS
- LOW PROBABILITY LIDAR LINEAMENT ANALYSIS

Jeb	EAST BERLIN FORMATION (Jeb): A REDDISH-BROWN SILTYSHALE
Jho	HOLYOKE BASALT (Jho): A DARK-GREY, ORANGE TO BROWN WEATHERING BASALT
Jsm	SHUTTLE MEADOW FORMATION (Jsm): A REDDISH BROWN SILTY SHALE
Jta	TALCOTT BASALT (Jta): A DARK GREY, ORANGE TO BROWN WEATHERING BASALT
TRnh	NEW HAVEN ARKOSE (TRnh): A REDDISH, POORLY SORTED ARKOSE

SOURCES:
1. CONNECTICUT DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION, CONNECTICUT HYDROGRAPHY LAYER, 2005 EDITION.
2. BEDROCK GEOLOGICAL MAP OF CONNECTICUT COMPILED BY JOHN RODGERS, 1985.

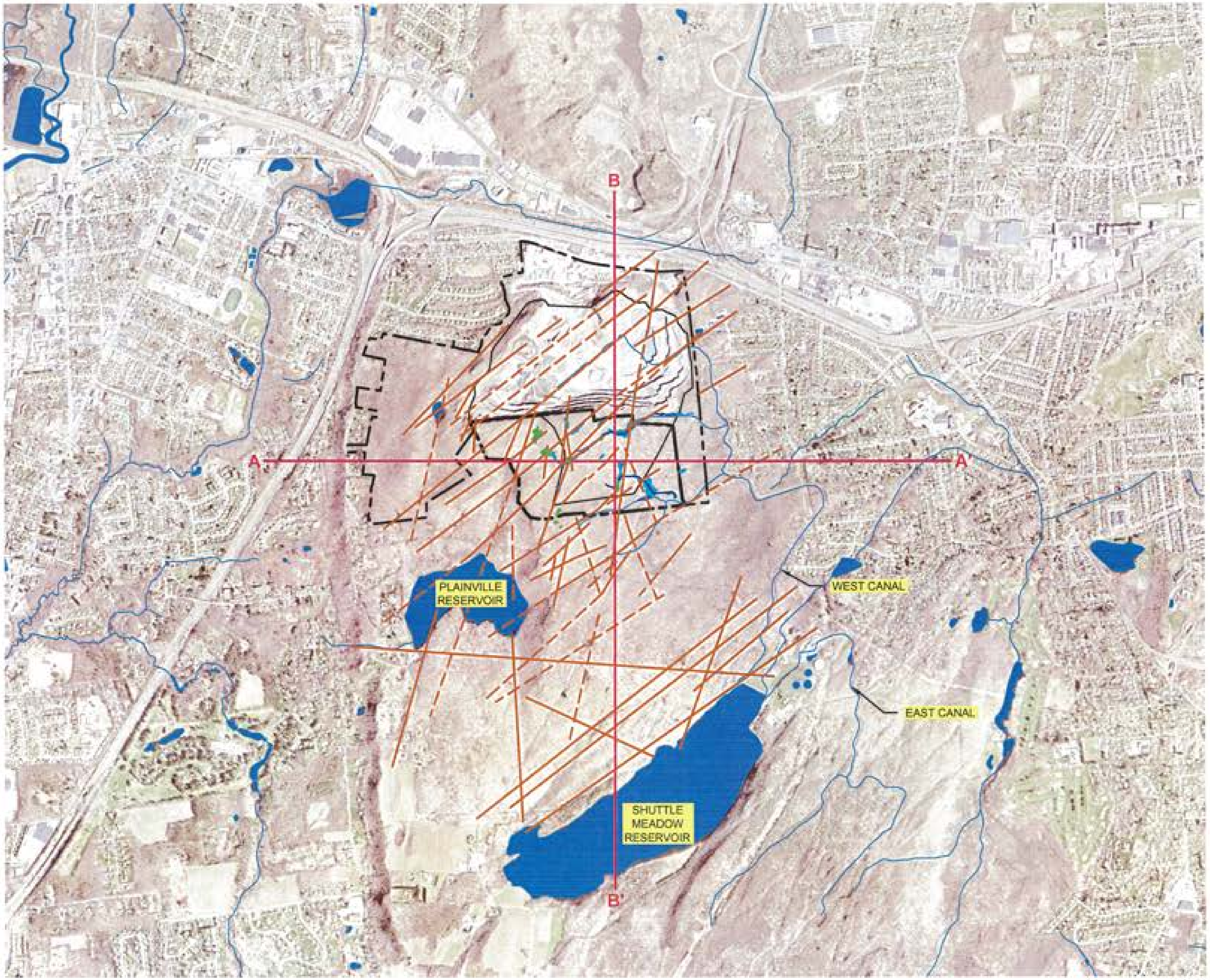
CITY OF NEW BRITAIN PROPOSED QUARRY EXPANSION AND STORAGE RESERVOIR CREATION

BEDROCK GEOLOGIC MAP

DATE	REVISED

PREPARED BY: LEGGETTE, BRASHEARS & GRAHAM
Professional Groundwater and Environmental Engineering Services
Member of WSP
6 Executive Drive
Suite 109
Farmington, Connecticut 06032
(860) 678-0404

DRAWN: RAC | CHECKED: RG | DATE: 12/11/17 | FIGURE: 2



0 2000

SCALE IN FEET

LEGEND

- CITY OF NEW BRITAIN PARCEL
- TILCON PROPERTY BOUNDARY
- LIMIT OF PROPOSED STORAGE RESERVOIR
- CROSS SECTION LOCATION
- WETLANDS
- VERNAL POOL
- HIGH PROBABILITY LIDAR LINEAMENT ANALYSIS
- LOW PROBABILITY LIDAR LINEAMENT ANALYSIS

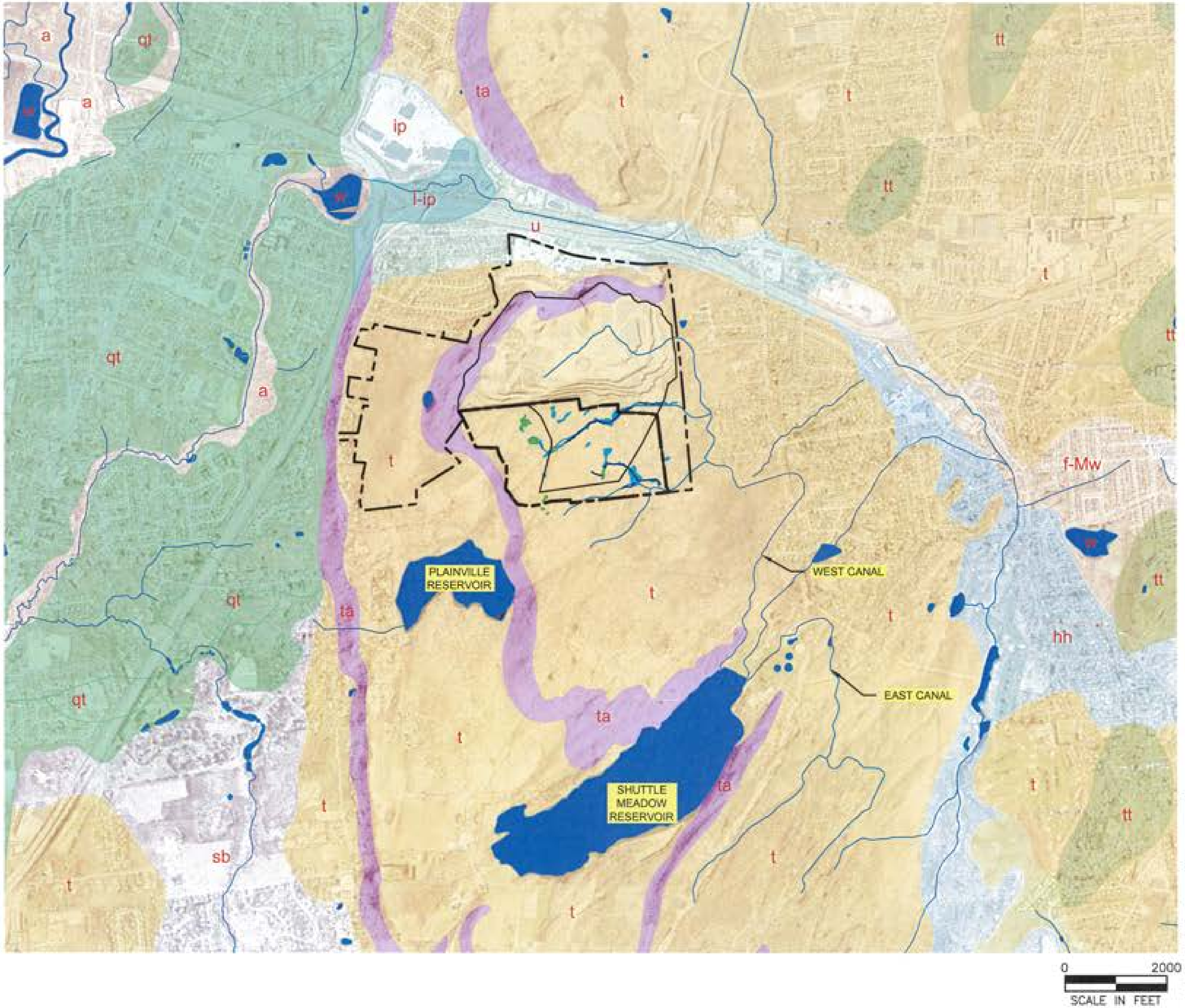
SOURCES:
1. CONNECTICUT DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION, CONNECTICUT HYDROGRAPHY LAYER, 2005 EDITION.

CITY OF NEW BRITAIN
PROPOSED QUARRY EXPANSION AND STORAGE RESERVOIR CREATION

LIDAR LINEAMENT ANALYSIS

DATE	REVISED	PREPARED BY: LEGGETTE, BRASHEARS & GRAHAM
		Professional Groundwater and Environmental Engineering Services
		Member of WSP — 6 Executive Drive, Suite 109, Farmington, Connecticut 06032, (860) 678-0404

DRAWN: RAC | CHECKED: RG | DATE: 12/11/17 | FIGURE: 3



LEGEND

	CITY OF NEW BRITAIN PARCEL
	TILCON PROPERTY BOUNDARY
	LIMIT OF PROPOSED STORAGE RESERVOIR
	WETLANDS
	VERNAL POOL
qt	QUINNIPIAC RIVER TERRACE DEPOSITS
a	FLOOD-PLAIN ALLUVIUM
ip	UNCORRELATED DEPOSITS OF ICE-DAMMED PONDS (IP)
l-ip	LAKE-BOTTOM FACEIS OF UNCORRELATED DEPOSITS OF ICE DAMMED PONDS
sb	SOUTHINGTON-BRISTOL DEPOSITS
t	THIN TILL DEPOSITS
ta	TALUS
u	UNDIFFERENTIATED MELTWATER DEPOSITS
f-Mw	GLACIOFLUVIAL FACIES OF GLACIAL LAKE MIDDLETOWN WESTERN MARGIN DELTAIC DEPOSITS (F-LMV)
hh	HANGING HILLS DEPOSITS
tt	THICK TILL DEPOSITS

SOURCES:
1. CONNECTICUT DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION, CONNECTICUT HYDROGRAPHY LAYER, 2005 EDITION.
2. QUATERNARY GEOLOGICAL MAP OF CONNECTICUT AND LONG ISLAND SOUND BASIN BY STONE et al, 2005.

CITY OF NEW BRITAIN PROPOSED QUARRY EXPANSION AND STORAGE RESERVOIR CREATION

SURFICIAL GEOLOGIC MAP

DATE	REVISED	PREPARED BY: LEGGETTE, BRASHEARS & GRAHAM
		Professional Groundwater and Environmental Engineering Services
		Member of WSP — 6 Executive Drive, Suite 109, Farmington, Connecticut 06032, (860) 678-0404

DRAWN: RAC | CHECKED: RG | DATE: 12/11/17 | FIGURE: 4

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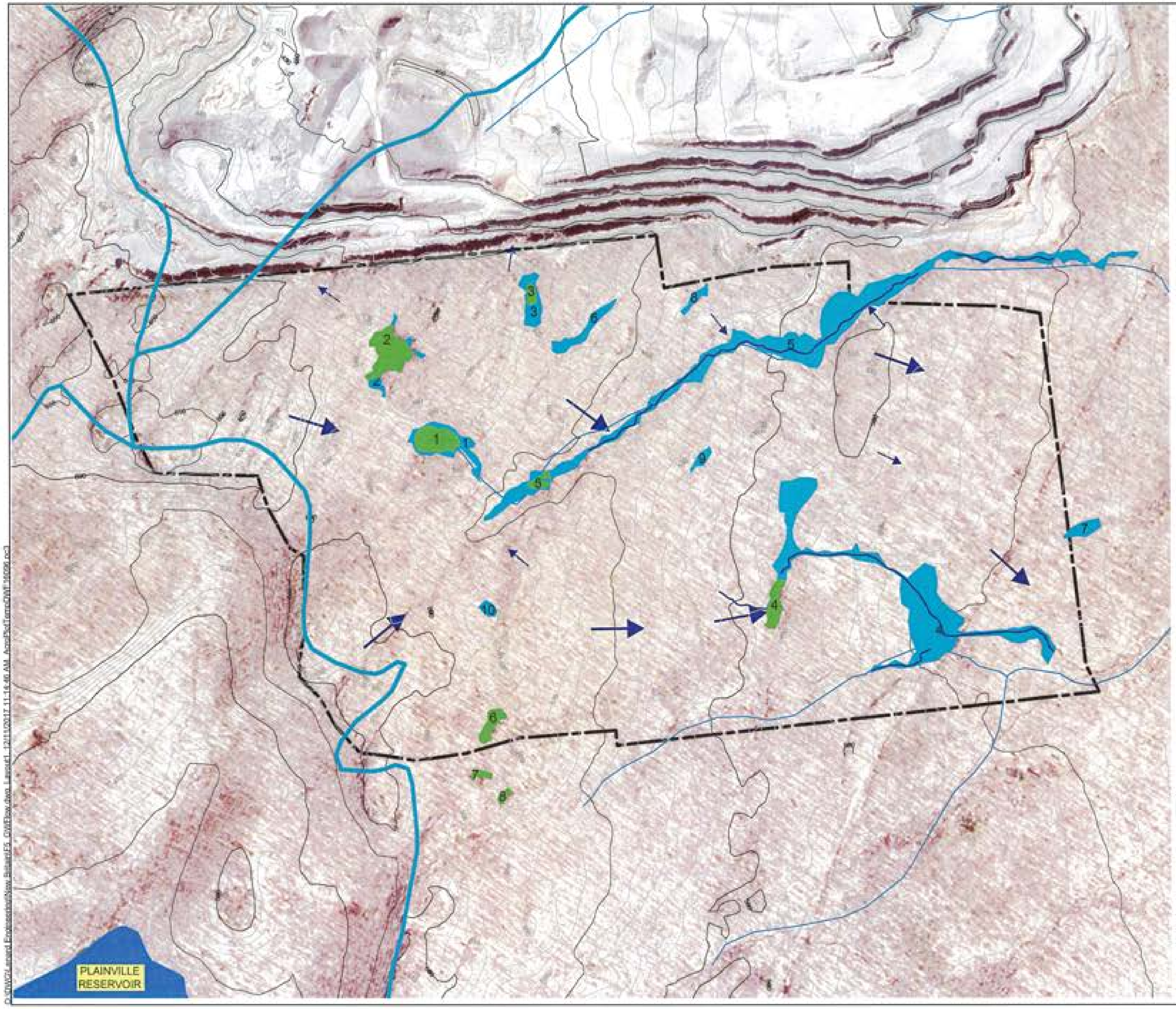


LEGEND

- CITY OF NEW BRITAIN PARCEL
- ELEVATION CONTOUR
- DRAINAGE BASIN BOUNDARY
- WETLANDS (WETLAND NUMBERS INDICATED)
- VERNAL POOL (POOL NUMBERS INDICATED)
- APPROXIMATE GROUNDWATER FLOW DIRECTION
  - REGIONAL
  - LOCAL

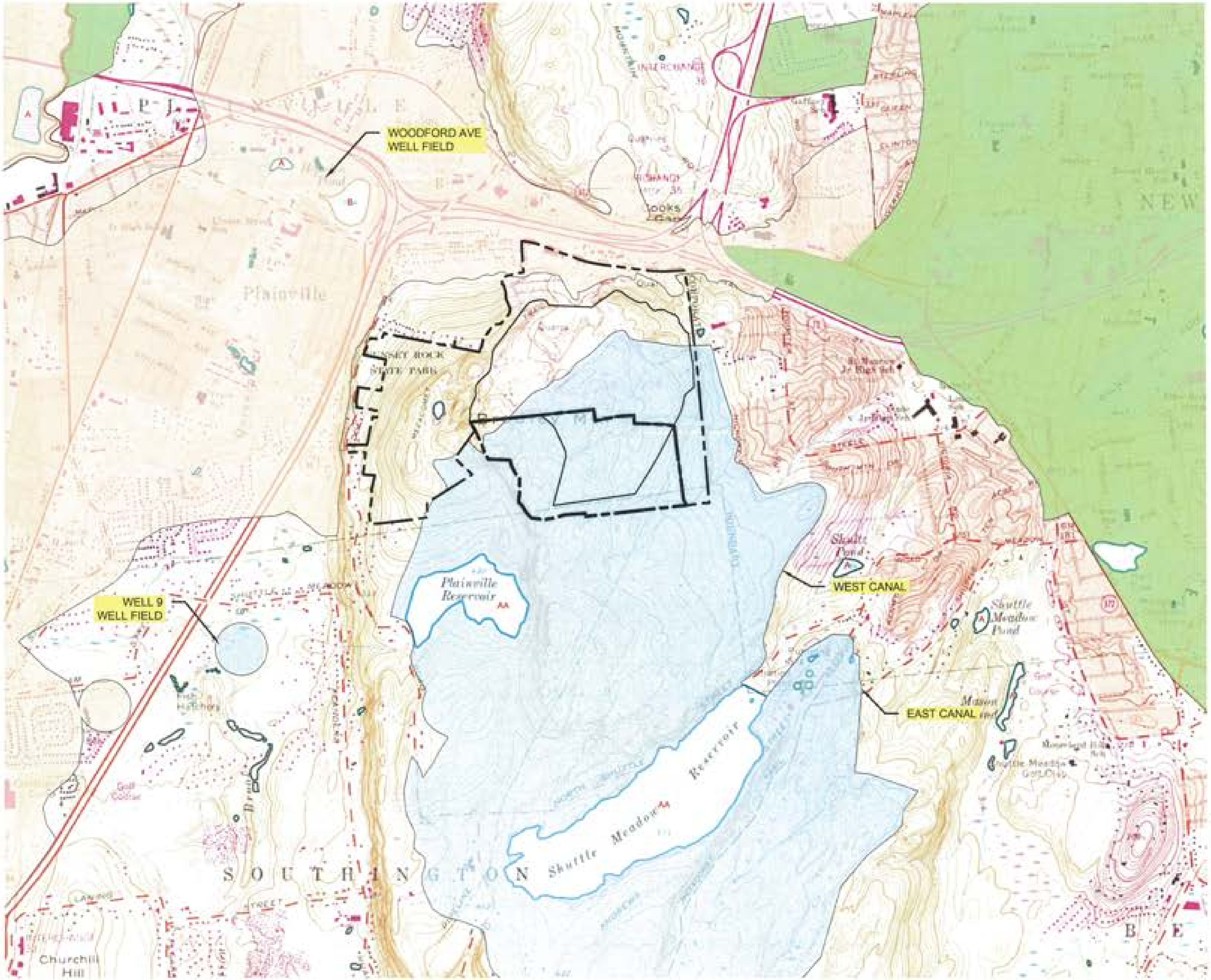
SOURCES:
1. CONNECTICUT DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION, CONNECTICUT HYDROGRAPHY LAYER, 2005 EDITION.

0 400
SCALE IN FEET

CITY OF NEW BRITAIN
PROPOSED QUARRY EXPANSION AND STORAGE RESERVOIR CREATION

GROUNDWATER FLOW DIRECTION

DATE	REVISED	PREPARED BY:
		LEGGETTE, BRASHEARS & GRAHAM Professional Groundwater and Environmental Engineering Services Member of WSP 6 Executive Drive Suite 109 Farmington, Connecticut 06032 (860) 678-0404
DRAWN: RAC		CHECKED: RG DATE: 12/11/17 FIGURE: 5



0 2000
SCALE IN FEET

LEGEND

- CITY OF NEW BRITAIN PARCEL
- TILCON PROPERTY BOUNDARY
- LIMIT OF PROPOSED STORAGE RESERVOIR

SURFACE WATER QUALITY CLASSES
- A
- AA
- B

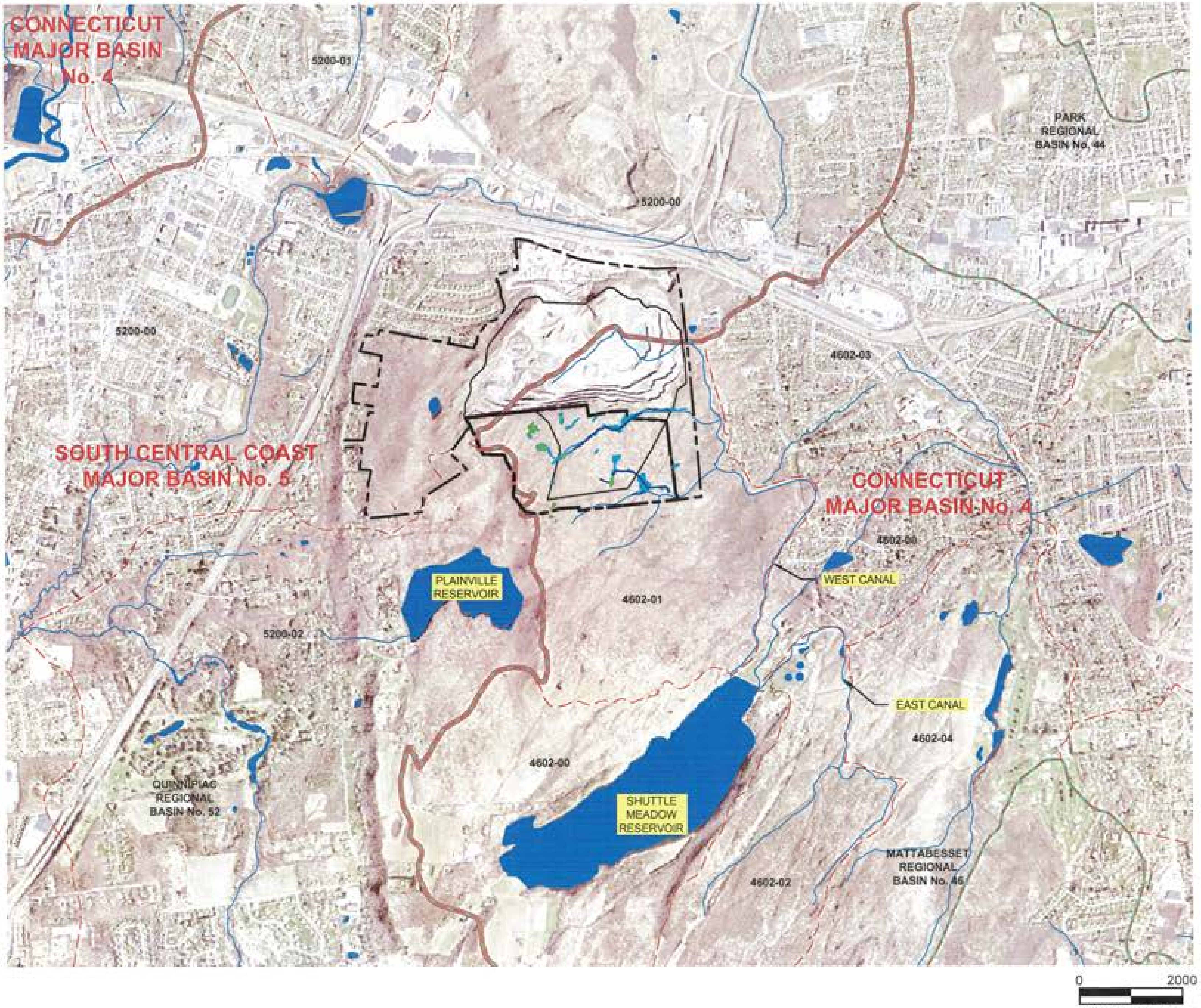
GROUND WATER QUALITY CLASSES
- GA
- GAA, GAAs
- GA, GAA MAY NOT MEET CURRENT STANDARDS
- GB

SOURCES:
1. USGS TOPOGRAPHIC QUADRANGLE NEW BRITAIN, CONNECTICUT (REVISED 1992).
2. STATE OF CONNECTICUT DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION "WATER QUALITY CLASSIFICATIONS PLAINVILLE, CT" NOVEMBER 2015.

CITY OF NEW BRITAIN
PROPOSED QUARRY EXPANSION AND STORAGE RESERVOIR CREATION

AQUIFER DELINEATIONS

DATE	REVISED	PREPARED BY: LEGGETTE, BRASHEARS & GRAHAM
		Professional Groundwater and Environmental Engineering Services
		Member of WSP — 6 Executive Drive, Suite 109, Farmington, Connecticut 06032, (860) 678-0404
DRAWN: RAC	CHECKED: RG	DATE: 12/11/17 FIGURE: 6



LEGEND

- CITY OF NEW BRITAIN PARCEL
- TILCON PROPERTY BOUNDARY
- LIMIT OF PROPOSED STORAGE RESERVOIR
- MAJOR BASIN
- REGIONAL BASIN
- SUBREGIONAL BASIN
- LOCAL BASIN (4602-01)
- WETLANDS
- VERNAL POOL

SOURCES:

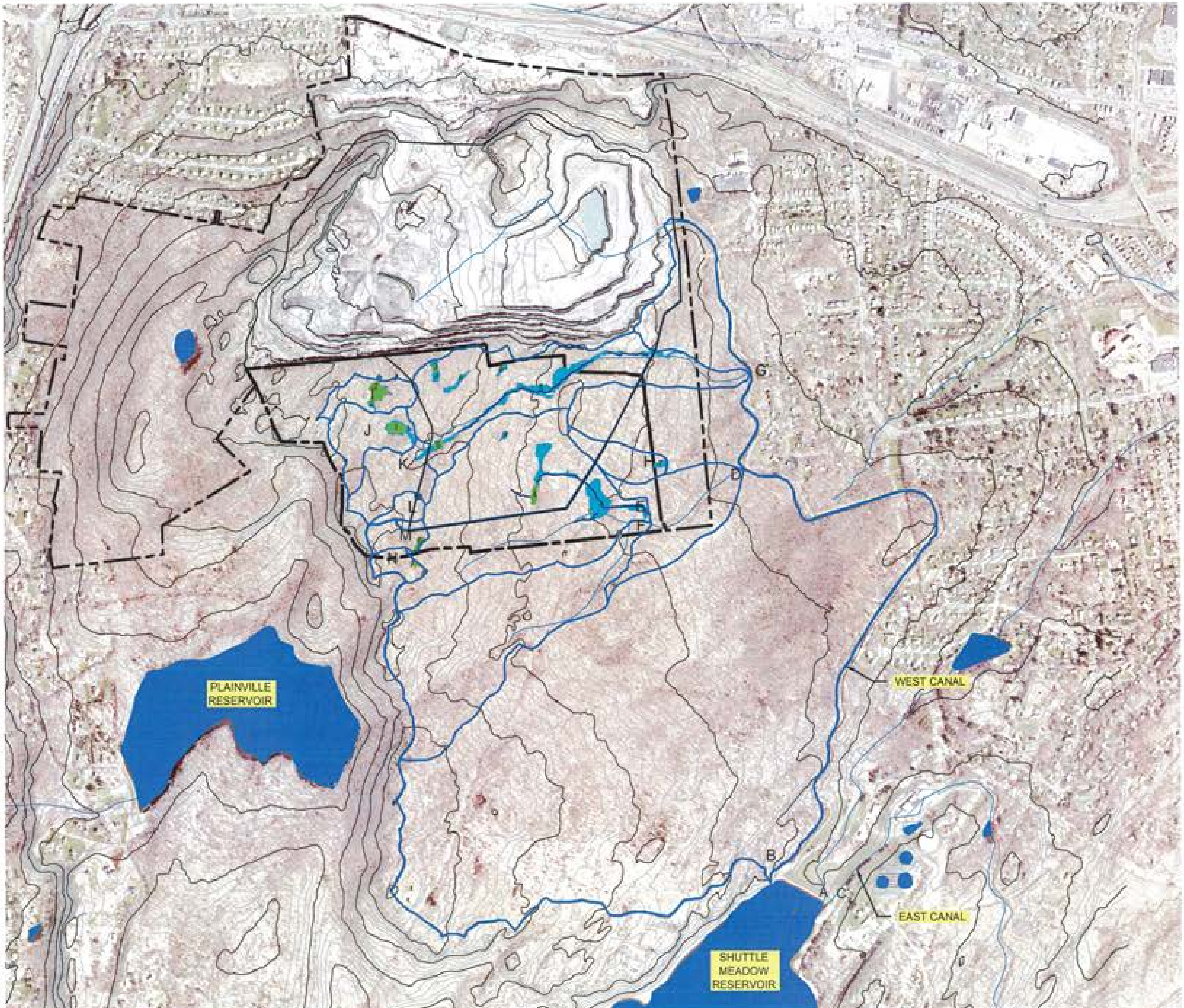
1. CONNECTICUT DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION, CONNECTICUT HYDROGRAPHY LAYER, 2005 EDITION.
2. CONNECTICUT DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION, CONNECTICUT DRAINAGE BASINS LAYER, 2006 EDITION.

CITY OF NEW BRITAIN
PROPOSED QUARRY EXPANSION AND STORAGE RESERVOIR CREATION

DRAINAGE BASIN MAP

DATE	REVISED	PREPARED BY: LEGGETTE, BRASHEARS & GRAHAM
		Professional Groundwater and Environmental Engineering Services Member of WSP 6 Executive Drive Suite 109 Farmington, Connecticut 06032 (860) 678-0404

DRAWN: RAC | CHECKED: RG | DATE: 12/11/17 | FIGURE: 7



LEGEND

- CITY OF NEW BRITAIN PARCEL
- TILCON PROPERTY BOUNDARY
- LIMIT OF PROPOSED STORAGE RESERVOIR
- ELEVATION CONTOUR
- PROJECT-AREA BASINS (DESIGNATED BY LETTER)
- 10 WETLANDS (WETLAND NUMBERS INDICATED)
- 8 VERNAL POOL (POOL NUMBERS INDICATED)

SOURCES:
1. CONNECTICUT DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION, CONNECTICUT HYDROGRAPHY LAYER, 2005 EDITION.

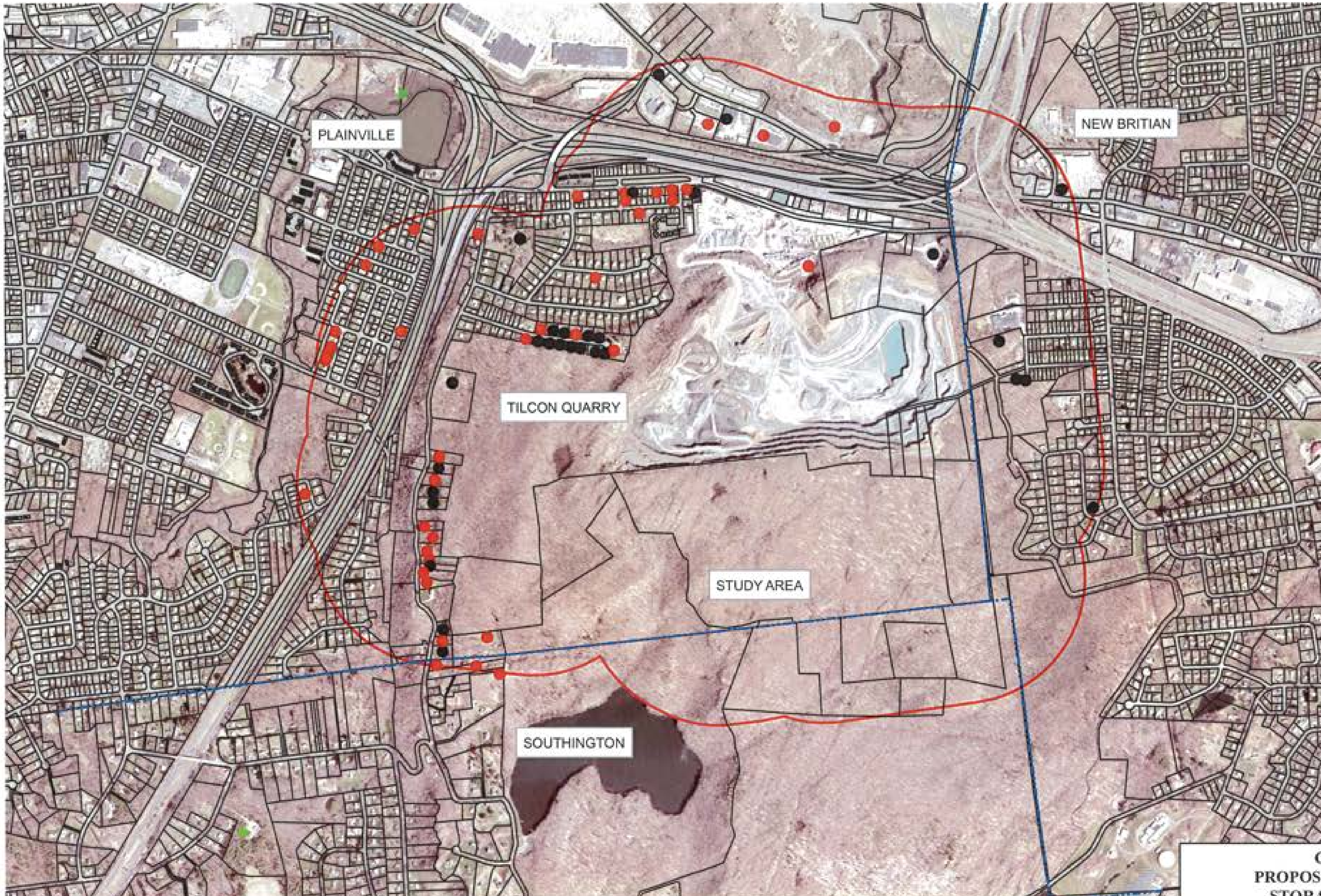
0 1000
SCALE IN FEET

CITY OF NEW BRITAIN PROPOSED QUARRY EXPANSION AND STORAGE RESERVOIR CREATION

PROJECT AREA BASIN MAP

DATE	REVISED	PREPARED BY: LEGGETTE, BRASHEARS & GRAHAM
		Professional Groundwater and Environmental Engineering Services
		Member of WSP — 6 Executive Drive, Suite 109, Farmington, Connecticut 06032, (860) 678-0404

DRAWN: RAC | CHECKED: RG | DATE: 12/11/17 | FIGURE: 8



SOURCE:
Aerial Image: CRCOG Orthoimagery, 2017, Shawn Benham, The Sanborn Map Company

Plainville Parcel Map: Plainville Parcel Shapefile, 2017, Town of Plainville, accessed from: http://plainville.mapxpress.net/portal.asp

Southington and New Britian Parcel Map: Connecticut Parcels for Protected Open Space Mapping, 2010, State of Connecticut Department of Energy and Environmental Protection, http://www.ct.gov/deep

K:\Jobs\Lenard Engineering\New Britain\LBG Report\Revisions\Figure 9 - Well Inventory Survey.mxd

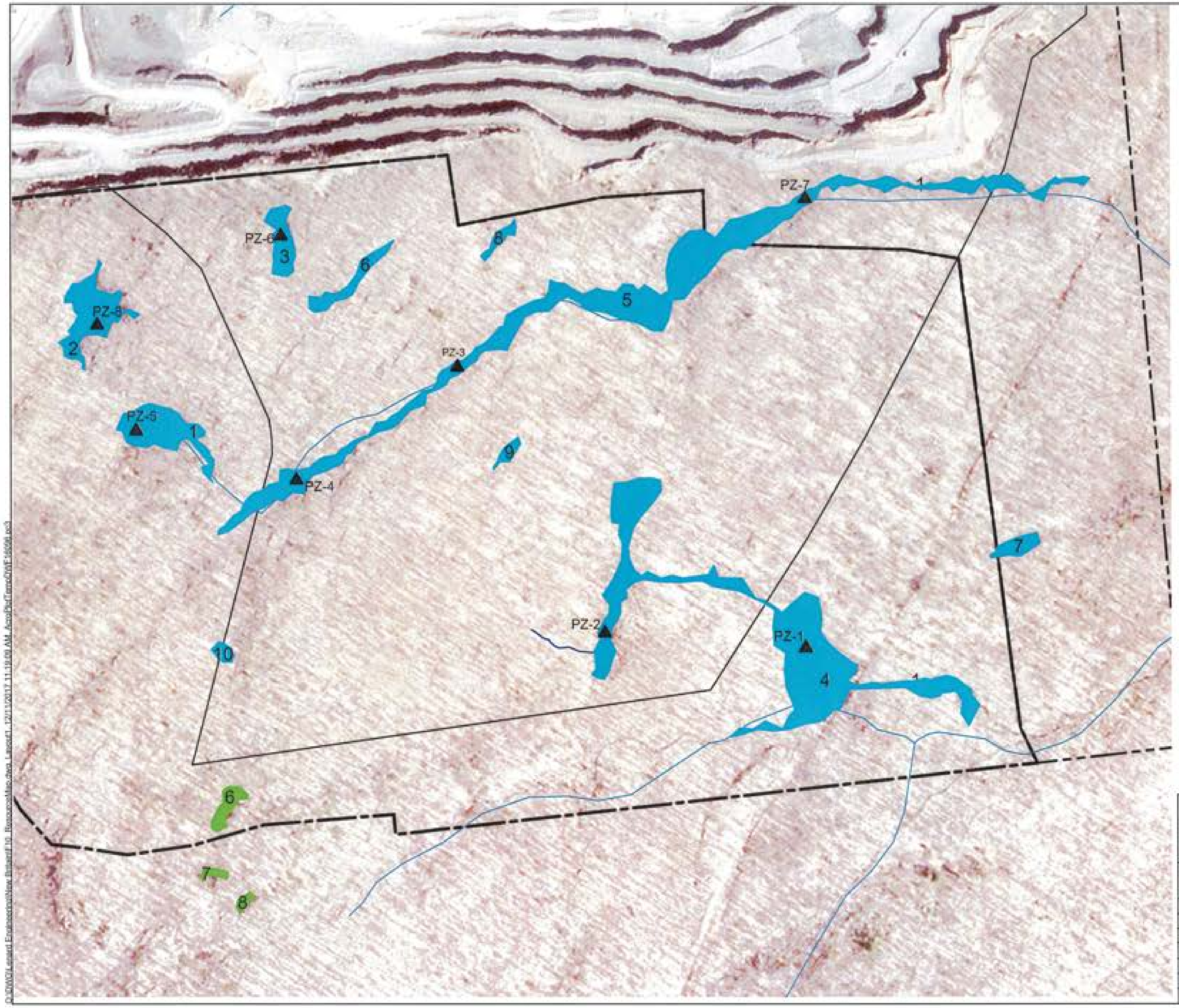
CITY OF NEW BRITAIN
PROPOSED QUARRY EXPANSION AND STORAGE RESERVOIR CREATION

WELL INVENTORY SURVEY

DATE	REVISED

PREPARED BY:
LEGGETTE, BRASHEARS & GRAHAM, INC.
Professional Groundwater and Environmental Engineering Services
6 Executive Drive
Suite 109
Farmington, Connecticut 06032
(860) 678-0404

DRAWN: AKM | CHECKED: RG | DATE: 10/26/17 | FIGURE: 9



LEGEND

- CITY OF NEW BRITAIN PARCEL
- TILCON PROPERTY BOUNDARY
- LIMIT OF PROPOSED STORAGE RESERVOIR
- WETLANDS (WETLAND NUMBERS INDICATED)
- VERNAL POOL (POOL NUMBERS INDICATED)
- INTERMITTENT WATERCOURSE BASED ON FIELD OBSERVATIONS BY DAVISON ENVIRONMENTAL
- PZ-1 PIEZOMETER LOCATION

SOURCES:
1. CONNECTICUT DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION, CONNECTICUT HYDROGRAPHY LAYER, 2005 EDITION.

0 300
SCALE IN FEET

CITY OF NEW BRITAIN PROPOSED QUARRY EXPANSION AND STORAGE RESERVOIR CREATION

NATURAL RECOURSE MAP AND PIEZOMETER LOCATIONS

DATE	REVISED	PREPARED BY: LEGGETTE, BRASHEARS & GRAHAM
		Professional Groundwater and Environmental Engineering Services
		Member of WSP
		6 Executive Drive Suite 109 Farmington, Connecticut 06032 (860) 678-0404

DRAWN: RAC | CHECKED: RG | DATE: 12/11/17 | FIGURE: 10

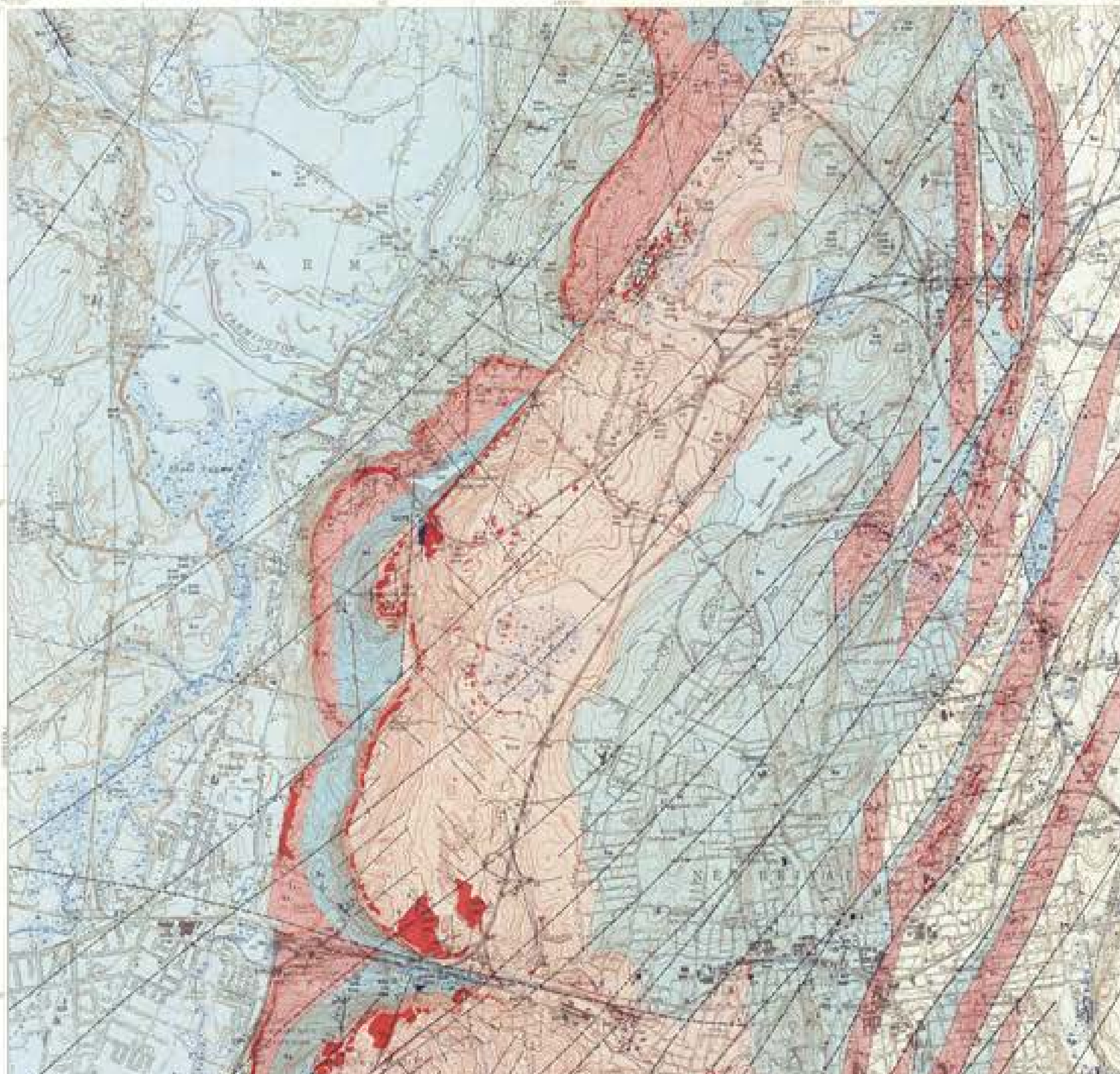
APPENDIX I

BEDROCK GEOLOGIC MAP OF NEW BRITAIN QUADRANGLE

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE STATE OF CONNECTICUT
GEOLOGICAL AND NATURAL HISTORY SURVEY

GEOLOGIC QUADRANGLE MAP
BEDROCK GEOLOGY
NEW BRITAIN QUADRANGLE, CONNECTICUT
GQ-494



SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

EXPLANATION

TRIASSIC

Portland Arkose

Hampden Basalt

East Berlin Formation

Holyoke Basalt

Shuttle Meadow Formation

Talcott Basalt

Basalt dike

New Haven Arkose

Contact

Fault

Lineament

Strike of inclined beds, showing direction and amount of dip where known

Strike of inclined columnar zone, showing direction and amount of dip

Joints, inclined and vertical

Quarry

Anomalously high radioactivity

Altitude of contact in contact

Mineral sampling locality

Type locality of formation

BEDROCK GEOLOGIC MAP OF THE NEW BRITAIN QUADRANGLE, CONNECTICUT

By

Howard E. Simpson

1966

Connecticut (New Britain quad.). Geol. 1:24,000. 1966.

APPENDIX II

NATURAL RESOURCE INVENTORY MAP,
DAVISON ENVIRONMENTAL LLC, 2017

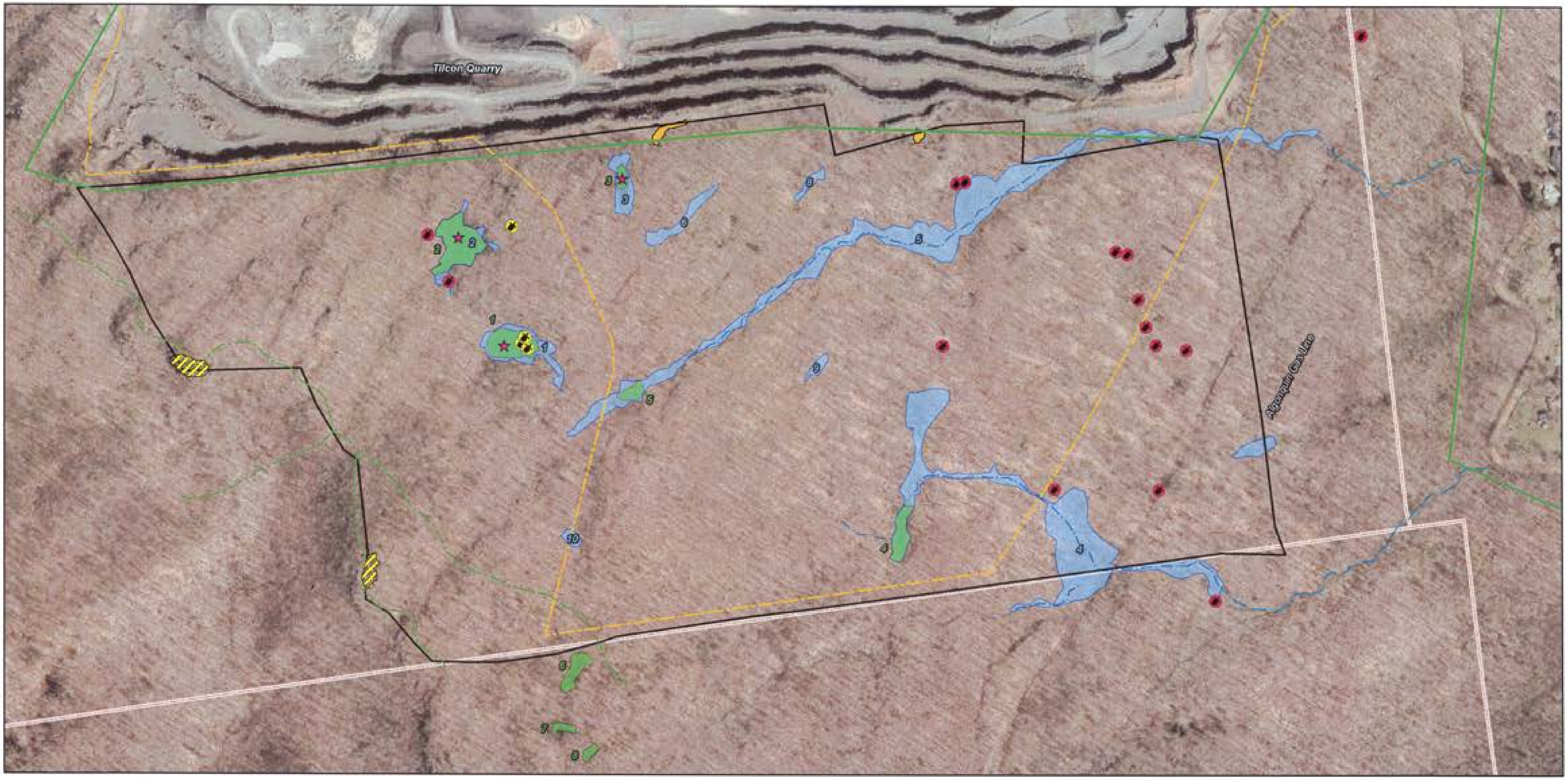


FIGURE 5
Wetlands, Vernal Pools & Rare Species

Map Description
Aerial photograph basemap (2016) showing the locations of wetlands, vernal pools and rare species. Resources illustrated were mapped based on field observations, GPS-collected data and aerial interpretation. Critical habitat locations were taken from the CT DEEP GIS dataset and confirmed by field observations.

Legend

- Site Boundary
- Wetlands (wetland numbers indicated in blue)
- Intermittent Watercourse (offsite flow indicated)
- Trails
- Recently logged forest
- Old field (gas line ROW)

Notable Habitats and State-listed Species

- Jefferson Salamander Breeding Pools (species of special concern)
- Eastern box turtle (state-listed species of special concern)
- Spotted turtle (state-listed species of special concern)
- Vernal Pools (pool numbers indicated in green)
- NDDB Critical Habitat (community type: sub-acidic rocky summit outcrop; data date 10/5/2009; habitat locations confirmed by field observations)
- Fir Clubmoss and Coastal Jointweed

SCALE
0 150 300 Feet
N

Prepared by:
DAVISON ENVIRONMENTAL
Davison Environmental, LLC
www.davisonenvironmental.com

APPENDIX III

WELL INVENTORY SURVEY INFORMATION

Tilcon Quarry Resevoir Study
Well Inventory Survey - 2016
New Britain, Connecticut

MBLU	Address	Owner	Record of Public Water Service	Evidence for Private Well		Potential for Private Well
				Record of Well Completion	Visual Observation or Research	
6044029	31 BUNNELL STREET		Y			
6044018	22 MAY STREET		Y			
6044028	25 BUNNELL STREET		Y			
6044019	20 MAY STREET		Y			
6044027	19 BUNNELL STREET		Y			
6044020	16 MAY STREET		Y			
6041008	29 COLT STREET		Y			
6041009	33 COLT STREET		Y			
6041010	37 COLT STREET		Y			
6041011	39 COLT STREET		Y			
6041012	47 COLT STREET		Y			
6041013	51 COLT STREET		Y			
6041014	59 COLT STREET		Y			
6041015	65 COLT STREET		Y			
6042004	85 COLT STREET				Undeveloped	
6042018	156 BLACK ROCK AVENUE		Y		Undeveloped	
6042020	630 BLACK ROCK AVENUE				Undeveloped	
6042001	31 WINCHELL ROAD				Undeveloped	
6052011	103 WESTWOOD DRIVE		Y			
6052010	115 WESTWOOD DRIVE		Y			
6052012	90 WESTWOOD DRIVE		Y			
6052013	110 WESTWOOD DRIVE		Y			
6052014	203 HICKORY HILL ROAD		Y			
6052015	189 HICKORY HILL ROAD		Y			
6052016	66 WESTWOOD DRIVE		Y			
6052018	177 HICKORY HILL ROAD		Y			
6052017	56 WESTWOOD DRIVE		Y			
6052020	44 WESTWOOD DRIVE		Y			
6052019	167 HICKORY HILL ROAD		Y			
6052021	155 HICKORY HILL ROAD		Y			
6052024	174 HICKORY HILL ROAD				Undeveloped	
6051109	41 WESTWOOD DRIVE		Y			
6051108	51 WESTWOOD DRIVE		Y			
6051105	61 WESTWOOD DRIVE		Y			
6051104	313 WOOSTER STREET		Y			
6051103	311 WOOSTER STREET		Y			
6051120	321 WOOSTER STREET				Undeveloped	
6051106	329 WOOSTER STREET		Y			
6051107	337 WOOSTER STREET		Y			
6054001	345 WOOSTER STREET		Y			
6052023	164 HICKORY HILL ROAD		Y			
6052022	152 HICKORY HILL ROAD		Y			
6044017	34 MAY STREET		Y			
6043026	94 MAY STREET		Y			
6043027	88 MAY STREET		Y			
6043028	84 MAY STREET		Y			
6043029	78 MAY STREET		Y			
6043030	72 MAY STREET		Y			
6043043	62 MAY STREET		Y			
6043031	54 MAY STREET		Y			
6043032	48 MAY STREET		Y			
6044016	40 MAY STREET		Y			
6044030	39 BUNNELL STREET		Y			
6044230	41 BUNNELL STREET		Y			
6043016	49 BUNNELL STREET		Y			
6043017	55 BUNNELL STREET		Y			
6043018	59 BUNNELL STREET		Y			
6043019	63 BUNNELL STREET		Y			
6043020	69 BUNNELL STREET		Y			
6043023	81 BUNNELL STREET		Y			
6043022	75 BUNNELL STREET		Y			
6043024	87 BUNNELL STREET		Y			
6043025	93 BUNNELL STREET		Y			
6051098	95 WESTWOOD DRIVE		Y			
6051099	89 WESTWOOD DRIVE		Y			
6051102	299 WOOSTER STREET		Y			
6051101	289 WOOSTER STREET		Y			
6051100	281 WOOSTER STREET		Y			
6034090	75 NORTH MOUNTAIN ROAD		Y			
6041037	31 WOOSTER STREET		Y			

MBLU	Address	Owner	Record of Public Water Service	Evidence for Private Well: Record of Well Completion	Evidence for Private Well: Visual Observation or Research	Potential for Private Well
6052025	184 HICKORY HILL ROAD		Y			
6052026	196 HICKORY HILL ROAD		Y			
6043102	143 WINCHELL ROAD				Undeveloped	
6041137	27 WOOSTER STREET				Undeveloped	
6034059	1080 WEST MAIN STREET				Undeveloped	
6034570	1095 WEST MAIN STREET		Y			
6043002	101 WINCHELL ROAD					Y
6043004	135 WINCHELL ROAD		Y			
6043007	151 WINCHELL ROAD					Y
6043006	147 WINCHELL ROAD					Y
6043046	145 WINCHELL ROAD				Undeveloped	
6043037	90 COLT STREET				Undeveloped	
6043036	95 MAY STREET		Y			
6043035	89 MAY STREET		Y			
6043034	83 MAY STREET		Y			
6043033	77 MAY STREET		Y			
6043042	67 MAY STREET		Y			
6043041	63 MAY STREET		Y			
6044015	57 MAY STREET		Y			
6044214	53 MAY STREET		Y			
6044014	47 MAY STREET		Y			
6044314	43 MAY STREET		Y			
6044013	37 MAY STREET		Y			
6044127	21 MAY STREET		Y			
6044002	50 COLT STREET		Y			
6044003	36 COLT STREET		Y			
6044004	28 COLT STREET		Y			
6044005	24 COLT STREET		Y			
6044001	56 COLT STREET		Y			
6043040	66 COLT STREET		Y			
6043039	78 COLT STREET		Y			
6042011	84 ESTHER STREET					
6042009	70 ESTHER STREET		Y			
6041020	56 ESTHER STREET		Y			
6041018	44 ESTHER STREET		Y			
6041019	50 ESTHER STREET		Y			
6041016	34 ESTHER STREET		Y			
6041007	23 COLT STREET		Y			
6042014	85 ESTHER STREET				Undeveloped	
6041030	1036 WEST MAIN STREET		Y			
6041031	1052 WEST MAIN STREET		Y			
6032102	184 NORTH MOUNTAIN ROAD				Undeveloped	
6033003	1185 WEST MAIN STREET		Y			
6042019	760 BLACK ROCK AVENUE				Undeveloped	
6042002	51 WINCHELL ROAD				Undeveloped	
6043201	85 WINCHELL ROAD				Undeveloped	
6043003	139 WINCHELL ROAD				Undeveloped	
6052005	153 WINCHELL ROAD				Undeveloped	
6052004	158 HICKORY HILL ROAD				Undeveloped	
6034001	1055 WEST MAIN STREET					Y
6052007	206 HICKORY HILL ROAD		Y			
6052008	133 WESTWOOD DRIVE		Y			
6051304	28 AIMEE LANE		Y			
6051303	20 AIMEE LANE		Y			
6051302	12 AIMEE LANE		Y			
6051307	51 AIMEE LANE		Y			
6051308	25 AIMEE LANE		Y			
6051309	19 AIMEE LANE		Y			
6051310	15 AIMEE LANE		Y			
6051306	46 AIMEE LANE		Y			
6051305	36 AIMEE LANE		Y			
6051097	26 QUARTETTE CLUB AVENUE		Y			
6051036	60 MOZART STREET				Undeveloped	
6051115	245 WOOSTER STREET		Y			
6052001	225 WOOSTER STREET		Y			
6043047	55 QUARTETTE CLUB AVENUE				Undeveloped	
6043008	94 BUNNELL STREET		Y			
6043009	88 BUNNELL STREET		Y			
6043010	82 BUNNELL STREET		Y			
6043011	76 BUNNELL STREET		Y			

MBLU	Address	Owner	Record of Pubilc Water Service	Evidence for Private Well		Potential for Private Well
				Record of Well Completion	Visual Observation or Research	
6043045	72 BUNNELL STREET		Y			
6043013	62 BUNNELL STREET		Y			
6043012	66 BUNNELL STREET		Y			
6043014	58 BUNNELL STREET		Y			
6043015	54 BUNNELL STREET				Undeveloped	
6044136	20 MOZART STREET				Undeveloped	
6041004	28 ESTHER STREET		Y			
6053017	12 WESTWOOD DRIVE		Y			
6053016	65 HICKORY HILL ROAD		Y			
6053015	81 HICKORY HILL ROAD		Y			
6053014	99 HICKORY HILL ROAD		Y			
6053003	74 HICKORY HILL ROAD		Y			
6053004	88 HICKORY HILL ROAD		Y			
6053005	100 HICKORY HILL ROAD		Y			
6053006	108 HICKORY HILL ROAD		Y			
6053007	116 HICKORY HILL ROAD		Y			
6053008	122 HICKORY HILL ROAD		Y			
6053009	134 HICKORY HILL ROAD		Y			
6053010	144 HICKORY HILL ROAD		Y			
6053011	143 HICKORY HILL ROAD		Y			
6053012	135 HICKORY HILL ROAD		Y			
6053013	123 HICKORY HILL ROAD		Y			
6053018	20 WESTWOOD DRIVE		Y			
6053019	26 WESTWOOD DRIVE		Y			
6053020	36 WESTWOOD DRIVE		Y			
6054003	23 HICKORY HILL ROAD					Y
	490 RESERVOIR ROAD				Undeveloped	
6051096	20 QUARTETTE CLUB AVENUE		Y			
6052009	123 WESTWOOD DRIVE		Y			
6043101	170 WINCHELL ROAD				Undeveloped	
6034057	1079 WEST MAIN STREET		Y			
6043038	84 COLT STREET				Undeveloped	
6053001	440 STEELE STREET				Undeveloped	
6044133	36 BUNNELL STREET				Undeveloped	
6043001	75 WINCHELL ROAD		Y			
6044012	27 MAY STREET		Y			

MBLU	Address	Owner	Record of Pubile Water Service	Evidence for Private Well: Record of Well Completion	Evidence for Private Well: Visual Observation or Research	Potential for Private Well
32-A-02A	405 NEW BRITAIN AVE				Undeveloped	
31-B-01.1	380 NEW BRITAIN AVE					Y
31-B-01.6.1	378 NEW BRITAIN AVE		Y			
31-B-01	0 CROOKED ST				Undeveloped	
31-B-01.3	0 NEW BRITAIN AVE		Y			
31-B-01.4	410 NEW BRITAIN AVE				Undeveloped	
31-B-01.5	0 NEW BRITAIN AVE				Undeveloped	
32-B-01	414 NEW BRITAIN AVE					Y
32-B-02	440 NEW BRITAIN AVE		Y			
32-A-05	NEW BRITAIN AVE		Y			
31-C-13	0 WOODFORD AVE EXT				Undeveloped	
31-C-12	135 WOODFORD AVE EXT			Y	Undeveloped	
31-C-11	123 WOODFORD AVE EXT		Y			
31-C-11A	115 WOODFORD AVE EXT		Y			
31-C-10	109 WOODFORD AVE EXT		Y			
31-C-09	101 WOODFORD AVE EXT		Y			
31-C-08.1	99 WOODFORD AVE EXT		Y			
31-C-08	95 WOODFORD AVE EXT		Y			
31-C-07	91 WOODFORD AVE EXT		Y			
31-C-07.1	87 WOODFORD AVE EXT		Y			
31-C-06	85 WOODFORD AVE EXT		Y			
31-C-05	79 WOODFORD AVE EXT		Y			
31-C-04	75 WOODFORD AVE EXT		Y			
31-C-01+2+3*C6	71 WHITE OAK AVE C-6		Y			
31-C-01+2+3*C5	71 WHITE OAK AVE C-5		Y			
31-C-01+2+3*C4	71 WHITE OAK AVE C-4		Y			
31-C-01+2+3*C3	71 WHITE OAK AVE C-3		Y			
31-C-01+2+3*C2	71 WHITE OAK AVE C-2		Y			
31-C-01+2+3*C1	71 WHITE OAK AVE C-1		Y			
31-C-01+2+3*B6	71 WHITE OAK AVE B-6		Y			
31-C-01+2+3*B5	71 WHITE OAK AVE B-5		Y			
31-C-01+2+3*B4	71 WHITE OAK AVE B-4		Y			
31-C-01+2+3*B3	71 WHITE OAK AVE B-3		Y			
31-C-01+2+3*B2	71 WHITE OAK AVE B-2		Y			
31-C-01+2+3*B1	71 WHITE OAK AVE B-1		Y			
31-C-01+2+3*A6	71 WHITE OAK AVE A-6		Y			
31-C-01+2+3*A5	71 WHITE OAK AVE A-5		Y			
31-C-01+2+3*A4	71 WHITE OAK AVE A-4		Y			
31-C-01+2+3*A3	71 WHITE OAK AVE A-3		Y			
31-C-01+2+3*A2	71 WHITE OAK AVE A-2		Y			
31-C-01+2+3*A1	71 WHITE OAK AVE A-1		Y			
31-G-22	180 WHITE OAK AVE		Y		Y	
31-D-08	170 WHITE OAK AVE		Y			
31-D-07.2	172 WHITE OAK AVE		Y			
31-D-07.1	160 WHITE OAK AVE		Y			
31-D-06	154 WHITE OAK AVE				Y	
31-D-05	142 WHITE OAK AVE		Y			
31-D-04	138 WHITE OAK AVE		Y			
31-D-03	134 WHITE OAK AVE		Y			
31-D-02	130 WHITE OAK AVE					Y
31-D-01	124 WHITE OAK AVE			Y		
31-E-05	114 WHITE OAK AVE		Y			
31-E-04	110 WHITE OAK AVE		Y			
31-E-03	94 WHITE OAK AVE		Y			
31-E-02	86 WHITE OAK AVE		Y			
31-E-01	78 WHITE OAK AVE		Y			
31-F-12	68 WHITE OAK AVE		Y		Y	
31-F-11	60 WHITE OAK AVE		Y			
31-F-10	56 WHITE OAK AVE		Y			
31-F-09	52 WHITE OAK AVE		Y			
31-F-08	48 WHITE OAK AVE		Y			
31-F-08A	81 WESTWOOD AVE		Y			
31-F-15	85 WESTWOOD AVE		Y			
31-F-14	87 WESTWOOD AVE		Y			
31-F-13	89 WESTWOOD AVE		Y			
31-F-12A	3 MILES AVE		Y			
31-E-13	2 MILES AVE		Y			
31-E-12	105 WESTWOOD AVE		Y			
31-E-11	111 WESTWOOD AVE		Y			
31-E-10	115 WESTWOOD AVE		Y			
31-E-09	119 WESTWOOD AVE		Y			
31-E-08	129 WESTWOOD AVE		Y			
31-E-07	139 WESTWOOD AVE		Y			

MBLU	Address	Owner	Record of Public Water Service	Evidence for Private Well: Record of Well Completion	Evidence for Private Well: Visual Observation or Research	Potential for Private Well
31-E-06	151 WESTWOOD AVE		Y			
31-D-13	1 HOBSON AVE		Y		Y	
31-D-12.1	179 WESTWOOD AVE		Y			
31-D-12.1	181 WESTWOOD AVE		Y			Y
31-D-11	185 WESTWOOD AVE		Y			
31-D-10	191 WESTWOOD AVE		Y			Y
31-D-07.4	211 WESTWOOD AVE		Y			Y
31-D-07.3	215 WESTWOOD AVE		Y			
31-D-09	219 WESTWOOD AVE		Y			
31-G-21	23 FORSHAW AVE		Y			
31-G-20	13 FORSHAW AVE			Y	Y	
31-G-20.1	15 FORSHAW AVE		Y	Y	Y	
31-G-19*1	66 FORSHAW AVE		Y			
31-G-19*2	64 FORSHAW AVE		Y			
31-G-19*3	62 FORSHAW AVE		Y			
31-G-19*4	60 FORSHAW AVE		Y			
31-G-19*5	58 FORSHAW AVE		Y			
31-G-19*6	56 FORSHAW AVE		Y			
31-G-19*7	54 FORSHAW AVE		Y			
31-G-19*8	52 FORSHAW AVE		Y			
31-G-19*9	50 FORSHAW AVE		Y			
31-G-19*10	48 FORSHAW AVE		Y			
31-G-19*11	46 FORSHAW AVE		Y			
31-G-19*12	44 FORSHAW AVE		Y			
31-G-19*13	42 FORSHAW AVE		Y			
31-G-19*14	40 FORSHAW AVE		Y			
31-G-19A	36 FORSHAW AVE		Y			
31-G-18	30 FORSHAW AVE		Y			
31-G-17	226 WESTWOOD AVE		Y			
31-G-16	212 WESTWOOD AVE		Y	Y		
31-G-15	200 WESTWOOD AVE		Y			
31-G-14	192 WESTWOOD AVE		Y			
31-G-14.1	182 WESTWOOD AVE		Y			
31-G-13	170 WESTWOOD AVE		Y			
31-G-12	164 WESTWOOD AVE		Y			
31-G-11	156 WESTWOOD AVE		Y			
36-A-01.77	142 WESTWOOD AVE		Y			
31-G-10	128 WESTWOOD AVE		Y			
31-G-09	108 WESTWOOD AVE		Y			
31-G-07A	88 WESTWOOD AVE		Y			
31-G-07A	86 WESTWOOD AVE		Y			
31-G-06.3	58 WESTWOOD AVE		Y			
31-G-06.2	54 WESTWOOD AVE		Y			
31-G-06.1	50 WESTWOOD AVE		Y			
31-G-06	46 WESTWOOD AVE		Y			
31-G-05	40 WESTWOOD AVE		Y			
31-G-04	34 WESTWOOD AVE		Y			Y
31-G-03	32 LEDGE RD		Y			
36-1-01.74	7 LINDA DR		Y			
36-A-01.73	11 LINDA DR		Y			
36-A-01.72	15 LINDA DR		Y			
36-1-01.57	5 KRISTIN LN		Y			
36-A-01.58	9 KRISTIN LN		Y			
36-1-01.59	13 KRISTIN LN		Y			
36-1-01.60	17 KRISTIN LN		Y			
36-A-01.61	21 KRISTIN LN		Y			
36-A-01.62	25 KRISTIN LN		Y			
36-A-01.63	29 KRISTIN LN		Y			
36-A-01.64	33 KRISTIN LN		Y			
36-A-01.65	37 KRISTIN LN		Y			
36-A-01.66	41 KRISTIN LN		Y			
36-A-01.67	45 KRISTIN LN		Y		Y	
36-A-01.54	46 KRISTIN LN		Y			
36-A-01.53	42 KRISTIN LN		Y			
36-A-01.52	38 KRISTIN LN		Y			
36-A-01.51	34 KRISTIN LN		Y			
36-A-01.50	30 KRISTIN LN		Y			
36-A-01.49	26 KRISTIN LN		Y			
36-A-01.48	22 KRISTIN LN		Y			
36-A-01.47	18 KRISTIN LN		Y			
36-A-01.46	14 KRISTIN LN		Y			
36-A-01.45	10 KRISTIN LN		Y			
36-A-01.44	6 KRISTIN LN		Y			

MBLU	Address	Owner	Record of Public Water Service	Evidence for Private Well		Potential for Private Well
				Record of Well Completion	Visual Observation or Research	
36-A-01.43	2 KRISTIN LN		Y			
36-A-01.42	31 LINDA DR		Y			
36-A-01.37	25 MARIA RD		Y			
36-A-01.36	29 MARIA RD		Y			
36-A-01.35	35 MARIA RD		Y			
36-A-01.34	37 MARIA RD		Y			
36-A-01.33	41 MARIA RD		Y			
36-A-01.32	45 MARIA RD		Y			
36-A-01.31	49 MARIA RD		Y			
36-A-01.30	53 MARIA RD		Y			
36-A-01.29	57 MARIA RD		Y			
36-A-01.27	61 MARIA RD		Y			
36-A-01.26	69 MARIA RD		Y			
36-A-01.25	73 MARIA RD		Y			
36-A-01.24	77 MARIA RD		Y			
36-A-01.23	81 MARIA RD		Y			
36-A-01.22	85 MARIA RD		Y			
36-A-01.21	82 MARIA RD		Y			
36-A-01.20	78 MARIA RD		Y			
36-A-01.19	74 MARIA RD		Y			Y
36-A-01.18	70 MARIA RD		Y			
36-A-01.17	66 MARIA RD		Y			
36-A-01.16	62 MARIA RD		Y			
36-A-01.15	58 MARIA RD		Y			
36-A-01.14	54 MARIA RD		Y			
36-A-01.13	50 MARIA RD		Y			
36-A-01.12	46 MARIA RD		Y			
36-A-01.11	42 MARIA RD		Y			
36-A-01.10	38 MARIA RD		Y			
36-A-01.9	34 MARIA RD		Y			
36-A-01.8	30 MARIA RD		Y			
36-A-01.7	26 MARIA RD		Y			
36-A-01.06	22 MARIA RD		Y			
36-A-01.05	18 MARIA RD		Y			
36-A-01.4	14 MARIA RD		Y			
36-A-01.3	10 MARIA RD		Y			
36-A-01.2	6 MARIA RD		Y			
36-A-01.1	2 MARIA RD		Y			
36-A-02	42 LEDGE RD		Y			
36-A-03	44 LEDGE RD		Y			
36-A-04	2 VIEW ST		Y			
36-A-05	6 VIEW ST		Y			
36-A-06	8 VIEW ST		Y			
36-A-07	10 VIEW ST		Y			
36-A-07A	12 VIEW ST		Y			
36-A-08	14 VIEW ST		Y			
36-A-09	16 VIEW ST		Y			
36-A-10	18 VIEW ST		Y			
36-A-11	20 VIEW ST		Y			
36-A-12	24 VIEW ST		Y			
36-A-13	28 VIEW ST					
36-A-14	30 VIEW ST					Y
36-A-15	36 VIEW ST					Y
36-A-16	40 VIEW ST			Y		
36-A-17	44 VIEW ST					Y
36-A-18	46 VIEW ST					Y
36-A-19	50 VIEW ST			Y	Y	
36-A-21	49 VIEW ST					Y
36-A-22	45 VIEW ST					Y
36-A-23	41 VIEW ST					Y
36-A-24	39 VIEW ST					Y
36-A-25	33 VIEW ST					Y
36-A-26	29 VIEW ST					Y
36-A-27	25 VIEW ST		Y			
36-A-28A	23 VIEW ST			Y		
36-A-28A	21 VIEW ST		Y			

MBLU	Address	Owner	Record of Public Water Service	Evidence for Private Well		Potential for Private Well
				Record of Well Completion	Visual Observation or Research	
36-A-29	17 VIEW ST		Y			
36-A-30	15 VIEW ST		Y			
36-A-31	13 VIEW ST		Y			
36-A-32	5 VIEW ST		Y			
36-A-32A	3 VIEW ST		Y			
36-A-33	48 LEDGE RD		Y			
36-A-34	50 LEDGE RD		Y			
37-R-01	52 LEDGE RD		Y			
31-G-02	34 LEDGE RD					Y
31-G-01.6	36 LEDGE RD		Y			
31-G-01.5	38 LEDGE RD		Y			
31-G-01.4	40 LEDGE RD		Y			
31-G-01.3	1 MARIA RD		Y			
31-G-01.2	5 MARIA RD		Y			
31-G-01.7	7 MARIA RD		Y			
31-6-01.1	9 MARIA RD		Y			
36-A-01.38	17 MARIA RD		Y			
36-A-01.39	38 LINDA DR		Y			
36-A-01.40	34 LINDA DR		Y			
36-A-01.41	30 LINDA DR		Y			
36-A-01.55	26 LINDA DR		Y			
36-A-01.56	22 LINDA DR		Y			
36-A-01.68	18 LINDA DR		Y			
36-A-01.69	14 LINDA DR		Y			
36-A-01.70	10 LINDA DR		Y			
36-A-01.71	6 LINDA DR		Y			
31-H-01	33 LEDGE RD		Y			
31-H-02	35 LEDGE RD		Y			
37-Q-01	37 LEDGE RD		Y			
37-Q-02	41 LEDGE RD		Y			
37-Q-03.1	41 1/2 LEDGE RD		Y			
37-Q-03	43 LEDGE RD		Y		Y	
37-Q-04	0 LEDGE RD				Undeveloped	
37-R-02	66 LEDGE RD					Y
37-R-03	84 LEDGE RD			Y		
45-A-01	86 LEDGE RD					Y
45-A-02	88 LEDGE RD			Y		
45-A-03	90 LEDGE RD					Y
45-A-04	92 LEDGE RD					Y
45-A-06	102 LEDGE RD			Y		
45-A-06.1	104 LEDGE RD			Y		
45-A-07	106 LEDGE RD			Y		
45-A-08	108 LEDGE RD			Y		
45-A-09	110 LEDGE RD					Y
45-A-10	112 LEDGE RD					Y
45-A-11	120 LEDGE RD			Y		
45-A-12	128 LEDGE RD					Y
45-A-13	130 LEDGE RD			Y		
45-A-14	132 LEDGE RD					Y
45-A-15	138 LEDGE RD			Y		
45-A-17	0 LEDGE RD			Y		
46-A-01	0 BIDDLE PASS					
44-E-12	135 LEDGE RD		Y			
44-E-11	133 LEDGE RD		Y			
44-E-10	123 LEDGE RD					
44-E-09	0 LEDGE RD					
44-E-05	0 LEDGE RD					
37-Q-09	99 LEDGE RD					
37-Q-05	46 SUNSET AVE		Y			
37-Q-06	50 SUNSET AVE		Y			
37-Q-08	60 SUNSET AVE		Y			
44-D-01	78 SUNSET AVE		Y			

MBLU	Address	Owner	Record of Public Water Service	Evidence for Private Well		Potential for Private Well
				Record of Well Completion	Visual Observation or Research	
44-D-02	88 SUNSET AVE		Y			
44-C-04	85 SUNSET AVE		Y			
44-C-01	6 PICKNEY AVE		Y			
44-E-04	90 SUNSET AVE		Y			
44-E-06A.E	JAMES PL REAR		Y			
44-E-22	0 JAMES PL REAR		Y			
44-E-23	26 JAMES PL		Y			
44-E-24	22 JAMES PL		Y			
44-E-32	48 LENA AVE		Y			
44-E-33	44 LENA AVE		Y			
44-E-35	40 LENA AVE		Y			
44-E-34	36 LENA AVE		Y			
44-E-36	32 LENA AVE		Y			
44-E-37	28 LENA AVE		Y			
44-E-38	24 LENA AVE		Y			
44-E-39	20 LENA AVE		Y			
44-E-40	16 LENA AVE		Y			
44-E-41	12 LENA AVE		Y			
44-E-01.2	8 LENA AVE		Y			
44-E-01.1	4 LENA AVE		Y			
30-C-06	16 MERILINE AVE		Y			
30-C-05	20 MERILINE AVE		Y			
30-C-04	30 MERILINE AVE		Y			
30-C-03.1	32 MERILINE AVE					
30-C-02	40 MERILINE AVE		Y			
30-C-01	207 MILFORD ST EXT		Y			
30-F-05	17 MERILINE AVE		Y			
30-F-06	27 MERILINE AVE		Y			
30-F-07	31 MERILINE AVE		Y			
30-F-08A	35 MERILINE AVE		Y			
30-F-08A	39 MERILINE AVE		Y			
30-F-09	43 MERILINE AVE		Y		Y	
30-F-14	36 ATHERTON TER		Y			
30-F-13	40 ATHERTON TER		Y			
30-F-12	54 ATHERTON TER		Y			
30-F-11	62 ATHERTON TER		Y			
30-G-08	47 ATHERTON TER		Y			
30-G-09	57 ATHERTON TER		Y			
30-G-10	63 ATHERTON TER		Y			
30-G-11	68 BELMONT PL		Y			
30-G-12	58 BELMONT PL		Y			
30-E-17	206 MILFORD ST EXT		Y			
30-E-16	202 MILFORD ST EXT		Y			
30-E-15	198 MILFORD ST EXT		Y			
30-F-14	194 MILFORD ST EXT		Y			
30-E-13	190 MILFORD ST EXT		Y			
30-E-12	186 MILFORD ST EXT		Y			
30-E-11	182 MILFORD ST EXT		Y			
30-E-10	178 MILFORD ST EXT		Y		Y	
30-E-09	174 MILFORD ST EXT		Y			
30-E-08	170 MILFORD ST EXT		Y			
30-E-07	166 MILFORD ST EXT		Y			
30-E-18	69 MACARTHUR RD		Y			
30-E-19	65 MACARTHUR RD		Y			
30-E-20	61 MACARTHUR RD		Y			
30-E-21	57 MACARTHUR RD		Y			
30-E-22	53 MACARTHUR RD		Y			
30-E-23	49 MACARTHUR RD		Y			
30-E-24	45 MACARTHUR RD		Y			
30-E-25	39 MACARTHUR RD		Y			
30-E-26	35 MACARTHUR RD		Y			
30-A-27	31 MACARTHUR RD		Y			

MBLU	Address	Owner	Record of Public Water Service	Evidence for Private Well		Potential for Private Well
				Record of Well Completion	Visual Observation or Research	
30-E-28	27 MACARTHUR RD		Y			
30-E-29	23 MACARTHUR RD		Y			
30-D-17	68 MACARTHUR RD		Y			
30-D-16	64 MACARTHUR RD		Y			
30-D-15	60 MACARTHUR RD		Y			
30-D-14	56 MACARTHUR RD		Y			
30-D-13	52 MACARTHUR RD		Y			
30-D-12	48 MACARTHUR RD		Y			
30-D-11	44 MACARTHUR RD		Y			
30-D-10	40 MACARTHUR RD		Y		Y	
30-D-09	36 MACARTHUR RD		Y			
30-D-08	32 MACARTHUR RD		Y			
30-D-07	28 MACARTHUR RD		Y			
30-D-06	24 MACARTHUR RD		Y			
30-D-05	20 MACARTHUR RD		Y			
30-D-18	80 HIGGINS AVE		Y			
30-D-19	76 HIGGINS AVE		Y			
30-D-20	72 HIGGINS AVE		Y			
30-D-21	64 HIGGINS AVE		Y			
30-D-22	56 HIGGINS AVE		Y			
30-D-23	44 HIGGINS AVE		Y			
30-D-24	40 HIGGINS AVE		Y			
30-D-25	34 HIGGINS AVE		Y			
30-D-26	28 HIGGINS AVE		Y			
30-D-27	12 HIGGINS AVE		Y			
37-G-01	54 ARCADIA AVE		Y			
37-G-02	58 ARCADIA AVE		Y			
37-G-03	62 ARCADIA AVE		Y			
37-G-04	66 ARCADIA AVE		Y			
37-G-05	70 ARCADIA AVE		Y			
37-G-06	74 ARCADIA AVE		Y			
37-G-07	78 ARCADIA AVE		Y			
37-G-08	82 ARCADIA AVE		Y			
37-G-09	86 ARCADIA AVE		Y			
37-G-10	90 ARCADIA AVE		Y			
37-G-11	94 ARCADIA AVE		Y			
37-G-12	98 ARCADIA AVE		Y			
37-G-13	102 ARCADIA AVE		Y			
37-G-14	106 ARCADIA AVE		Y			
37-G-15	110 ARCADIA AVE		Y			
37-G-16	114 ARCADIA AVE		Y			
37-G-17	118 ARCADIA AVE		Y			
37-G-18	122 ARCADIA AVE		Y		Y	
37-G-19	126 ARCADIA AVE		Y			
37-G-20	130 ARCADIA AVE		Y			
37-G-21	132 ARCADIA AVE		Y			
37-H-01	146 ARCADIA AVE		Y			
37-H-01.1	172 ARCADIA AVE		Y			
37-F-01	79 HIGGINS AVE		Y			
37-F-02	99 ARCADIA AVE		Y			
37-F-04A	115 ARCADIA AVE		Y			
37-F-05	117 ARCADIA AVE		Y			
37-F-06	123 ARCADIA AVE		Y			
37-F-07	127 ARCADIA AVE		Y			
37-F-08	131 ARCADIA AVE		Y			
37-F-09	133 ARCADIA AVE		Y			
37-F-10	36 ORRIN AVE		Y			
37-F-04A	12 TYLER AVE		Y			
37-F-03	8 TYLER AVE		Y			
37-E-01	3 TYLER AVE		Y			
37-E-02	5 TYLER AVE		Y			
37-E-03	9 TYLER AVE		Y			

MBLU	Address	Owner	Record of Public Water Service	Evidence for Private Well: Record of Well Completion	Evidence for Private Well: Visual Observation or Research	Potential for Private Well
37-E-05	11 TYLER AVE		Y			
37-E-10A	25 TYLER AVE		Y			
37-E-10	31 TYLER AVE		Y			
37-E-11	40 ORRIN AVE		Y			
37-E-12	0 LOOMIS AVE					
37-E-09	30 LOOMIS AVE		Y			
37-E-07	20 LOOMIS AVE		Y			
37-E-06	16 LOOMIS AVE		Y			
37-E-04	14 LOOMIS AVE		Y			
37-D-08	43 LOOMIS AVE		Y			
37-D-07	33 LOOMIS AVE		Y			
37-D-06	29 LOOMIS AVE		Y			
37-D-05	21 LOOMIS AVE		Y			
37-D-05A	17 LOOMIS AVE		Y			
37-D-04	13 LOOMIS AVE		Y			
37-D-03	9 LOOMIS AVE		Y			
37-D-02	5 LOOMIS AVE		Y			
37-D-01	37 HIGGINS AVE		Y			
37-C-05	80 ORRIN AVE		Y			
37-C-06	4 WHITES CROSSING		Y			
37-C-04.1	6 WHITES CROSSING		Y			
37-C-04	8 WHITES CROSSING		Y			
37-C-03	10 WHITE CROSSING		Y			
37-C-02	12 WHITE CROSSING		Y			
37-C-01	29 HIGGINS AVE		Y			
37-B-02	7 HIGGINS AVE		Y			
37-B-03	11 WHITES CROSSING		Y			
37-B-04	9 WHITES CROSSING		Y			
37-B-05	7 WHITES CROSSING		Y			
37-B-06	5 WHITES CROSSING		Y			
37-B-07	3 WHITES CROSSING		Y			
37-N-01	53 CYRENIUS AVE		Y		Y	
37-N-02	55 CYRENIUS AVE		Y			
37-N-03	57 CYRENIUS AVE		Y	Y		
37-N-04.2	59 CYRENIUS AVE		Y	Y		
37-N-04.1	61 CYRENIUS AVE		Y	Y		
37-N-04	63 CYRENIUS AVE		Y			
37-N-05	215 TOMLINSON AVE		Y			
37-M-06	79 LOOMIS AVE		Y			
37-M-05	73 LOOMIS AVE		Y			
37-M-04	71 LOOMIS AVE		Y			
37-M-03	69 LOOMIS AVE		Y			
37-M-02	63 LOOMIS AVE		Y			
37-M-02.1	57 LOOMIS AVE		Y			
37-M-02	51 LOOMIS AVE		Y			
37-M-01	47 LOOMIS AVE		Y			
37-L-10	247 TOMLINSON AVE		Y			
37-L-09	76 LOOMIS AVE		Y			
37-L-08	74 LOOMIS AVE		Y			
37-L-07	70 LOOMIS AVE		Y			
37-L-05	62 LOOMIS AVE		Y			
37-L-04	54 LOOMIS AVE		Y			
37-L-01	53 ORRIN AVE		Y			
37-L-02	47 ORRIN AVE		Y			
37-L-03	51 TYLER AVE		Y			
37-J-01	37 ORRIN AVE		Y			
37-J-05	54 TYLER AVE		Y			
37-K-04	251 TOMLINSON AVE		Y			
37-K-03	177 ARCADIA AVE		Y			
37-K-02	175 ARCADIA AVE		Y			
37-J-03	169 ARCADIA AVE		Y			
37-J-02	33 ORRIN AVE		Y			

MBLU	Address	Owner	Record of Public Water Service	Evidence for Private Well: Record of Well Completion	Evidence for Private Well: Visual Observation or Research	Potential for Private Well
37-O-06A	252 TOMLINSON AVE		Y			
37-O-05	224 TOMLINSON AVE		Y			
37-O-04	222 TOMLINSON AVE		Y			
37-O-03	220 TOMLINSON AVE		Y			
37-O-02	0 TOMLINSON AVE		Y			
37-O-06B	183 ARCADIA AVE		Y			
37-O-06C	185 ARCADIA AVE		Y			
37-O-11	0 BILODEAU R/W		Y			
37-O-07	189 ARCADIA AVE		Y			
37-O-14	191 ARCADIA AVE		Y			
37-O-13	2 FIELD ST		Y			
37-O-12	4 FIELD ST		Y			
37-P-01	1 FIELD ST		Y			
37-P-01A	3 FIELD ST		Y			
37-P-02	197 ARCADIA AVE		Y			
44-P-01	201 ARCADIA AVE		Y			
44-P-03	1 PAUL ST		Y			
44-P-04	3 PAUL ST		Y			
44-P-05	5 PAUL ST		Y			
44-B-02	6 PAUL ST		Y		Y	
44-B-03-B	4 PAUL ST		Y			
44-B-03A	2 PAUL ST		Y			
44-B-04	70 PICKNEY AVE		Y			
44-B-05	78 PICKNEY AVE		Y			
44-B-07A	3 GILBERTE ST		Y			
44-B-07A	5 GILBERTE ST		Y			
44-A-01	73 PICKNEY AVE		Y			
44-A-02	75 PICKNEY AVE		Y			
Tilcon Properties						
31-G-23	196 WHITE OAK AVE					Y
32-C-02	383 WOODFORD AVE			Y		
32-C-04	387 WOODFORD AVE				Undeveloped	
32-C-05	389 WOODFORD AVE				Undeveloped	
32-C-06	391 WOODFORD AVE				Undeveloped	
32-C-07	393 WOODFORD AVE				Undeveloped	
32-C-08	395 WOODFORD AVE				Undeveloped	
32-C-09	397 WOODFORD AVE			Y		
34-A-03	400 WOODFORD AVE				Undeveloped	
34-A-01	230 WOODFORD AVE			Y		
35-A-01	300 WOODFORD AVE			Y	Y	

MBLU	Address	Owner	Record of Public Water Service	Evidence for Private Well		Potential for Private Well
				Record of Well Completion	Visual Observation or Research	
197-001	375 NORTH SHUTTLE MEADOW RD	City of New Britain			Undeveloped	
214-003	950 NORTH SHUTTLE MEADOW RD	Tilcon Inc.			Undeveloped	
213-003	800 NORTH SHUTTLE MEADOW RD	City of New Britain			Undeveloped	
213-002	750 NORTH SHUTTLE MEADOW RD	Tilcon Inc.			Undeveloped	
213-001	700 NORTH SHUTTLE MEADOW RD	Tilcon Inc.			Undeveloped	
207-015	495 SHUTTLE MEADOW RD	City of Southington			Undeveloped	
214-001	850 NORTH SHUTTLE MEADOW RD	Tilcon Inc.			Undeveloped	
214-002	900 NORTH SHUTTLE MEADOW RD	Tilcon Inc.			Undeveloped	
212-003	47 LEDGE RD	Marek & Ursula Dara				Y
212-002	99 LEDGE RD	Mervin & Barbara Terry				Y
212-004	87 LEDGE RD	CT Light and Power Co.			Undeveloped	
212-001	88 LEDGE RD	Daniel Levine & Sarah Spielman			Undeveloped	
212-009	81 LEDGE RD	Walter D Roberge Sr.			Undeveloped	
207-010	9 LEDGE RD	John A Susco Jr & Marie C				Y

APPENDIX IV

NOAA PRECIPITATION DATA

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Current Location: Elev: 415 ft. Lat: 41.6445° N Lon: -72.8167° W
Station: **SHUTTLE MEADOW RESERVOIR, CT US USC00067432**

Summary of Monthly Normals 1981-2010

Generated on 10/23/2017

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Precipitation (in.)

	Totals	Mean Number of Days				Precipitation Probabilities Probability that precipitation will be equal to or less than the indicated amount		
	Means	Daily Precipitation				Monthly Precipitation vs. Probability Levels		
Month	**Mean**	**>= 0.01**	**>= 0.10**	**>= 0.50**	**>= 1.00**	**0.25**	**0.50**	**0.75**
01	4.07	8.1	5.7	2.7	1.2	2.44	3.75	5.30
02	3.69	7.2	5.7	2.4	1.0	2.34	3.24	4.61
03	4.43	7.6	5.8	2.8	1.4	2.29	3.90	5.96
04	4.43	8.4	6.5	2.7	1.1	2.19	4.07	5.54
05	4.16	9.0	6.2	3.0	1.2	2.20	3.78	4.81
06	4.59	8.6	6.0	2.5	1.3	2.65	3.95	6.50
07	4.82	7.8	6.0	3.1	1.4	3.07	4.73	6.09
08	4.11	7.7	5.5	2.5	1.0	2.02	3.32	5.61
09	4.40	7.3	5.2	2.8	1.3	2.06	3.51	5.84
10	5.02	7.0	4.9	2.6	1.4	2.50	3.57	6.58
11	5.01	7.3	5.4	3.0	1.7	3.66	4.81	6.41
12	4.07	7.9	5.8	2.9	1.3	2.29	4.05	5.41
Summary	52.80	93.9	68.7	33.0	15.3	29.71	46.68	68.66

-7777: a non-zero value that would round to zero

Empty or blank cells indicate data is missing or insufficient occurrences to compute value

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Summary of Monthly Normals
1981-2010

Generated on 10/23/2017

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Current Location: Elev: 415 ft. Lat: 41.6445° N Lon: -72.8167° W
Station: **SHUTTLE MEADOW RESERVOIR, CT US USC00067432**

Snow (in.)

	Totals	Mean Number of Days									Snow Probabilities Probability that snow will be equal to or less than the indicated amount		
	Means	Snowfall >= Thresholds					Snow Depth >= Thresholds				Monthly Snow vs. Probability Levels Values derived from the incomplete gamma distribution.		
Month	Snowfall Mean	0.01	1.0	3.0	5.00	10.00	1	3	5	10	.25	.50	.75
01	11.5	4.4	3.4	1.4	0.8	0.1					4.5	9.1	18.0
02	9.3	3.5	2.8	1.1	0.7	0.2					4.5	8.1	13.1
03	7.4	2.3	2.0	1.0	0.5	0.1					1.8	4.4	10.5
04	1.6	0.4	0.3	0.1	0.1	0.1					0.0	0.0	0.7
05	0.0	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0
06	0.0	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0
07	0.0	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0
08	0.0	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0
09	0.0	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0					0.0	0.0	0.0
11	1.3	0.5	0.4	0.2	0.2	0.0					0.0	0.0	1.3
12	6.2	2.2	1.8	0.8	0.6	0.2					2.2	4.0	8.7
Summary	37.3	13.3	10.7	4.6	2.9	0.7	0.0	0.0	0.0	0.0	13.0	25.6	52.3

-7777: a non-zero value that would round to zero

Empty or blank cells indicate data is missing or insufficient occurrences to compute value

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Record of Climatological Observations

These data are quality controlled and may not be identical to the original observations.

Generated on 10/23/2017

Current Location: Elev: 415 ft. Lat: 41.6445° N Lon: -72.8167° W
Station: **SHUTTLE MEADOW RESERVOIR, CT US USC00067432**

Observation Time Temperature: Unknown Observation Time Precipitation: 0800

Year	Month	Day	Temperature (F) 24 Hrs. Ending at Observation Time Max.	Min.	At Observation	Precipitation 24 Hour Amounts Ending at Observation Time Rain, Melted Snow, Etc. (in)	Flag	Snow, Ice Pellets, Hail (in)	Flag	At Obs. Time Snow, Ice Pellets, Hail, Ice on Ground (in)	Evaporation 24 Hour Wind Movement (mi)	Amount of Evap. (in)	Soil Temperature (F) 4 in. Depth Ground Cover (see *)	Max.	Min.	8 in. Depth Ground Cover (see *)	Max.	Min.
2016	11	01				0.00		0.0		0								
2016	11	02				0.00		0.0		0								
2016	11	03				0.00		0.0		0								
2016	11	04				0.00		0.0		0								
2016	11	05																
2016	11	06																
2016	11	07				0.00		0.0		0								
2016	11	08				0.00		0.0		0								
2016	11	09				0.00		0.0		0								
2016	11	10				0.04		0.0		0								
2016	11	11																
2016	11	12																
2016	11	13																
2016	11	14				0.00		0.0		0								
2016	11	15				0.00		0.0		0								
2016	11	16				0.85		0.0		0								
2016	11	17				0.00		0.0		0								
2016	11	18				0.00		0.0		0								
2016	11	19																
2016	11	20																
2016	11	21				0.60		0.0		0								
2016	11	22				0.00		0.0		0								
2016	11	23				0.00		0.0		0								
2016	11	24																
2016	11	25																
2016	11	26																
2016	11	27																
2016	11	28				0.10		0.0		0								
2016	11	29				0.00		0.0		0								
2016	11	30				0.89		0.0		0								
		Summary				2.48		0.0										

Empty, or blank, cells indicate that a data observation was not reported.

*Ground Cover: 1=Grass; 2=Fallow; 3=Bare Ground; 4=Brome grass; 5=Sod; 6=Straw mulch; 7=Grass muck; 8=Bare muck; 0=Unknown

"s" This data value failed one of NCDC's quality control tests.

"T" values in the Precipitation or Snow category above indicate a "trace" value was recorded.

"A" values in the Precipitation Flag or the Snow Flag column indicate a multiday total, accumulated since last measurement, is being used.

Data value inconsistency may be present due to rounding calculations during the conversion process from SI metric units to standard imperial units.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Record of Climatological Observations

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National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Current Location: Elev: 415 ft. Lat: 41.6445° N Lon: -72.8167° W

Station: **SHUTTLE MEADOW RESERVOIR, CT US USC00067432**

Observation Time Temperature: Unknown Observation Time Precipitation: 0800

Year	Month	Day	Temperature (F) 24 Hrs. Ending at Observation Time Max.	Temperature (F) 24 Hrs. Ending at Observation Time Min.	Temperature (F) At Observation	Precipitation 24 Hour Amounts Ending at Observation Time Rain, Melted Snow, Etc. (in)	Flag	Snow, Ice Pellets, Hail (in)	Flag	Precipitation At Obs. Time Snow, Ice Pellets, Hail, Ice on Ground (in)	Evaporation 24 Hour Wind Movement (mi)	Evaporation Amount of Evap. (in)	Soil Temperature (F) 4 in. Depth Ground Cover (see *)	4 in. Depth Max.	4 in. Depth Min.	8 in. Depth Ground Cover (see *)	8 in. Depth Max.	8 in. Depth Min.
2016	12	01				0.90		0.0										
2016	12	02				0.00		0.0										
2016	12	03																
2016	12	04																
2016	12	05				0.02		0.3										
2016	12	06				0.00		0.0										
2016	12	07				0.40		0.0										
2016	12	08				0.00		0.0										
2016	12	09				0.00		0.0										
2016	12	10																
2016	12	11																
2016	12	12				0.50		0.8										
2016	12	13				0.00		0.0										
2016	12	14				0.00		0.0										
2016	12	15				0.00		0.0										
2016	12	16				0.02		0.3										
2016	12	17																
2016	12	18																
2016	12	19				0.92		6.0										
2016	12	20				0.00		0.0										
2016	12	21				0.00		0.0										
2016	12	22				0.00		0.0										
2016	12	23				0.00		0.0										
2016	12	24																
2016	12	25																
2016	12	26																
2016	12	27				0.50		0.0										
2016	12	28				0.00		0.0										
2016	12	29				0.00		0.0										
2016	12	30				0.50		0.0										
2016	12	31																
		Summary				3.76		7.4										

Empty, or blank, cells indicate that a data observation was not reported.

*Ground Cover: 1=Grass; 2=Fallow; 3=Bare Ground; 4=Brome grass; 5=Sod; 6=Straw mulch; 7=Grass muck; 8=Bare muck; 0=Unknown

"s" This data value failed one of NCDC's quality control tests.

"T" values in the Precipitation or Snow category above indicate a "trace" value was recorded.

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Asheville, North Carolina 28801

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Station: **SHUTTLE MEADOW RESERVOIR, CT US USC00067432**

Observation Time Temperature: Unknown Observation Time Precipitation: 0800

			Temperature (F)			Precipitation					Evaporation		Soil Temperature (F)					
			24 Hrs. Ending at Observation Time		At Observation	24 Hour Amounts Ending at Observation Time				At Obs. Time			4 in. Depth			8 in. Depth		
Year	Month	Day	Max.	Min.		Rain, Melted Snow, Etc. (in)	Flag	Snow, Ice Pellets, Hail (in)	Flag	Snow, Ice Pellets, Hail, Ice on Ground (in)	24 Hour Wind Movement (mi)	Amount of Evap. (in)	Ground Cover (see *)	Max.	Min.	Ground Cover (see *)	Max.	Min.
2017	01	01																
2017	01	02																
2017	01	03				0.20		0.0										
2017	01	04				0.70		0.0										
2017	01	05				0.00		0.0										
2017	01	06				0.06		2.0										
2017	01	07																
2017	01	08																
2017	01	09				0.25		5.5										
2017	01	10				0.00		0.0										
2017	01	11				0.20		0.0										
2017	01	12				0.38		0.0										
2017	01	13				0.02		0.0										
2017	01	14																
2017	01	15																
2017	01	16																
2017	01	17				0.00		0.0										
2017	01	18				0.30		0.0										
2017	01	19				0.03		0.0										
2017	01	20				0.00		0.0										
2017	01	21																
2017	01	22																
2017	01	23				0.02		0.0										
2017	01	24				1.10		1.5										
2017	01	25				0.20		0.0										
2017	01	26				T		0.0										
2017	01	27				0.00		0.0										
2017	01	28																
2017	01	29																
2017	01	30				0.00		0.0										
2017	01	31				0.00		0.0										
		Summary				3.46		9.0										

Empty, or blank, cells indicate that a data observation was not reported.

*Ground Cover: 1=Grass; 2=Fallow; 3=Bare Ground; 4=Brome grass; 5=Sod; 6=Straw mulch; 7=Grass muck; 8=Bare muck; 0=Unknown

"s" This data value failed one of NCDC's quality control tests.

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U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Current Location: Elev: 415 ft. Lat: 41.6445° N Lon: -72.8167° W
Station: **SHUTTLE MEADOW RESERVOIR, CT US USC00067432**

Record of Climatological Observations

These data are quality controlled and may not be identical to the original observations.

Generated on 10/23/2017

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Observation Time Temperature: Unknown Observation Time Precipitation: 0800

Year	Month	Day	Temperature (F) 24 Hrs. Ending at Observation Time Max.	Min.	At Observation	Precipitation 24 Hour Amounts Ending at Observation Time Rain, Melted Snow, Etc. (in)	Flag	Snow, Ice Pellets, Hail (in)	Flag	At Obs. Time Snow, Ice Pellets, Hail, Ice on Ground (in)	Evaporation 24 Hour Wind Movement (mi)	Amount of Evap. (in)	Soil Temperature (F) 4 in. Depth Ground Cover (see *)	Max.	Min.	8 in. Depth Ground Cover (see *)	Max.	Min.
2017	02	01				0.23		3.0										
2017	02	02				0.00		0.0										
2017	02	03				0.00		0.0										
2017	02	04																
2017	02	05																
2017	02	06				0.00		0.0										
2017	02	07				0.00		0.0										
2017	02	08				0.20		0.0										
2017	02	09				0.00		0.0										
2017	02	10				1.60		15.0										
2017	02	11																
2017	02	12																
2017	02	13																
2017	02	14				0.60		5.0										
2017	02	15				0.00		0.0										
2017	02	16				T		0.0										
2017	02	17				0.00		0.0										
2017	02	18																
2017	02	19																
2017	02	20																
2017	02	21				0.00		0.0										
2017	02	22				0.00		0.0										
2017	02	23				0.00		0.0										
2017	02	24				0.00		0.0										
2017	02	25																
2017	02	26																
2017	02	27				0.40		0.0										
2017	02	28				0.00		0.0										
		Summary				3.03		23.0										

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151 Patton Avenue
Asheville, North Carolina 28801

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Station: **SHUTTLE MEADOW RESERVOIR, CT US USC00067432**

Observation Time Temperature: Unknown Observation Time Precipitation: 0800

Year	Month	Day	Temperature (F)			Precipitation					Evaporation		Soil Temperature (F)					
			24 Hrs. Ending at Observation Time		At Observation	24 Hour Amounts Ending at Observation Time				At Obs. Time			4 in. Depth			8 in. Depth		
			Max.	Min.		Rain, Melted Snow, Etc. (in)	Flag	Snow, Ice Pellets, Hail (in)	Flag	Snow, Ice Pellets, Hail, Ice on Ground (in)	24 Hour Wind Movement (mi)	Amount of Evap. (in)	Ground Cover (see *)	Max.	Min.	Ground Cover (see *)	Max.	Min.
2017	03	01				0.02		0.0										
2017	03	02				0.03		0.0										
2017	03	03				0.00		0.0										
2017	03	04																
2017	03	05																
2017	03	06				0.00		0.0										
2017	03	07				0.02		0.0										
2017	03	08				0.15		0.0										
2017	03	09				0.00		0.0										
2017	03	10				0.05		2.0										
2017	03	11																
2017	03	12																
2017	03	13				0.00		0.0										
2017	03	14																
2017	03	15				2.65		16.0										
2017	03	16				0.00		0.0										
2017	03	17				0.00		0.0										
2017	03	18																
2017	03	19																
2017	03	20				0.00		0.0										
2017	03	21				0.00		0.0										
2017	03	22				0.00		0.0										
2017	03	23				0.00		0.0										
2017	03	24				0.00		0.0										
2017	03	25																
2017	03	26																
2017	03	27				0.15		0.0										
2017	03	28				0.55		0.0										
2017	03	29				0.40		0.0										
2017	03	30				0.00		0.0										
2017	03	31				0.05		0.0										
		Summary				4.07		18.0										

Empty, or blank, cells indicate that a data observation was not reported.

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National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Current Location: Elev: 415 ft. Lat: 41.6445° N Lon: -72.8167° W

Station: **SHUTTLE MEADOW RESERVOIR, CT US USC00067432**

Observation Time Temperature: Unknown Observation Time Precipitation: 0800

Year	Month	Day	Temperature (F): 24 Hrs. Ending at Observation Time: Max.	Temperature (F): 24 Hrs. Ending at Observation Time: Min.	Temperature (F): At Observation	Precipitation: 24 Hour Amounts Ending at Observation Time: Rain, Melted Snow, Etc. (in)	Flag	Snow, Ice Pellets, Hail (in)	Flag	Precipitation: At Obs. Time: Snow, Ice Pellets, Hail, Ice on Ground (in)	Evaporation: 24 Hour Wind Movement (mi)	Evaporation: Amount of Evap. (in)	Soil Temperature (F): 4 in. Depth: Ground Cover (see *)	4 in. Depth: Max.	4 in. Depth: Min.	8 in. Depth: Ground Cover (see *)	8 in. Depth: Max.	8 in. Depth: Min.
2017	04	01																
2017	04	02																
2017	04	03				1.20												
2017	04	04				1.02												
2017	04	05				0.30												
2017	04	06				0.05												
2017	04	07				1.00												
2017	04	08																
2017	04	09																
2017	04	10				0.00												
2017	04	11				0.00												
2017	04	12				0.00												
2017	04	13				0.04												
2017	04	14																
2017	04	15																
2017	04	16																
2017	04	17				0.03												
2017	04	18				0.00												
2017	04	19				0.00												
2017	04	20				0.22												
2017	04	21				0.30												
2017	04	22																
2017	04	23																
2017	04	24				0.15												
2017	04	25				0.03												
2017	04	26				1.05												
2017	04	27				0.03												
2017	04	28				0.02												
2017	04	29																
2017	04	30																
		Summary				5.44		0.0										

Empty, or blank, cells indicate that a data observation was not reported.

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Observation Time Temperature: Unknown Observation Time Precipitation: 0800

Year	Month	Day	Temperature (F)			Precipitation					Evaporation		Soil Temperature (F)					
			24 Hrs. Ending at Observation Time		At Observation	24 Hour Amounts Ending at Observation Time				At Obs. Time			4 in. Depth			8 in. Depth		
			Max.	Min.		Rain, Melted Snow, Etc. (in)	Flag	Snow, Ice Pellets, Hail (in)	Flag	Snow, Ice Pellets, Hail, Ice on Ground (in)	24 Hour Wind Movement (mi)	Amount of Evap. (in)	Ground Cover (see *)	Max.	Min.	Ground Cover (see *)	Max.	Min.
2017	05	01				0.00		0.0		0								
2017	05	02				0.00		0.0		0								
2017	05	03				0.00		0.0		0								
2017	05	04				0.00		0.0		0								
2017	05	05				0.04		0.0		0								
2017	05	06																
2017	05	07																
2017	05	08				2.44		0.0		0								
2017	05	09				0.00		0.0		0								
2017	05	10				0.00		0.0		0								
2017	05	11				0.00		0.0		0								
2017	05	12				0.00		0.0		0								
2017	05	13																
2017	05	14																
2017	05	15				1.35		0.0		0								
2017	05	16				0.00		0.0		0								
2017	05	17				0.00		0.0		0								
2017	05	18				0.00		0.0		0								
2017	05	19				0.19		0.0		0								
2017	05	20																
2017	05	21																
2017	05	22				0.00		0.0		0								
2017	05	23				0.19		0.0		0								
2017	05	24				0.00		0.0		0								
2017	05	25				0.03		0.0		0								
2017	05	26				1.12		0.0		0								
2017	05	27																
2017	05	28																
2017	05	29																
2017	05	30				0.05		0.0		0								
2017	05	31				0.03		0.0		0								
		Summary				5.44		0.0										

Empty, or blank, cells indicate that a data observation was not reported.

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Observation Time Temperature: Unknown Observation Time Precipitation: 0800

			Temperature (F)			Precipitation					Evaporation		Soil Temperature (F)					
			24 Hrs. Ending at Observation Time		At Observation	24 Hour Amounts Ending at Observation Time				At Obs. Time			4 in. Depth			8 in. Depth		
Year	Month	Day	Max.	Min.		Rain, Melted Snow, Etc. (in)	Flag	Snow, Ice Pellets, Hail (in)	Flag	Snow, Ice Pellets, Hail, Ice on Ground (in)	24 Hour Wind Movement (mi)	Amount of Evap. (in)	Ground Cover (see *)	Max.	Min.	Ground Cover (see *)	Max.	Min.
2017	06	01				0.39		0.0		0								
2017	06	02				0.00		0.0		0								
2017	06	03																
2017	06	04																
2017	06	05				0.39		0.0		0								
2017	06	06				0.39		0.0		0								
2017	06	07				0.77		0.0		0								
2017	06	08				0.00		0.0		0								
2017	06	09				0.00		0.0		0								
2017	06	10																
2017	06	11																
2017	06	12				0.00		0.0		0								
2017	06	13				0.00		0.0		0								
2017	06	14				0.00		0.0		0								
2017	06	15				0.00		0.0		0								
2017	06	16				0.00		0.0		0								
2017	06	17																
2017	06	18																
2017	06	19				0.57		0.0		0								
2017	06	20				0.78		0.0		0								
2017	06	21				0.00		0.0		0								
2017	06	22				0.00		0.0		0								
2017	06	23				0.00		0.0		0								
2017	06	24																
2017	06	25																
2017	06	26				0.00		0.0		0								
2017	06	27				0.00		0.0		0								
2017	06	28				0.54		0.0		0								
2017	06	29				0.00		0.0		0								
2017	06	30				0.00		0.0		0								
		Summary				3.83		0.0										

Empty, or blank, cells indicate that a data observation was not reported.

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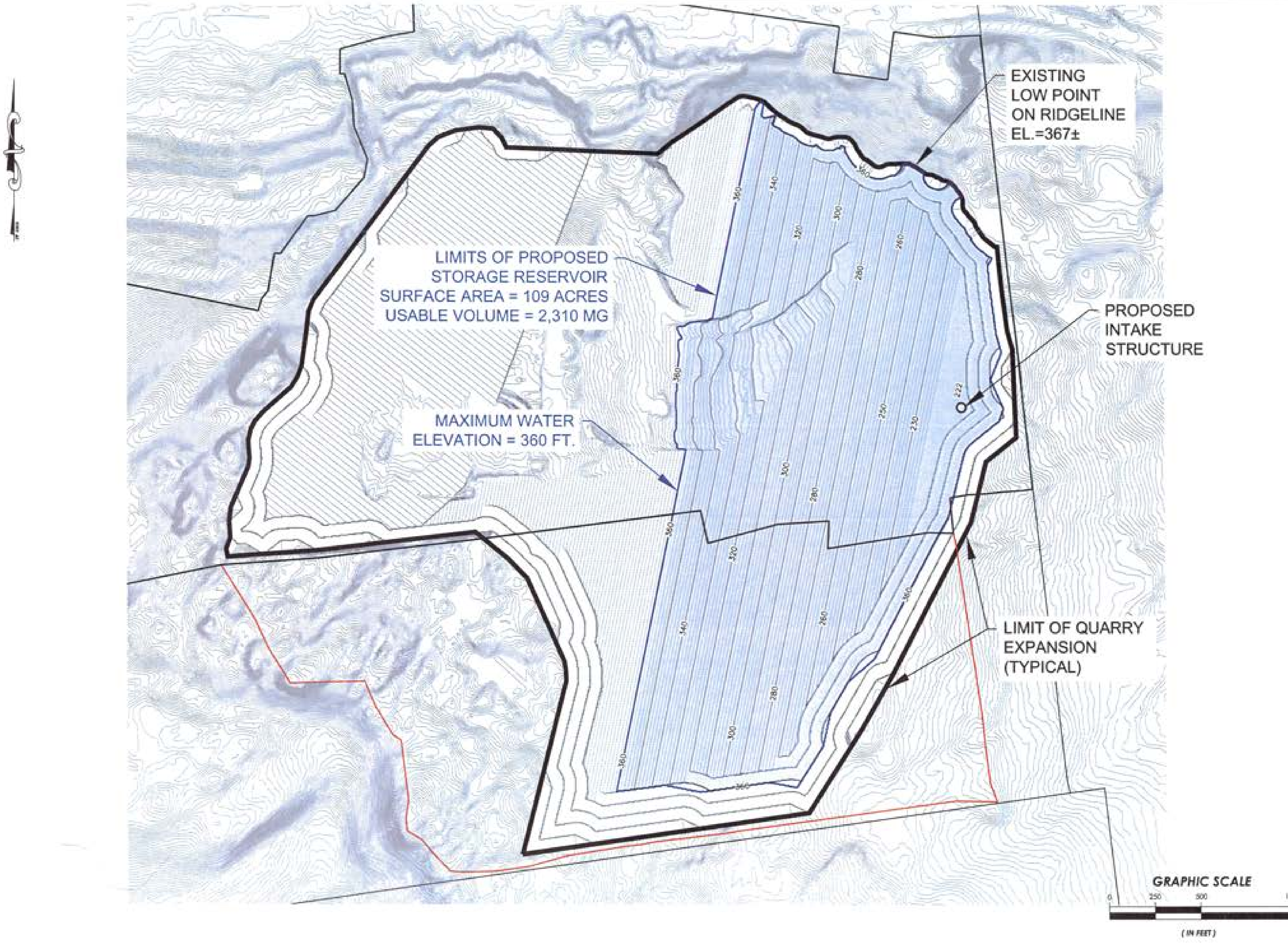
APPENDIX V

RESERVOIR PLAN



PROPOSED STORAGE RESERVOIR

Lenard Engineering, Inc.
Civil, Environmental and Hydrogeological Consultants

PREPARED FOR

PROPOSED STORAGE RESERVOIR

CITY OF NEW BRITAIN

0 BIDDLE PASS, PLAINVILLE, CONNECTICUT

Drawing date: DEC. 8, 2017

Drawing Scale: 1"=500'

Rev.	Date	Revision	By

Designed By: JEE

Drawn By: KLD

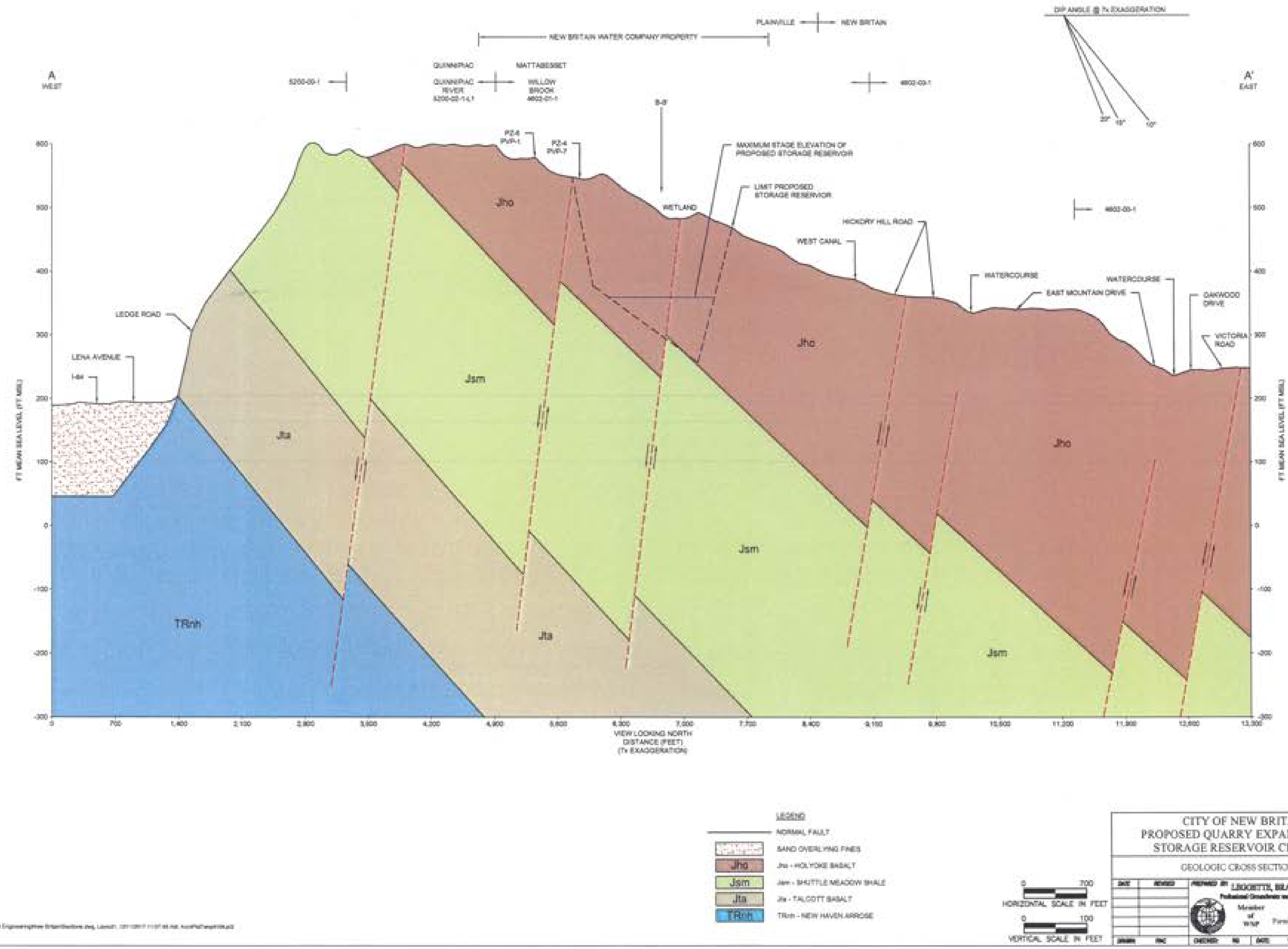
Checked By: JEE

CAD File: UPDATE

Figure #: 3-8

Job #: 16-370

PLATES

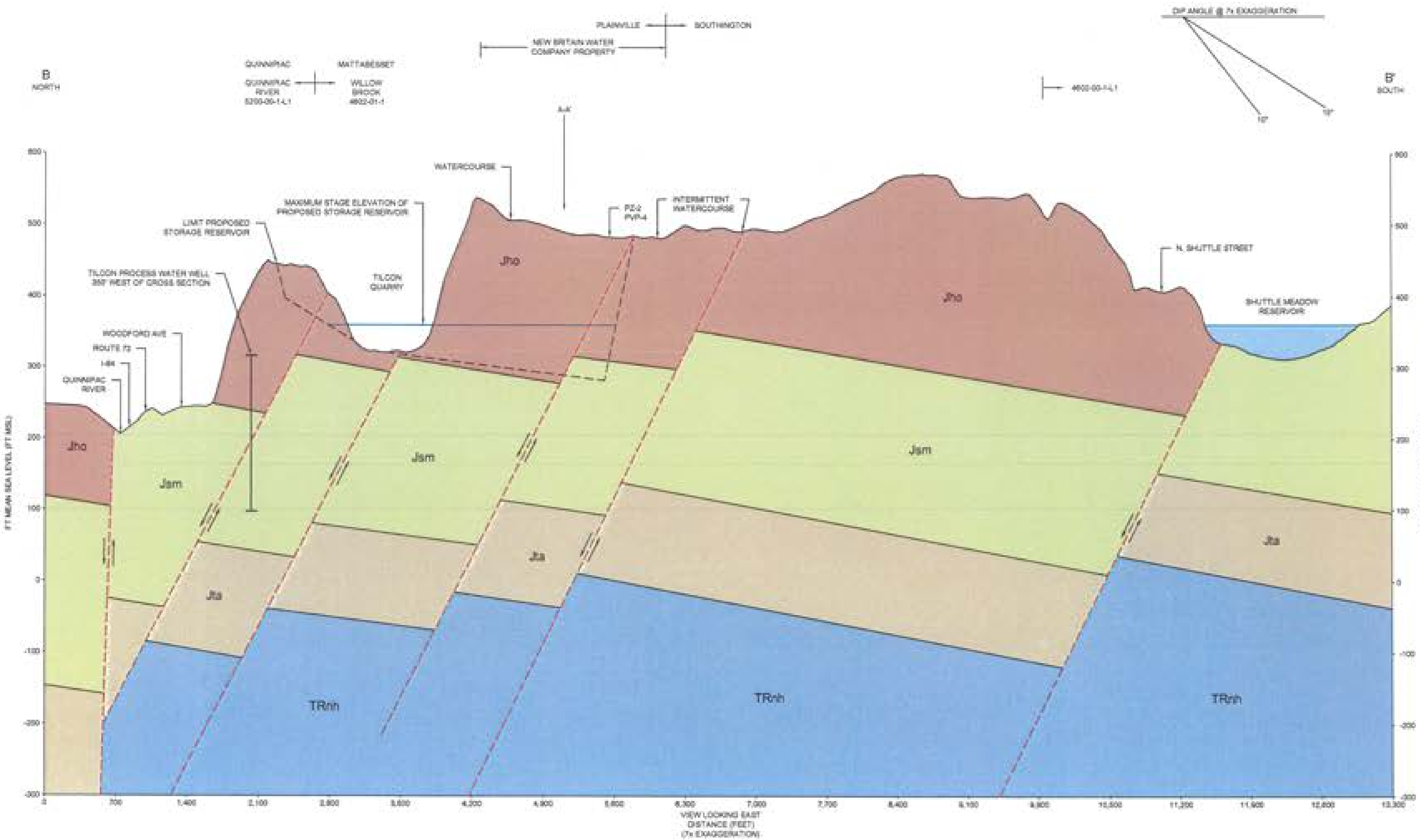


CITY OF NEW BRITAIN
PROPOSED QUARRY EXPANSION AND
STORAGE RESERVOIR CREATION

GEOLOGIC CROSS SECTION AA'

PREPARED BY: LEGGETTE, BRASHEARS & GRAHAM
Professional Groundwater and Environmental Engineering Services
Member of WNP
6 Executive Drive
Suite 109
Farmington, Connecticut 06032
(860) 678-0404

DATE: 12/11/17 PLATE: 1



LEGEND

NORMAL FAULT

Jho	Jho - HOLYOKE BASALT
Jsm	Jsm - SHUTTLE MEADOW SHALE
Jta	Jta - TALCOTT BASALT
TRnh	TRnh - NEW HAVEN ARKOSE

0 700 HORIZONTAL SCALE IN FEET

0 100 VERTICAL SCALE IN FEET

CITY OF NEW BRITAIN PROPOSED QUARRY EXPANSION AND STORAGE RESERVOIR CREATION

GEOLOGIC CROSS SECTION B-B'

PREPARED BY: LEGGETTE, BRASHEARS & GRAHAM
Professional Groundwater and Environmental Engineering Services
Member of WSP
6 Executive Drive, Suite 110, Farmington, Connecticut 06032
(860) 678-0404

DATE: 12/11/17 PLATE: 3

▪ Wetland and Biological Inventory and Assessment, Proposed Quarry Expansion and Storage Reservoir

(Davison Environmental)

Wetland and Biological Inventory and Assessment
Proposed Quarry Expansion and Storage Reservoir Study
Plainville, CT

Submitted To:

Lenard Engineering, Inc.
2210 Main Street
Glastonbury, CT 06033

Prepared By:

Davison Environmental, LLC

December 10, 2017

CONTENTS

ATTACHMENTS

1.0 INTRODUCTION

A multi-season biological survey was conducted in 2016 and 2017 at an approximately 131-acre site where the expansion of the existing Tilcon quarry is being considered. The subsequent end-use of this quarry will be the creation of a water supply reservoir. The site under consideration is owned by the City of New Britain (referred to hereafter as the "site"). This study included detailed multiyear surveys for plants (including rare plant species), habitat characterizations, unique ecological communities (e.g., vernal pools), and surveys to determine habitat use and diversity of amphibians, reptiles and birds. The goal of this study was to fully identify the natural resources at the site, to provide base-line data for an impact assessment for the proposed activities.

2.0 SITE CHARACTERISTICS

2.1 General

The site lies in the southeastern corner of the Town of Plainville (see Figure 1). The southern boundary of the site roughly parallels the Town's border with Southington. The northern boundary lies along the southern boundary of the active Tilcon quarry. The City of New Britain boundary lies approximately 500 feet east of the site's eastern boundary.

2.2 Topography, Watershed and Geology

The site lies in the North-Central Lowlands Ecoregion defined by Dowhan and Craig (1976). Within that region, the site lies atop Bradley Mountain which is part of the traprock ridge (see Figures 1-3). Site elevations range from approximately 430 feet in the eastern portions of the site to 660 feet in the northwest corner of the site.

The site lies largely within the Willow Brook sub-regional drainage basin (CT DEEP Basin #4602-01-1) which is part of the Mattabesett River regional drainage basin. A small portion of the northwest corner of the site lies within the Quinnipiac River sub-regional basin, but this area is outside of the proposed quarry expansion. More locally, the quarry expansion area drains southeast to Shuttle Meadow Reservoir

Figure 1: the site is situated in southwest Plainville along the traprock ridge (traprock ridges shown in orange)

The bedrock geology is basalt traprock of the Holyoke Basalt Formation. The surficial geology of the site is predominately thin till[1]. Thin till refers to areas where till is generally less than 10-15 ft. thick and including areas of bedrock outcrop where till is absent. Areas of Talus were also observed on the site. Talus is loose, angular blocks (mostly boulders) accumulated by rockfall at the bases of steep bedrock cliffs. Talus forms steep unstable slopes and is generally less than 10 ft. thick. It occurs most extensively along the linear basalt and diabase ridges within the central Connecticut lowlands.

[1] Source: CT ECO surficial materials descriptions

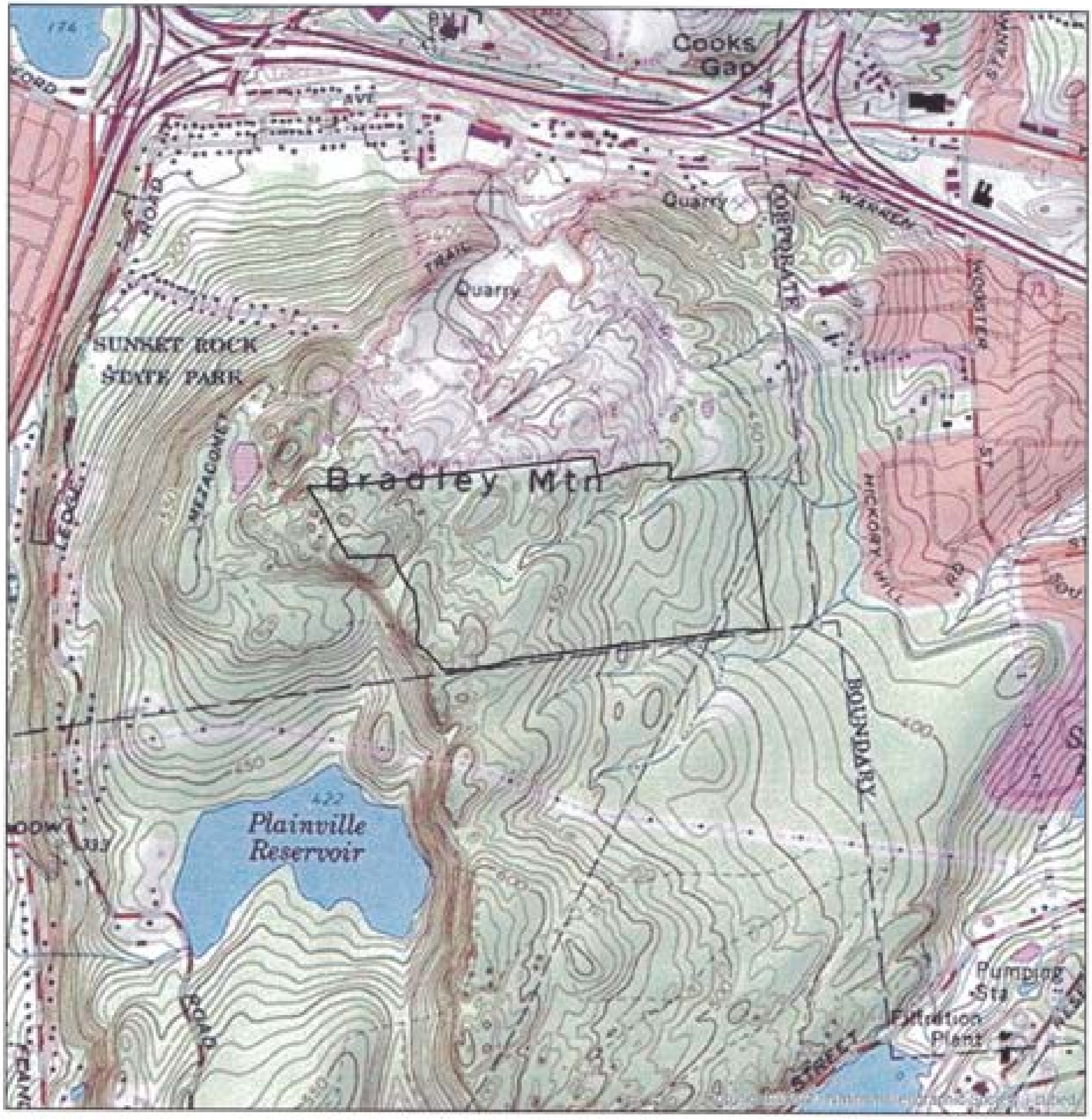


FIGURE 2
USGS Topographic Map

Map Description
USGS topographic map showing site boundary

Legend

Site Boundary

SCALE

0 500 1,000 Feet

N

Prepared by:

Davison Environmental, LLC
www.davisonenvironmental.com

FIGURE 3
2016 Aerial Photograph

Map Description
2016 aerial photograph showing site boundary

Legend

Site Boundary

SCALE

0 400 800 Feet

N

Prepared by:

DAVISON ENVIRONMENTAL

Davison Environmental, LLC
www.davisonenvironmental.com

From a landscape-scale perspective, the site is part of a larger ecological unit. It lies within a large block of contiguous and unfragmented forest approximately 1,000 acres in size. This forest block stretches south to Shuttle Meadow Reservoir, west to Shuttle Meadow Road, east to Hickory Hill in New Britain, and north to Sunset Rock State Park. Such a large and interconnected "core" forest increases the ecological significance of the site and its value to wildlife, particularly forest-interior species.

2.3 Historic Land Use

Review of historical aerial photography and U.S.G.S. topographic maps, as well as observations of physical features in the field offer an indication of historic land use at the site.

Historic maps and aerial photography suggest that the site was formerly used as a pasture. Aerial photography of the site taken in 1934 shows a lightly wooded site, with several large open (un-forested) areas (see Figure 4). Scattered evergreen trees are visible, which are likely eastern red cedar (*Juniperus virginiana*), a tree typically found in pastureland. The remains of these red cedars are visible throughout the site. These observations are consistent with the earliest topographic mapping available from 1895, which illustrates no mapped anthropogenic features on the site, indicating that it was at that time undeveloped.

Pastureland appears most prevalent within the less rugged terrain of the eastern portions of the site. Visible evidence of this former land use include numerous ditched wetlands, small stone dams within intermittent streams and a shallow stone-lined well; all measures aimed at managing surface water most likely for the purpose of providing water to pastured livestock.

2.4 Vegetation

A botanical survey of the property was conducted by botanist James Cowen. This survey encompassed the entire 2017 growing season. Field data were collected on May 2, 30, July 11, August 15, and September 18, 2017. Botanical data collection were timed to encompass the entire growing season, as well as those periods when potentially uncommon taxa would be most conspicuous and/or identifiable (i.e., typically in flower and/or fruit). Those species not identifiable in the field were either collected and pressed and/or photo documented for identification in the office. Microscopic examination and technical dichotomous keys were employed to identify species as needed. Collection protocols per the Connecticut Department of Energy and Environmental Protection's (CT DEEP) plant collection permit were followed.

The vegetation communities on site have been characterized using descriptions from <u>The Vegetation of Connecticut: A Preliminary Classification</u> (Metzler and Barrett, 2006). Descriptions have been supplemented with information from Bulletin 41, <u>Trap Rock Ridges of Connecticut: Natural History & Land Use</u> (Sharp *et. al.*, 2013) and Connecticut Critical Habitat descriptions (CT ECO online).

Six plant communities were identified at the site including forest, woodland and shrubland cover types (see Table 1). These communities are described in the following sections. A comprehensive floral species list is included in Attachment B.

FIGURE 4
1934 Aerial Photograph

Map Description
1934 aerial photograph showing site boundary

Legend

Site Boundary

SCALE

0 250 500 Feet

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Table 1: Vegetation community types

Community Type	Habitat
Deciduous forest communities	
Black Oak-Chestnut Oak/Black Huckleberry	Occurs on shallow dry rocky soils usually on upper slopes
Northern Red Oak-Black Oak/ Blue Ridge Blueberry	Occurs on dry to well-drained soil on upper and middle slopes.
Red Maple-Skunk Cabbage seasonally flooded forest communities	
Red Maple/Northern Spicebush	Usually occurs along small streams and drainageways
Red Maple/Common Winterberry/Highbush Blueberry	Forms in bedrock depressions with a perched water table or in lowlands.
Evergreen woodland community	
Eastern Red Cedar Poverty Oatgrass/Subacidic Rocky Summit Outcrop	Dry to xeric exposed summits, ledges, and other outcrops (primarily basalt and other mafic rocks)
Deciduous shrubland community	
Buttonbush, semi-permanently flooded	Wetland 2

KEY	
Vegetation Types	*Description*
Forests	*Trees with their crowns overlapping 60-100%*
Deciduous forest	*Deciduous tree species generally contribute more than 75% of the total tree canopy; includes some mixed evergreen/deciduous forest types*
Woodlands	*Open stands of trees with crowns not usually touching, generally forming 25-60% tree canopy. Shrubs, herbs, and nonvascular plants may be present with variable cover.*
Shrublands	*Shrubs generally greater than 0.5 meters tall generally forming more than 25% canopy coverage and tree cover less than 25%*
Deciduous shrublands	*Deciduous shrubs contributing more than 75% of shrub cover*

2.4a Upland Cover Types

The upland (non-wetland) portions of the site are predominately deciduous (mixed hardwood) forest. This is the most widespread and characteristic vegetation type that occurs in Connecticut. Connecticut's forests are part of the Central Hardwoods-Hemlock zone within the classification of New England forests. These forests have also been designated as part of the Appalachian Oak Forest Section of the Eastern Broadleaf Forest Province. Since most of Connecticut has been cleared in the past, forests are referred to as second growth. Given the duration of time that has elapsed since post-agricultural abandonment, many second growth forests in Connecticut are comprised of mature trees with a diameter at breast height (dbh) of greater than one foot (i.e., sawtimber).

The forest on the site is even-aged, well-stratified, and predominantly characterized by sawtimber-sized trees. There is local variability in tree diameters based on slope position, site fertility, and associated forest community types which are described further below. Sawtimber-sized trees are more prevalent in fertile mid and low-slope communities. Portions of the eastern side of the site have been logged, resulting in a partially open canopy where invasive non-native species have become established. Where canopy trees were removed, shade-tolerant mid-canopy species such as Sugar Maple (*Acer saccharum*) have been released, and over time will become more prevalent in the canopy.

<u>Black Oak-Chestnut Oak/Black Huckleberry Community</u>
This community occurs on shallow dry rocky soils usually on upper slopes. Bedrock outcrops and knolls are common throughout the site and support this community. The tree canopy consists predominantly of Chestnut Oak (*Quercus prinus*), Black Oak (*Quercus velutina*), Scarlet Oak (*Quercus coccinea*), White Oak (*Quercus alba*), Eastern Red Cedar, Mockernut Hickory (*Carya tomentosa*), and Shagbark Hickory (*Carya ovata*). The open shrub layer is mostly Black Huckleberry (*Gaylussacia baccata*) and Blue Ridge Blueberry (*Vaccinium pallidum*).

The open herb layer is mostly Poverty Oat Grass *(Danthonia spicata)*, Marginal Woodfern (*Dryopteris marginalis*), Christmas Fern (*Polystichum acrostichoides*), Pilewort (*Erechtites hieracifolia*), Canada Mayflower (*Maianthemum canadense*), Hairy Solomon's Seal (*Polygonatum pubescens*), Haircap Moss (*Polytrichum commune*). Poison Ivy (*Toxicodendron radicans*), Virginia Creeper (*Parthenocissus quiquefolia*), Pennsylvania Sedge (*Carex pennsylvanica*), and various other sedge species.

<u>Northern Red- Oak Black Oak/ Blue Ridge Blueberry Community</u>
This community occurs on dry to well-drained soil on upper and middle slopes which are interspersed with the bedrock knolls. The tree layer consists mainly of Red Oak (*Quercus rubra*), Black Oak, Scarlet Oak, White Oak, Red Cedar, Black Birch (*Betula lenta*), Black Cherry *(Prunus serotina)*, Sugar Maple, Shagbark Hickory, Mockernut Hickory, Hophornbeam (*Ostrya virginiana*), American Beech (*Fagus grandifolia*), Red Cedar, Sassafras (*Sassafras albidum*), American Elm (*Ulmus americana*), White Pine (*Pinus strobus*), and Eastern Hemlock (*Tsuga canadensis*).

The open shrub layer includes Blue Ridge Blueberry (*Vaccinium pallidum*), Black Huckleberry, Maple-leaved Viburnum (*Viburnum acerifolium*), Witch Hazel (*Hamamelis virginiana*), Allegheny Blackberry (*Rubus allegheniensis*), Multiflora Rose* (*Rosa multiflora*), Japanese Barberry* (*Berberis thunbergii*), and Wineberry* (*Rubus phoenicolasius*). The vine layer includes Asiatic Bittersweet* (*Celastrus orbiculatus*), Fox grape (*Vitis labrusca*), and Virginia Creeper (*Parthenocissus quinquefolia*).

The herb layer is composed mainly of Christmas Fern, Hay-scented Fern (*Dennstaedtia punctiloba*), Canada Mayflower (*Maianthemum canadense*), Trout Lily (*Erythronium americanum*), Haircap Moss (*Polytrichum commune*), Yellow Star Grass (*Hypoxis hirsuta*), White Wood Aster (*Eurybia divaricata*), Wreath Goldenrod (*Solidago caesia*), New York Fern (*Thelypteris noveboracensis*), Enchanter's Nightshade (*Circaea lutetiana*), Japanese Stiltgrass* (*Microstegium vimineum*), Pennsylvania sedge, Fox Sedge (*Carex vulpinoidea*), and various sedges.

* Invasive non-native plant

Eastern Red Cedar/Poverty Oatgrass Community

This community usually occurs on basalt traprock, including summit outcrops. This community is also known by natural community type as *Subacidic Rocky Summit Outcrop* (Metzler & Barrett 2006, Appendix II) which is classified as a CT DEEP NDDB-designated Critical Habitat[2].

This community occurs on two summit outcrops along the western edge of the site (± 650 feet elevation) which are mapped in the CT DEEP NDDB critical habitat GIS layer (see Figure 5). These units will not be directly affected by the quarry expansion, as they lie a minimum of 600 feet west of the proposed quarry limits. Additionally, this community type occurs in several areas along the northern edge of the property where the tree canopy has been removed on the adjacent parcel (Tilcon Quarry). These areas are variable in species composition and range in elevation from 500 to 600 feet.

Subacidic Rocky Summit Outcrop habitats consist of dry to xeric exposed summits, ledges, and other outcrops (primarily basalt and other mafic rocks) with a vegetation of low shrubs, grasses and herbs (see Figure 5). Subtypes include grassy glades/balds, cedar woodlands and scrub oak. There is an existing hiking trail that follows along and through these summit outcrops. The open tree canopy is a variable mix of evergreens and deciduous trees. The community could also be classified as mixed evergreen-deciduous woodland. The Red Cedar community is often associated with trap rock ridges and was determined to be a more suitable classification.

The tree layer is characterized by Red Cedar, Pitch Pine (*Pinus rigida*), White Pine, Chestnut Oak, Scrub Oak (*Quercus ilicifolia*), Post Oak (*Quercus stellata*), Black Birch, and Flowering Dogwood (*Cornus florida*).

The shrub layer is mostly Black Huckleberry, Blue Ridge Blueberry, Lowbush Blueberry (*Vaccinium angustifolium*), Sweet Fern (*Comptonia peregrine*), and Mountain Laurel (*Kalmia latifolia*).

The diverse herb layer includes Little Bluestem (*Schizachyrium scoparium*), Pennsylvania sedge (*Carex pennsylvanica*), Poverty Oat Grass (*Danthonia spicata*), Herb Robert (*Geranium robertianum*), Columbine (*Aquilegia canadensis*), Early Saxifrage (*Saxifraga virginiensis*), Smooth Rock Cress (*Arabis laevigata*), Woman's Tobacco (*Antennaria plantaginifolia*), Bottlebrush Grass (*Elymus hystrix*), Common Polypody (*Polypodium virginianum*), Poison Ivy (*Toxicodendron radicans*), Pilewort (*Erechtites hieracifolia*), Stiff Aster (*Lonactis linariifolius*), Bastard Toadflax (*Comandra umbellate*), Pineweed (*Hypericum gentianoides*), and Rock Harlequin (*Corydalis sempervirens*). Mosses such as *Politrichum spp.* and lichens such as *Cladonia spp.* are common on the exposed bedrock.

Two of the bedrock areas along the northern property line are vegetated with patches of Fir Clubmoss (*Huperzia appressa*), a state-listed species of Special Concern Species. Coastal Jointweed (*Polygonella articulata*), which is the host plant for *Schinia spinosae* (Jointweed Flower Moth) is also present in these areas. The Jointweed Flower Moth is State-listed species of special concern[3] (See Figure 5).

[2] Connecticut Critical Habitats depicts the classification and distribution of twenty-five rare and specialized wildlife habitats in the state (CT ECO 0nline).

[3] Though the presence of the moth is unconfirmed, these areas are considered potential habitat.

2.4b Wetland Cover Types

Site wetlands were delineated by Registered Soil Scientist Eric Davison. The wetland delineation was conducted according to the requirements of the CT Inland Wetlands and Watercourses Act (P.A. 155). Wetlands are defined as areas of poorly drained, very poorly drained, floodplain, and alluvial soils, as delineated by a soil scientist. Watercourses are defined as bogs, swamps, or marshes, as well as lakes, ponds, rivers, streams, etc., whether natural or man-made, permanent or intermittent.

A total of 10 wetlands occur on the site (see Figure 5). Wetlands 4 and 5 are headwater wetlands with embedded intermittent streams that flow offsite to the east. These streams merge to the east of the site, flowing southward into the West Canal and ultimately to Shuttle Meadow Reservoir. Wetlands 1 through 3 and 6 through 10 are isolated wetlands with no inlet or outlet (i.e., no connection with other wetlands or watercourses). Wetlands 6, 8, 9 and 10 are marginally wet from a drainage-class perspective (i.e. nearly moderately-well drained). While they meet the soil-based designation criteria for wetlands, biologically these areas offer little habitat for wetland-dependent flora and fauna.

<u>Red Maple/Northern Spicebush Community (Wetlands 4, 5, 6, 8, 9 & 10)</u>
Red Maple/Northern Spicebush Community usually occurs along small streams and drainageways. The tree layer is largely Red Maple (*Acer rubrum*) with Black Gum (*Nyssa sylvatica*).

The open shrub layer is mostly Spicebush (*Lindera benzoin*), Sweet Pepperbush (*Clethra alnifolia*), and Highbush Blueberry (*Vaccinium corymbosum*). The herb layer is characterized by Skunk Cabbage (*Symplocarpus foetidus*), Cinnamon Fern (*Osmunda cinnamomea*), Royal Fern (*Osmunda regalis*), Sensitive Fern (*Onoclea sensibilis*), Shallow Sedge (*Carex lurida*), Fringed Sedge (*Carex crinita*), Bladder Sedge (*Carex intumescens*), Tussock Sedge (*Carex stricta*), and Japanese Stiltgrass* *(Microstegium vimineum)*.

<u>Red Maple/ Common Winterberry /Highbush Blueberry Community (Wetlands 1 & 3)</u>
Red Maple/ Common Winterberry /Highbush Blueberry Community form in bedrock depressions with a perched water table or in lowlands. The tree layer is largely Red Maple with Black Gum (*Nyssa sylvatica*) also occurring. The shrub layer consists primarily of Highbush Blueberry with Arrow-wood (*Viburnum dentatum*). The herb layer has a similar composition of the forested wetlands and also grows around the edges of the flooded areas.

<u>Buttonbush Semi-Permanently Flooded Shrubland (Wetland 2)</u>
The tree layer growing at the perimeter of the shrubland is largely Red Maple with Black Gum. The nearly continuous shrub layer consists predominantly of Buttonbush (*Cephalanthus occidentalis*) with Highbush Blueberry around the edges. The herb layer has a similar composition of the forested wetlands and also grows around the edges.

2.5 Soil Types

Digitally available soil survey information were obtained from the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) and generally confirmed in the course of the field surveys. Non-wetland soil types present include the Ludlow, Holyoke-rock outcrop complex, rock-outcrop-Holyoke complex and Wethersfield series.

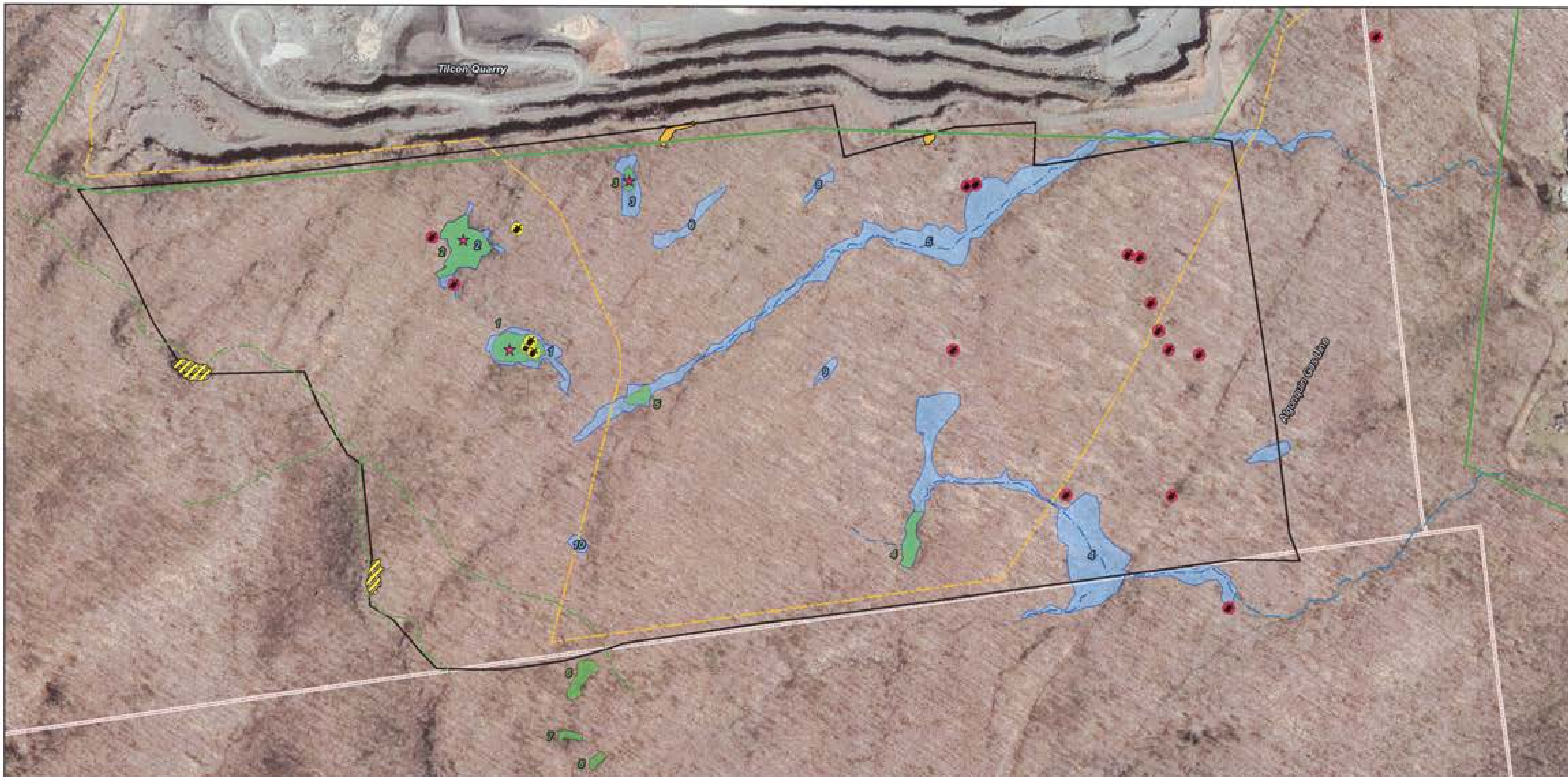

FIGURE 5
Wetlands, Vernal Pools & Rare Species

Map Description
Aerial photograph basemap (2016) showing the locations of wetlands, vernal pools and rare species. Resources illustrated were mapped based on field observations, GPS-collected data and aerial interpretation. Critical habitat locations were taken from the CT DEEP GIS dataset and confirmed by field observations.

Legend

- Site Boundary
- Wetlands (wetland numbers indicated in blue)
- Intermittent Watercourse (offsite flow indicated)
- Trails
- Recently logged forest
- Old field (gas line ROW)

Notable Habitats and State-listed Species

- Jefferson Salamander Breeding Pools (species of special concern)
- Eastern box turtle (state-listed species of special concern)
- Spotted turtle (state-listed species of special concern)
- Vernal Pools (pool numbers indicated in green)
- NDDB Critical Habitat (community type: sub-acidic rocky summit outcrop; data date 10/5/2009; habitat locations confirmed by field observations)
- Fir Clubmoss and Coastal Jointweed

SCALE
0 150 300 Feet
N

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The Ludlow series consists of moderately well drained soils formed in loamy subglacial till. They are very deep to bedrock and moderately deep to a densic contact or hardpan. They are nearly level to strongly sloping soils on till plains, hills, and drumlins. Ludlow soils have a seasonal high-water table at a depth of about 20"- 42" from November through May.

The Holyoke series consists of shallow, well drained and somewhat excessively drained soils formed in a thin mantle of till derived mainly from basalt and red sandstone, conglomerate, and shale. They are nearly level to very steep soils on bedrock controlled ridges and hills. Rock outcrops range from few to many. Hard bedrock is typically present within the upper 20".

The Wethersfield series consists of very deep well drained loamy soils formed in dense glacial till on uplands. The soils are moderately deep to dense basal till. They are nearly level to steep soils on till plains, low ridges, and drumlins. Permeability is moderately rapid or moderate in the solum and slow or very slow in the dense substratum. Slope ranges from 0 to 35 percent.

Wetland soil types present include the Catden and Freetown complex and the Wilbraham and Menlo complex. The Catden series consists of very deep, very poorly drained organic soils formed in incompletely decomposed woody and herbaceous organic materials in depressions on lake plains, outwash plains, moraines, and flood plains. These soils have moderate or moderately rapid permeability. Slope ranges from 0 to 2 percent.

The Freetown series consists of very deep, very poorly drained organic soils formed in more than 51 inches of highly decomposed organic material. They are in depressions or on level areas on uplands and outwash plains. Permeability is moderate or moderately rapid.

The Wilbraham series consists of poorly drained loamy mineral soils formed in subglacial till. The soils are very deep to bedrock and moderately deep to a densic contact. They are nearly level to gently sloping soils in drainageways and low-lying positions of till hills. Wilbraham soils have a water table at or near the surface much of the year. They have an aquic moisture regime.

The Menlo series consists of very poorly drained loamy soils formed in subglacial till. They are very deep to bedrock and moderately deep to a densic contact (hardpan). They are nearly level soils in depressions and drainageways of till covered plains and hills. Depth to bedrock is commonly more than 6 feet. Menlo soils have a water table at or above the surface most of the year (i.e., the soil may be ponded).

3.0 WILDLIFE

Wildlife surveys were conducted from August of 2016 through September of 2017. These surveys were focused on three suites of wildlife: amphibians; reptiles and breeding-season birds. These three taxonomic groups are especially helpful in assessing the relative value of landscapes at the 1000-acre scale. Although the project site is 131-acres, the secondary impacts potentially extend beyond the actual quarry footprint, well into the 1,000 acres of core forest that this site is part of. There was significant focus placed on amphibians, particularly vernal pool-dependent species, as these species, due to their life cycle which includes varied habitat use, were considered to be most susceptible to secondary impacts associated with land-use changes on a landscape-scale.

Survey methods for amphibians and reptiles included cover searching (turning of rocks, logs and other surface debris), visually searching for egg masses, dip-netting for larvae and audial surveys for calling frogs and toads. Live trapping using minnow traps was also conducted within vernal pools[4] during the late winter, primarily for the purpose of identifying the breeding locations of the cryptic state-listed Special Concern Jefferson salamander complex (*Ambystoma jeffersonianum*).

Survey methods for birds included audial and visual surveys during late May and early June when most migratory birds have returned to Connecticut for the breeding season. Box turtle surveys were conducted during May and June and included visual surveys focused in areas of low dense vegetation with sunny openings where box turtles basked during the late spring.

This report focuses on species considered to be of high conservation priority in Connecticut as designated in the 2015 Connecticut Wildlife Action Plan (WAP) and those that have State listing status. The WAP was created to establish a framework for proactively conserving Connecticut's fish and wildlife, including their habitats. The WAP identifies species of "Greatest Conservation Need" (GCN) and prioritizes those species into three categories in descending order of significance from "most important to "very important" and finally "important".

3.1 Amphibians and Reptiles

Amphibians and reptiles observed on the site are listed in Table 2. Species include those typical for the region and particularly the traprock ridge of the central valley. Several high-conservation priority species were observed including the Jefferson salamander, marbled salamander, spotted salamander, wood frog, spotted turtle and eastern box turtle.

Table 2: Amphibians and reptiles observed

Common Name	Scientific Name	CT WAP Status	State-listed Status
Jefferson Salamander	*Ambystoma jeffersonianum*	VI	SC
Spotted Salamander	*Ambystoma maculatum*	I	
Marbled Salamander	*Ambystoma opacum*	I	
Red-spotted Newt	*Notopthalmus viridescens*		
Eastern American Toad	*Anaxyrus americanus*		
Gray Treefrog	*Hyla versicolor*		
Northern Spring Peeper	*Pseudacris crucifer*		
Green Frog	*Lithobates clamitans*		
Pickerel Frog	*Lithobates palustris*		
Wood Frog	*Lithobates sylvaticus*	I	
Spotted Turtle	*Clemmys guttata*	VI	SC
Eastern Box Turtle	*Terrapene carolina*	VI	SC
Eastern Garter Snake	*Thamnophis sirtalis*		
CT Wildlife Action Plan (CT WAP) Status: I = important; VI = very important; MI = most important State-listed Status: SC = species of special concern			

[4] Minnow trapping including handling of State-listed wildlife was done under a Scientific Collectors Permit #0319001

In addition to the species listed in Table 2, the black rat snake (*Pantherophis alleghaniensis*) was considered probable but unverified. In September of 2017, a large black snake was observed but we were not able to observe field characteristics necessary to make a positive identification. Based on the forested habitat present, it was likely a black rat snake which favors forest areas on trap rock ridges, as opposed to a black racer (*Coluber constrictor*) that favors open field habitats.

3.2 Vernal Pools

Calhoun and Klemens (2002) provides the following definition of vernal pools:

Vernal pools are seasonal bodies of water that attain maximum depths in the spring or fall, and lack permanent surface water connections with other wetlands or water bodies. Pools fill with snowmelt or runoff in the spring, although some may be fed primarily by groundwater sources. The duration of surface flooding, known as hydroperiod, caries depending upon the pool and the year; vernal pool hydroperiods range along a continuum from less than 30 days to more than one year. Pools are generally small in size (<2 acres), with the extent of vegetation varying widely. They lack established fish populations, usually as a result of periodic drying, and support communities dominated by animals adapted to living in temporary, fishless pools. In the region, they provide essential breeding habitat for one or more wildlife species including Ambystomid salamanders (Ambystoma spp., called "mole salamanders" because they live in burrows), wood frogs (Rana sylvatica), and fairy shrimp (Eubranchipus spp.).

Vernal pool physical characteristics can vary widely while still providing habitat for indicator species. "Classic" vernal pools are natural depressions in a wooded upland with no hydrologic connection to other wetland systems. Often, vernal pools are depressions or impoundments within larger wetland systems. These vernal pool habitats are commonly referred to as "cryptic" vernal pools. The pools are defined by the presence of indicator (obligate) species breeding in them, as opposed to a wetland type or definition.

Several species of amphibians depend upon vernal pools for reproduction and development. These species are referred to as indicator vernal pool species. Indicator species present on the site include the marbled salamander, spotted salamander, Jefferson salamander, wood frog and fairy shrimp.

Of critical importance to vernal pool indicator species is not just the breeding pools themselves, but the habitat surrounding the pools. Most adult vernal pool amphibian species spend only a few weeks in breeding pools. The rest of their life cycle is spent in adjacent uplands (primarily forest) surrounding breeding pools. In these areas favored habitat consists of deeply shaded forest with small mammal burrows, or cover objects such as coarse woody debris or stones and a thick duff (organic) soil surface. Calhoun and Klemens (2002) indicate that a 750-foot upland habitat zone around the vernal pools is required to sustain the non-breeding terrestrial activity of those species of amphibians breeding within the pools.

Eight vernal pools were identified (see Figure 5). Pools 1 through 5 are located on the subject parcel, while Pools 6 through 8 are located immediately south of the site within the Town of

Southington but their required terrestrial habitat lies on the project site. Indicator species observed within each pool are summarized in Table 3.

Vernal pool activity began earlier than typical this year, with surficial amphibian movement first noted on February 25th. Vernal pool surveys began on March 2nd, with minnow traps deployed to capture mole salamanders and wood frogs.

Table 3: Vernal pool indicator species observations

Pool	Indicator Species Present	Total Egg Masses		
		Ajef	Amac	Lsyl
1	Eub, Amac, Ajef, Lsyl, Aopa	n.o.	28	5
2	Eub, Amac, Ajef, Lsyl,	27	17	n.o.
3	Amac, Ajef, Lsyl,	126	77	21
4	Aopa, Lsyl	n.o.	47	4
5	Aopa, Amac		15	
6	Aopa, Amac	See note 2		
7	Aopa, Amac			
8	Aopa, Amac			

KEY:
Species: Amac = spotted salamander; Ajef = Jefferson salamander; Lsyl = wood frog; Aopa = marbled salamander; Eub = fairy shrimp
n.o. = not observed

Notes:
1. Pool 2 contains deep water and very dense vegetation, so egg mass counts in these pools should be considered conservative.
2. Pools 6, 7 and 8 were identified in June during offsite reconnaissance surveys. Due to the timing of our observations, total egg mass counts were not possible.

Vernal pools 1, 2, 3, 6, 7 and 8 are classic vernal pools. Pools 4 and 5 are cryptic vernal pools, as they are embedded within larger wetland systems (Wetlands 4 and 5). Both pools occupy the uppermost reaches (i.e., headwaters) of these wetlands that drain offsite to the east.

The spotted turtle, a State-listed species of special concern which utilizes vernal pools particularly for feeding in spring and early summer were observed in Pool 1. Spotted turtles move across the terrestrial landscape often utilizing a group of vernal pools during their seasonal activity.

Other wetland-dependent amphibians observed within the vernal pools include red-spotted newt, spring peeper, gray treefrog and green frog. Wood duck, a disturbance sensitive wetland-dependent species that often inhabits larger, long hydroperiod vernal pools, was observed in Pools 1 through 3.

Several discrete breeding sites were observed in road ruts within the gas line ROW, as well as a single egg mass observed within the old well. These resources are considered "decoy pools" by Calhoun and Klemens (2002). Decoy pools are areas of standing water that attract indicator species to deposit their eggs, but the hydrology is often unsuitable to allow these species to complete their development through metamorphosis. Therefore, these decoy pools are considered a detriment to the overall health of the amphibian populations as they siphon of reproductive output and serve as an ecological sink.

3.3 Breeding Birds

Birds were cataloged from March through August, 2017 (see Table 4). Several intensive early morning (5:00am-9:00am) surveys were conducted from late May through mid-June to document birds present during the principal breeding season for neotropical migratory songbirds.

Table 4: Birds observed

Common Name	Scientific Name	Habitat	CT WAP Status
Jays and Crows			
Blue Jay	*Cyanocitta cristata*	1	
Chickadees and Titmice			
Tufted Titmouse	*Baeolophus bicolor*	1	
Black-capped Chickadee	*Poecile atricapillus*	1	
Nuthatches			
White-breasted Nuthatch	*Sitta carolinensis*	1	
Wrens			
Carolina Wren	*Thryothorus ludovicianus*	1	
Gnatcatchers			
Blue-gray Gnatcatcher	*Polioptila caerulea*	1	I
Thrushes			
Wood Thrush	*Hylocichla mustelina*	1	MI
American Robin	*Turdus migratorius*	1	
Mockingbirds and Thrashers			
Gray Catbird	*Dumetella carolinensis*	2,3	
Northern Mockingbird	*Mimus polyglottos*	2	
Wood Warblers			
Ovenbird	*Seiurus aurocapilla*	1	I
American Redstart	*Setophaga ruticilla*	1	I
Common Yellowthroat	*Geothlypis trichas*	2,3	
Worm-easting Warbler	*Helmitheros vermivorum*	1	VI
Prairie Warbler	*Setophaga discolor*	2	MI
Louisiana Waterthrush	*Parkesia motacilla*	3	VI
Blue-winged Warbler	*Vermivora cyanoptera*	1	MI
Black and White Warbler	*Mniotilta varia*	1	I
Towhees and Sparrows			
Chipping Sparrow	*Spizella passerina*	2	
Eastern Towhee	*Pipilo erythrophthalmus*	1,2	VI
Cardinals, Tanagers, Grosbeaks, Buntings			
Scarlet Tanager	*Piranga olivacea*	1	VI
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	1	I

Table 4 continued			
Common Name	Scientific Name	Habitat	CT WAP Status
Northern Cardinal	*Cardinalis cardinalis*	1	
Indigo Bunting	*Passerina cyanea*	2	VI
Blackbirds and Orioles			
Brown-headed Cowbird	*Molothrus ater*	1,2	
Baltimore Oriole	*Icterus galbula*	2	I
Ducks, Geese and Swans			
Wood Duck	*Aix sponsa*	3	
Finches			
American Goldfinch	*Spinus tristis*	2	
Hummingbirds			
Ruby-throated Hummingbird	*Archilochus colubris*	1,2	
Woodpeckers			
Downy Woodpecker	*Picoides pubescens*	1	
Hairy Woodpecker	*Leuconotopicus villosus*	1	
Pileated Woodpecker	*Hylatomus pileatus*	1	
Northern Flicker	*Colaptes auratus*	1	VI
Red-bellied Woodpecker	*Melanerpes carolinus*	1	
Tyrant Flycatchers			
Eastern Wood Pewee	*Contopus virens*	1	I
Eastern Phoebe	*Sayornis phoebe*	1,2	
Great-crested Flycatcher	*Myiarchus crinitus*	1,2	
Hawks, Kites and Eagles			
Red-tailed Hawk	*Buteo jamaicensis*	1,2	
New World Quail, Grouse and Turkeys			
Wild Turkey	*Meleagris gallopavo*	1,2	
New World Vultures			
Turkey Vulture	*Cathartes aura*	1,2	
Pigeons and Doves			
Mourning Dove	*Zenaida macroura*	1	
Typical Owls			
Barred Owl	*Strix varia*	1	I
Vireos			
Red-eyed Vireo	*Vireo olivaceus*	1	

Habitat Codes:
1 = forest; 2 = old field (quarry perimeter/gasline right-of-way) 3 = wetlands and watercourses

CT Wildlife Action Plan (CT WAP) Status:
I = important; VI = very important; MI = most important

Overall, bird diversity is relatively low due primarily to the fact that habitat diversity is limited at the site. The site is essentially one habitat type (mixed hardwood forest) with minimal amounts sub-optimal early-successional (i.e., non-forested) habitat present.

A total of 43 birds are identified in the breeding bird inventory. This list includes a total of 17 GCN species (39.5%): eight *important* species; six *very important* species; and three *most important* species. The majority of Greatest Conservation Need species identified are forest-dwelling birds including a number of forest-interior neotropical migrants of high-conservation concern. These include the wood thrush, scarlet tanager and worm-eating warbler.

Several high-conservation priority early-successional birds that inhabit old field/shrubland habitats were present on the site including the indigo bunting, blue-winged warbler and prairie warbler. These species are restricted to the margins of the existing quarry as well as the gas line ROW. Much of the habitat lies between the Tilcon quarry's southerly mining wall and the limits of the mature wooded treeline where the vegetation has been cleared and is maintained as early-successional habitat.

Overall, habitat for such early-successional birds is limited in extent, both in acreage and interior area, and therefore the habitat quality is considered low.

3.4 Mammals

While no detailed mammalian surveys were conducted at the site, several species were observed. These include white-tailed deer (*Odocoileus virginiana*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), gray squirrel (*Sciurus carolinensis*), eastern chipmunk (*Tamias striatus*) and woodland jumping mouse (*Napaeozapus insignis*). Due to the presence of large areas of in interconnected core forest, the site is suitable for area-sensitive mammals such as the bobcat (*Lynx rufus*).

4.0 STATE-LISTED SPECIES

4.1 Spotted Turtle

The spotted turtle is a State-listed species of special concern. Spotted turtle inhabit a wide variety of shallow water aquatic habitats, both temporary and permanent. Spotted turtle commonly move overland between wetland habitats throughout the spring and summer. Upland forest adjacent to wetlands is often used during the summer (Klemens, 1993).

Multiple spotted turtles were observed within Vernal Pool 1, along with a shell (carapace) found adjacent to Wetland 2. While Vernal Pools 1 and 2 were considered the principal wetland habitats for these species, all the vernal pools on the site represent suitable habitat. In particular Pools 3 and 5 are likely utilized due to their proximity to Pools 1 and 2. Wetland/Vernal Pool 2 is likely used for hibernation based on its larger size and longer hydroperiod, and the absence of other wetland types such as red maple swamp on the ridgetop.

4.2 Jefferson Salamander Complex

The Jefferson Salamander complex is a State-listed species of special concern. This species occurs west of the Connecticut River, favoring upland sites. They inhabit upland forest, typically deciduous forest, but are also known to occur in forests dominated by eastern hemlock. Steep, rocky areas with rotten logs and heavy duff layers are favored microclimates (Klemens, 1993). Breeding occurs in vernal pools, most commonly perched wetlands in ledge and shallow-to-bedrock topography. Jefferson salamanders have a biogeographical affinity to the trap rock ridge system of the Central Connecticut Lowland, of which this site lies within.

The Jefferson Salamander complex was confirmed breeding in Vernal Pools 1, 2 and 3. These pools represent optimal habitat for this species and serve as a meta-population. Basically, due to the spatial proximity of these three pools to one-another, they serve as an ecological unit, with genetic exchange anticipated between them. All three of these pools are perched pools surrounding by bedrock outcroppings, talus, and mature forest. Pool 3 had the highest abundance of egg masses of the three pools; however, this egg mass count may be a function of the ease with which this pool can be surveyed (i.e., smaller pool lacking dense vegetation).

4.3 Eastern Box Turtle

The eastern box turtle is a State-listed species of special concern. Box turtle are widespread throughout the low-lying portions of Connecticut. They favor old field habitat and deciduous forest ecotones, including powerline cuts and logged over woodland (Klemens, 1993). Box turtles utilize different habitat types at different times of the year (Dodd, 2001). Early-successional habitats are generally inhabited during months with moderate temperate while forested habitats are utilized during the heat of the summer as well as for hibernation (Erb, 2011).

A total of 10 box turtles were observed. An additional five box turtle shells were found on the site or within the adjacent gas line ROW (upper shell, or carapace). Box turtles were observed in two areas of the site. Eight of the ten turtles, as well as all the turtle shells, were observed within the eastern portions of the site including the gas line ROW. The remaining two box turtles were found within the forest immediately adjacent to Wetland 2. Box turtle observation locations are shown on Figure 5. Photos of each of the ten turtles observed are included in Attachment A.

Box turtles strongly favored the areas of logged forest in the eastern portions of the site. A typical observation location consisted of a small, sunny tree-canopy opening within a former logging skid road or log landing. The ground was covered in woody slash and herbaceous and shrub cover including Japanese barberry, various ferns, Japanese stiltgrass and brambles were moderately dense.

Five males and five females were observed. Plastral scute ring counts (which can roughly be used to approximate age) exceeded 18 for all individuals observed. Most turtles were worn smooth (n=5) or had too much wear to accurately county the annuli (n=3). Based on these annuli data, turtles were assigned to three age classes: Five turtles were considered aged, three turtles were considered middle-aged, and two were considered young. These data point to a population that has recruitment. Additional research would provide a fuller picture of this population. The number of shells found (5) would indicate that this is a much larger box turtle population than these data collected to date indicate.

4.4 Fir Clubmoss

Two of the bedrock area along the northern property line are vegetated with patches of Fir Clubmoss *(Huperzia appressa)*, a state-listed species of Special Concern Species.

5.0 WILDLIFE IMPACTS

The proposed quarry expansion totals approximately 72 acres extending from the southeast corner of the existing Tilcon Quarry. The expansion shifts the current quarry limits south a maximum distance of approximately 1,700 feet. Potential wildlife impacts resulting from a project of this type would be multifaceted, and include:

- Habitat loss: direct loss of a species habitat due to quarry expansion which results in direct mortality. This includes fragmentation and loss of core forest.
- Direct mortality: this impact would occur with resident (non-migratory) terrestrial species are killed when clearing, soil and overburden removal occurs. This is of particular concern for less mobile species (e.g., surficial/fossorial mole salamanders, and turtles). Direct mortality could also occur with migratory birds if tree removal occurred during the breeding season (April through August) when young are unable to leave the nest.
- Habitat degradation: these are largely secondary impacts that can occur in habitats adjacent to the quarry limits. These include the phenomenon of "edge affect" when core forest is fragmented (which impacts forest-interior birds); noise pollution which can disrupt calling or singing; or hydrologic alterations of wetlands due to large-scale changes in the site topography and the loss of critical habitat required to sustain species.

5.1 Vernal Pool Impact Assessment

Impacts of the proposed project on vernal pool wildlife would be associated with the following three factors:

1. direct loss of the breeding pool;
2. loss of terrestrial forest (i.e., essential non-breeding critical terrestrial habitat) surrounding the pools; and
3. impacts to breeding productivity resulting from diminished wetland hydroperiods (i.e., depth and duration of standing water).

To assess these pools qualitatively, the methodology described in Best Development Practices, Conserving Pool-Breeding Amphibians in Residential and Commercial Developments in the Northeastern United States[5] (Calhoun and Klemens, 2002, a.k.a. "the BDP") was used. This assessment methodology utilizes a three-tiered rating system, with the tier designation determined by examining the biological value of the pool in conjunction with the condition of the habitat surrounding the pool, which is the area used by vernal pool amphibians during the non-breeding season. The higher the species diversity and abundance, coupled with an

[5] http://www.nae.usace.army.mil/Portals/74/docs/regulatory/VernalPools/BestDevelopmentPractices20Oct2014.pdf

undeveloped forested landscape surrounding the pool, the higher the tier rating. Tier 1 pools are considered the highest quality pools, while Tier 3 are the lowest.

The BDP examines land use changes within two management zones surrounding the breeding pool, defined as the *Vernal Pool Envelope* (VPE, 0 to 100 feet) and the *Critical Terrestrial Habitat* (CTH, 100 to 750 feet). For a pool to be considered a Tier 1 pool (the highest quality), the following criteria must be met:

1. Biological Criteria: Pools must contain 25 or more egg masses from a single indicator species, support a State-listed indicator species, or support two or more indicator species (BDP pg. 9, Section A).

2. Landscape Criteria: Pools must have no development within the VPE and less than 50% development within the CTH (BDP pg. 9, Section B).

All eight pools are Tier 1 pools which is the highest quality rating in the BDP. All pools meet the Tier 1 biological criteria of the BDP since all pools contained two or more indicator species, many pools contain a high number of egg masses, and three of the pools support the State-listed Jefferson salamander. Additionally, all pools meet the landscape condition within the CTH, as no pool currently have encroachment within the VPE, and development within the CTH does not exceed 50%. The effect of the proposed quarry expansion on the two vernal pool management zones is illustrated on Figure 6 and summarized in Table 5. For proposed projects, BDP compliance requires that no development occurs within the VPE zone, and less than 25% development occurs within the CTH zone[6].

Table 5: Vernal Pool Impact Analysis

Pool	Existing Conditions		Proposed Quarry (existing and proposed development)		
	VPE	CTH	Loss of Pool	VPE	CTH
1	0%	2.31%	0%	0%	36.83%
2	0%	25.61%	0%	0%	42.96%
3	0%	37.15%	100%	n/a	n/a
4	0%	0%	100%	n/a	n/a
5	0%	0%	100%	n/a	n/a
6	0%	0%	0%	3.74%	18.94%
7	0%	0%	0%	0%	10.27%
8	0%	0%	0%	0%	9.28%

*BDP non-compliant pools highlighted in orange
Vernal Pool Management Zone Codes:
VPE = 0-100 feet from pool; CTH = 100-750 feet from pool

[6] Other site-specific recommendations are required for BDP compliance (BDP pages 18 through 26).

For Pools 1 through 6, the quarry expansion is non-compliant with the BDP guidelines due to the acreage of habitat loss as well as direct impact to several pools. The quarry will result in the direct loss of pools 3, 4 and 5 as they are located within the proposed quarry limits. Pool 1 is non-compliant due to the proposed 34.52% development within the CTH (i.e., exceeds 25%). Pool 2 is non-compliant due to the fact that it is presently beyond the 25% development threshold recommended in the BDP (currently at 25.61%), and therefore additional terrestrial habitat loss is considered a threat to the long-term viability of the pool. Pool 6 is non-compliant due to the minor encroachment of 3.74% development within the VPE; however, the level of development within the CTH (18.94%) is compliant as it is less than 25%.

In addition to direct impacts to the breeding pools and the terrestrial habitat that supports vernal pool wildlife, the potential for landscape-scale affects to the vernal pool meta-population must be considered. Five vernal pools occur on the site, with another three occurring immediately offsite to the south (Pools 6-8). These pools, along with other vernal pools located beyond our study area[7] represent a vernal pool metapopulation.

Individual vernal pools consist essentially of a single population. While these individual populations are spatially separated and function somewhat independently, over time individuals from each population disperse between pools. This serves an important function, by providing for gene dispersal and source animals from one population to another (Dodd, 2010).

Loss of three pools and further isolation of the remaining pools through fragmentation of the forest block will negatively affect dispersal corridors and serve to isolate certain pools (particularly pools 1 and 2). This has the potential to result in the long-term decline of indicator species within certain pools if a *critical landscape threshold* (With and Crist, 1995) is reached, upon which there could be an abrupt decrease in the abundance of species within a vernal pool. The BDP manual notes (pg. 4) "*Connections between pools, through the upland landscape, must be maintained to accommodate population movements-dispersal to and from pools for breeding, foraging, resting and replenishing locally extinct populations.*"

Impacts to breeding productivity due to hydrologic impacts on remaining pools are not anticipated to be significant. Only two pools will lose contributing watershed. Pool 6 will lose 15%, and Pool 2 will lose 1.3%. If contributing watershed loss were more substantial, this could reduce surface water runoff which would result in a reduced hydroperiod. If the pools hydroperiod is shortened, the pool could dry prematurely, prior to full metamorphosis of amphibian larvae.

[7] Review of 2016 aerial photography strongly suggest that other vernal pools located beyond the study area, particularly to the south in Southington.

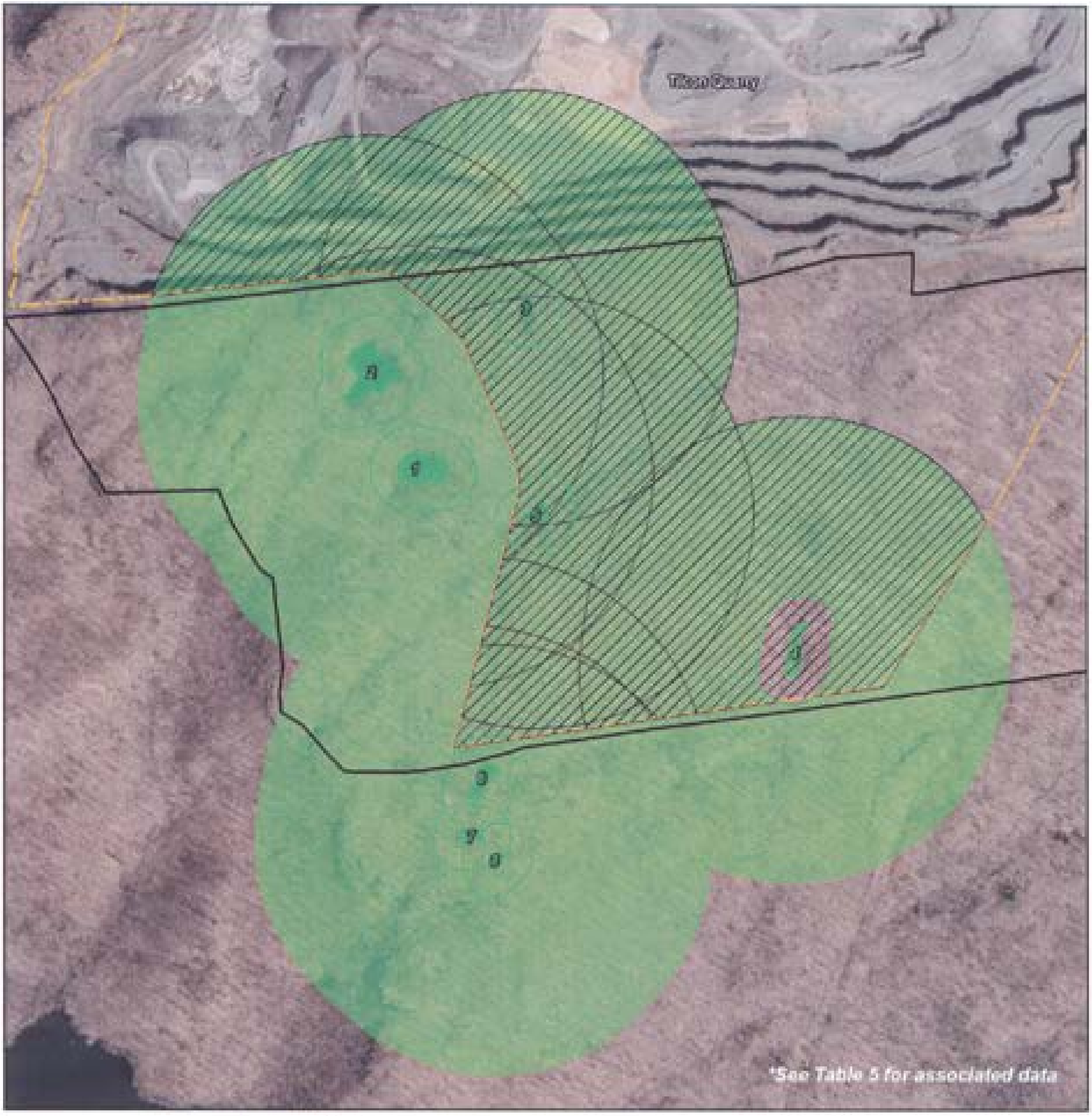

FIGURE 6
Vernal Pool Impact Analysis

Map Description
Map illustrating vernal pools with associated habitat management zones described by Calhoun and Klemens, 2002.

Legend
- Site Boundary
- Future Quarry Development
- Proposed Quarry Boundary
- Vernal Pools
- VPE Zone
- CTH Zone

SCALE
0 250 500 Feet
N

Prepared by:
DAVISON ENVIRONMENTAL
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5.2 Impacts to State-listed Species

Three State-listed special concern herpetofauna will be impacted by the proposed project. From a State-wide conservation perspective, the most severe impact will be to the Jefferson salamander. This species has a very restricted range in the Central Connecticut Lowland located atop trap rock ridges. While the spotted turtle is also at risk, its distribution is the Central Connecticut Lowland is much broader and less specialized than the Jefferson salamander. Both these species are concentrated in several vernal pools that will be in and very near the impact zone. The box turtle is the most widespread species of the three species in the Central Connecticut Lowland.

5.2a Spotted Turtle

The critical habitat for this species is Wetlands/Vernal Pools 1 and 2. These wetlands represent the observed locations and presumed hibernacula. Based upon the known movement patterns of this species, Vernal Pools 3 and 5, and the forest connecting Pools 3 and 5 west to Pools 1 and 2, are also likely habitat. No direct impact is proposed to occur within the primary wetland habitat for this species (i.e., Wetlands/Vernal Pools 1 and 2). The propose quarry will eliminate Pools 3 and 5 and will encroach within approximately 250 feet of Pools 1 and 2. The loss of terrestrial habitat and secondary wetland habitat will potentially impact this long-lived turtle species. Loss of a few adults could result in extirpation of the population atop Bradley Mountain.

5.2b Jefferson Salamander Complex

The Jefferson Salamander complex was confirmed breeding in Vernal Pools 1, 2 and 3 which serve as a metapopulation. Additionally, the forested habitat surrounding these pools represents their terrestrial non-breeding habitat. Of the three breeding sites, no direct impact to Pools 1 and 2 are proposed, but Pool 3 will be lost as it lies within the proposed quarry limits. With respect to impacts to terrestrial habitat surrounding Pools 1 and 2 (within 750 feet of the pool), there will be a loss of 34.52% and 17.35%, respectively.

The direct loss of Pool 3 is considered a significant impact to the onsite population of Jefferson salamander. Of the three pools where this species breeds, Pool 3 contained the highest abundance (126 total egg masses). In addition to loss of breeding habitat, terrestrial non-breeding forest habitat will be lost surrounding Pools 1 and 2, which could reduce the breeding productivity within these pools. The proposed development scenario is likely to lead to the extirpation of Jefferson salamanders at the site due to the outrights loss of one breeding pool and a significant reduction in the amount of terrestrial habitat required by these salamanders surrounding the two other nearby pools where they breed. Jefferson salamanders are the most disturbance-sensitive of Connecticut's mole salamanders, and exist on trap rock ridges in areas of core forest. While the current population exists near the edge of the quarry wall, the current proposal will greatly impact the survivability of this species by eliminating proximal forest habitat around two pools, and completely removing one pool.

5.2c Eastern Box Turtle

A total of 10 live box turtles were observed. An additional five box turtle shells (upper shell, or "carapace") were found. Box turtles were observed in two areas of the site. Eight of the ten turtles, as well as all the turtle shells, were observed within the eastern portions of the site including the gas line ROW. The remaining two box turtles were found within the forest immediately adjacent to Wetland 2.

A large portion of the primary habitat used by box turtle, consisting of the logged forest within the eastern portion of the site (west of the gas line ROW) will be lost, as it lies directly within the proposed quarry limits. It is impossible to assess with these limited data the long-term impacts of the proposed project on box turtles. While there are significant amounts of habitat existing off site, no inventories have been conducted to determine whether box turtles and box turtle habitat exist off site. The concentration of box turtles in the logged forest is likely in part a sampling bias though this area may serve as an attraction zone for turtles to move into from surrounding denser forest. Much of the logged forest where turtles were found will be lost. However, the affinity for logged forest also demonstrates that suitable mitigation habitat for box turtles could be recreated in nearby areas of Southington and New Britain by creating openings in the forest. It is also possible that box turtles could be relocated to these re-created areas of habitat, much in the manner that was employed in an area of quarry expansion in East Granby (Galasso Quarry). Any mitigation proposal would require additional surveys to develop better understanding of the population size and distribution of box turtles both on and off the project site.

5.2d Fir Clubmoss

Two of the bedrock area along the northern property line are vegetated with patches of Fir Clubmoss. Both patches are within the proposed quarry limits and therefore will be lost. However, the presence of this species, at the margins of the existing clearing along the southern quarry limits, was likely enhanced by the quarrying activities which opened the tree canopy and improved the growing conditions.

5.3 Breeding Bird Impact Assessment

Land development can impact breeding birds via direct habitat loss as well as degradation of habitats adjacent to development, resulting from what is commonly referred to as the "edge effect". The edge effect refers to habitats which are degraded as a result of their adjacency to development. This results from several factors, including habitat avoidance due to noise or visual disturbances, increased rates of predation or brood parasitism caused by improved habitat conditions for predators (e.g., raccoons), and nest parasites (i.e., brown-headed cowbirds). The specific factors which cause the edge effect, as well as its severity, depend upon the habitat being impacted as well as the type of land development being proposed. Generally speaking, the edge effect may extend up to 300 feet outward from a developed area. Within this zone, breeding productivity can be diminished and disturbances associated with the adjacent development can result in outright avoidance by nesting birds.

Based on the breeding bird inventory, a total of 17 GCN species likely breed at the site. 14 of these species are associated with forested habitat that will be directly affected by the proposed project. Impacts include direct habitat loss of approximately 72 acres of forest. Much of this forest is interior or "core" forest, which is part of an approximately 1,000-acre forest block. When considering edge affect and its impact on forest-interior species, an additional approximately 37 acres of interior forest will be converted to edge forest, as it will be located along the boundary of the new quarry limits.

6.0 WETLAND IMPACTS

6.1 Wetland Functions and Values

A total of 10 wetlands occur on the site. These wetlands are classified in Table 6. The functions and values attributed to these wetlands is summarized in Table 7. The evaluation methodology utilized was The Highway Methodology Workbook – Wetland Functions and Values: A Descriptive Approach developed by the U.S. Army Corp of Engineers ("the Highway Methodology" hereinafter). Detailed *Functions and Values Summary Forms* are provided in Appendix C.

The Highway Methodology recognizes the following 13 separate wetland functions and values: groundwater recharge/discharge, floodwater storage, fish and shellfish habitat, sediment/toxicant/pathogen retention, nutrient removal/retention/transformation, production export, sediment/shoreline stabilization, wetland wildlife habitat, recreational value, educational/scientific value, uniqueness, visual/aesthetic quality and threatened and endangered species habitat.

The degree to which a wetland provides each of these functions is determined by one or more of the following factors: landscape position, substrate, hydrology, vegetation, history of disturbance, and size. Each wetland may provide one or more of the listed functions at significant levels. The determining factors that affect the level of function provided by a wetland can often be broken into two categories. The *effectiveness* of a wetland to provide a specified function is generally dependent on factors within the wetland whereas the *opportunity* to provide a function is often influenced by the wetland's position in the landscape as well as adjacent land uses. For example, a depressed wetland with a restricted outlet may be considered highly effective in trapping sediment due to the long residence time of runoff water passing through the system. If this wetland is located in gently sloping woodland, however, there is no significant source of sediment in the runoff therefore the wetland is considered to have a small opportunity of providing this function.

Table 6: Wetland Characteristics Summary Table

Wetland	Cowardin Type	Drainage
1	PFO1C	Isolated
2	PSS1C	Isolated
3	PFO1C	Isolated
4	PFO1E	Headwater (drains offsite)
5	PFO1E	Headwater (drains offsite)
6	PFO1B	Isolated
7	PFO1B	Isolated
8	PFO1B	Isolated
9	PFO1B	Isolated
10	PFO1B	Isolated
Classification of Wetlands and Deepwater Habitats of the United States, Cowardin *et al.* 1979: PFO1 – palustrine forested, broad-leaved deciduous PSS1 – palustrine scrub-shrub, broad leaved deciduous Water Regime: A-temporarily flooded; B-saturated; C-seasonally flooded; E-seasonally flooded/saturated		

Table 7: Summary of Wetland Functions and Values

Wetland Functions and Values	Groundwater Recharge/Discharge	Sediment/Shoreline Stabilization	Floodflow Alteration	Fish & Shellfish Habitat	Sediment/Toxicant/ Pathogen Retention	Nutrient Removal/Attenuation	Production Export	Wildlife Habitat	Recreation	Educational/Scientific Value	Uniqueness/Heritage	Visual Quality/Aesthetics	Listed Species Habitat
Wetlands 1,2,3	U	N/A	S	N/A	S	S	P	P	U	P	P	S	P
Wetlands 4,5	P	S	P	U	S	S	P	P	S	S	S	S	U
Wetlands 6,7,8,9,10	U	N/A	S	N/A	S	S	S	U	U	S	S	S	U

<u>Suitability</u>
P = principal function
S = secondary function
U = function unlikely to be provided at a significant level
N/A = not applicable

Wetlands in Table 2 were grouped and evaluated based on similar vegetative, topographic, hydrologic and biologic characteristics. Group 1 (Wetlands 1, 2 and 3) are all isolated vernal pools supporting similar species including the State-listed Jefferson Salamander. Wetlands in Group 2 (Wetlands 4 and 5) are forested headwater wetlands which feed downstream perennial streams and wetlands, both of which contain an embedded vernal pool. Wetlands in Group 3 (Wetlands 6 through 10) are isolated forested wetlands that have a saturated hydrology (as opposed to flooded) and were not found to provide habitat for wetland-dependent wildlife. Vegetation in Group three wetlands is also similar; all have very sparse herbaceous and shrub cover.

The principal functions for Group 1 wetlands are wildlife habitat, production export, educational/scientific value, uniqueness and State-listed species habitat. The principal functions for Group 2 wetlands are wildlife habitat, groundwater discharge/recharge, floodflow alteration and production export. No principal functions for Group 3 wetlands were identified due to their marginally hydric hydrology, lack of standing water, low vegetation diversity/abundance and isolated nature.

6.2 Impact to Wetlands

Wetland impacts associated with a project of this type include:

- Loss of wetland area
- Changes in wetland hydrology due to:
    - a loss of contributing watershed
    - modification of groundwater flows

Based on the limits of the expanded quarry, a total of 4.70 acres of wetlands will be lost from the project, as these wetlands lie within the quarry limits. Wetlands that will be lost entirely include Wetlands 3, 6, 8 and 9.

The loss of Wetland 3 is significant due to the fact that it is a highly productive vernal pool that supports the State-listed Jefferson salamander. Loss of Wetlands 6, 8 and 9 is not considered significant, as these wetlands provide little functions and values, and their hydrology is too marginal to support wetland-dependent wildlife (i.e., these wetlands have no long-term soil saturation, no temporary flooding, no developed herbaceous and shrub vegetation).

Wetlands in which the quarry will result in a partial impact include Wetlands 4, 5 and 10. For Wetlands 5 and 10, the westernmost headwaters of the wetlands will remain. However, significant hydrologic impacts are anticipated due to the close proximity of the propose quarry limits. For Wetland 10 and 5, approximately 35 linear feet and 160 linear feet of wetland will remain westerly of the new quarry limits, respectively. By truncating these wetlands, groundwater will now have a downslope discharge point. This will act to steepen the hydrologic gradient and increase the groundwater flow velocity. These factors will likely result in a decrease in soil saturation time or "drying" of the wetland. The remaining portions of Wetland 5 to the east of the quarry will see significant reduction in flow to the immediate downstream portions of the wetland due to a 91% loss of the local drainage basin.

With respect to Wetland 4, the westernmost headwaters of the wetland including Vernal Pool 4, will be directly lost. Furthermore, a 44% reduction in the drainage basin will occur, which will negatively affect the downstream wetland hydrology.

Perhaps the most significant impacts to wetlands functions and values is the diminishment of wetland wildlife function through the loss of habitat for vernal pool species.

7.0 IMPACTS TO TRAILS

A trail system traverses the western side of the site as shown on Figure 5. This trail system includes the Metacomet Trail along with a spur trail known as the "Ledge Road Connector" that links the Metacomet Trail to Ledge Road in Plainville (source: CT Forest and Park Association, www.ctwoodlands.org). As proposed, the quarry expansion will directly affect approximately 200 linear feet of the blue trail along the southwest corner of the site. Additionally, it is anticipated that areas adjoining this impact zone would also need to be re-routed due to safety concerns.

8.0 PERMITTING REQUIREMENTS

We anticipate that the following U.S. Army Corps of Engineers (ACOE) and Connecticut Department of Energy and Environmental Protection (CTDEEP) permits will be required for the project:

- ACOE Individual Permit (IP): Work within wetlands and waters of the United States is subject to jurisdiction under Section 404 of the Clean Water Act, which is administered by the ACOE. Based upon our knowledge of the project, it would not be eligible for authorization under the Connecticut General Permit due to the total square footage of wetland and watercourse impacts (>1 acre) and impacts to Special Wetlands[8]. As a result, an ACOE IP would likely be required.

  Approval time for an ACOE IP is typically 12 – 18 months from the time of submittal, and includes a public hearing process. The ACOE typically prefers mitigation for project wetland impacts in the form of a compensation fee paid to the Audubon Connecticut In Lieu Fee Program in place of other forms of compensatory mitigation. The total fee varies depending on factors such as wetland cover type of the impacted wetlands (forested demands highest value), presence of vernal pool habitat and/or rare species, and regional location.

  The following additional agency consultations are required for submittal:

  - Natural Diversity Database and U.S. Fish & Wildlife Service consultations for rare species
  - State Historic Preservation Officer consultation for archaeological resources
  - Tribal Historic Preservation Office consultations for tribal resources

[8] Special Wetlands include vernal pools, bogs, fens, cedar swamps, spruce swamps, calcareous seepage swamps, and wetlands that provide habitat for threatened or endangered species or species of special concern as designated by the State of Connecticut Natural Diversity Database.

- CTDEEP Water Quality Certification (WQC): A Section 401 WQC is required for any applicant for a federal license or permit who seeks to conduct an activity that may result in any discharge into the navigable waters, including all wetlands, watercourses, and natural and man-made ponds. Section 401 WQC and ACOE Section 404 Individual Permits are typically issued concurrently and the required consultations are the same for each.
- CTDEEP General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities (Stormwater GP): The project will result in the disturbance of greater than one acre of land due to clearing, grading and/or excavation activities. As such, project activities would be subject to the Stormwater GP. This GP is administered by CTDEEP to provide coverage under the National Pollutant Discharge Elimination System (NPDES) Construction General Permit. Approval time for a Stormwater GP on project of this size is typically 90 days.
- CTDEEP Water Diversion Permit: A Water Diversion Permit is required to relocate, retain, detain, bypass, channelize, pipe, culvert, ditch, drain, redirect, fill, excavate, dredge, dam, impound, dike, or enlarge or diminish waters of the state. Further evaluation of the impacted area, and consultation with CTDEEP would be needed to determine whether this permit is required.

Locally the project would require an Inland Wetlands and Watercourses Permit from the Town of Plainville. This would require compliance with the Town's Inland Wetlands and Watercourses Regulations (adopted July 1, 1974) for work occurring within "regulated areas" which are defined as wetlands, watercourses and all lands within 100 feet of wetlands and watercourses. Given the amount of wetland disturbance proposed, it is anticipated that a project of this scale would receive significant scrutiny from the Inland Wetlands and Watercourses Commission. The commission would require demonstration by the applicant that no "feasible and prudent alternative" exists that would accomplish the project goals while reducing wetland impacts. Further complicating the matter would be the likely requirement that loss of wetlands be mitigated at the local level, irrespective of mitigation requirements of the ACOE. Presently in Connecticut, local permitting agencies have no mechanism for accepting fee in lieu payments as compensation for wetland impacts. Therefore, a wetland mitigation plan fully independent of the ACOE mitigation requirements would likely need to be developed.

Undeveloped parcels that lie adjacent to the project area, which are currently owned by Tilcon but are intended to be donated as open space, could be investigated as potential mitigation sites.

9.0 REFERENCES

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ATTACHMENTS

ATTACHMENT A

SITE PHOTOGRAPHS (taken September 2016 through September 2017)

- Photos 1-13: Habitats
- Photos 14-18: Selected Species
- Box Turtle Photo Log (Turtles 1-10)
- Photos 18-19: Historical Features


Photo 1: Vernal Pool 3


Photo 2: Vernal Pool 1


Photo 3: Vernal Pool 2 (shrub swamp portion)


Photo 4: Vernal Pool 2 (western forested area)


Photo 5: Wetland/Vernal Pool 2 (overview)


Photo 6: Bedrock/talus outcroppings

Photo 7: Sub-acidic rocky summit outcrop habitat

Photo 8: Hardwood forest with dense ericaceous shrub cover

Photo 9: Upland mixed hardwood forest

Photo 10: Meadow habitat within utility ROW

Photo 11: Wetland 4

Photo 12: Wetland 5

Photo 13: Wetland 9; note marginal wetland hydrology

Photo 14: Juvenile wood frog

Photo 15: Jefferson salamanders caught via minnow trapping

Photo 16: Marbled salamander under cover object

Photo 17: Marbled salamander larvae in early March

Photo 18: Spotted turtle in vernal pool in early March

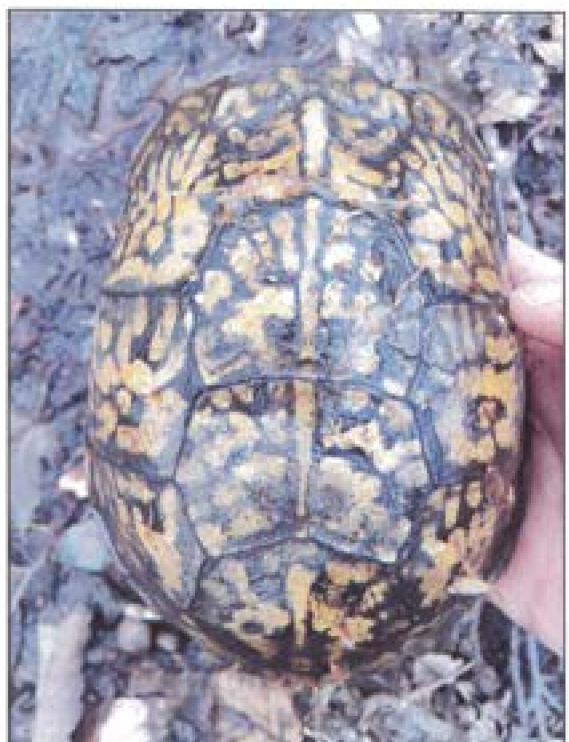
BOX TURTLE PHOTO LOG

8-19-16, male (also recaptured 6-27-17)

8-19-16, female

4-14-17, female

5-2-17, male



5-25-17, female

6-4-17, female

6-4-17, male

7-11-17 Male

8-

8-15-17, male

10-1-17 female

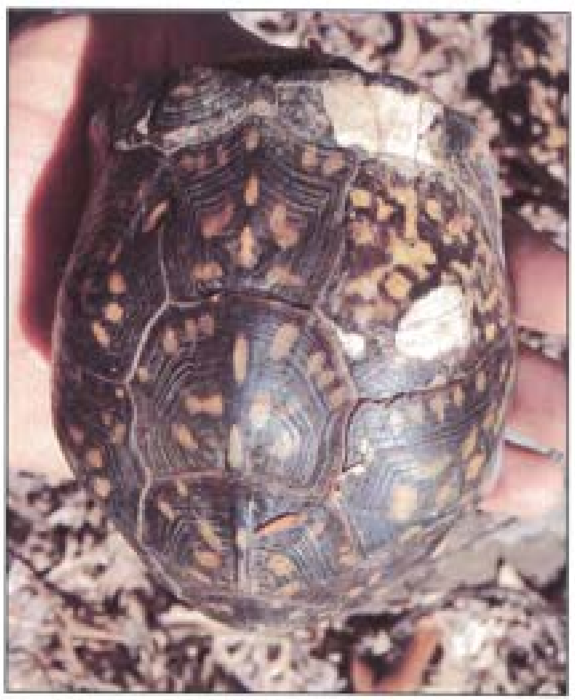


Photo 18: Stone-lined stream banks

Photo 19: Stone-lined shallow well

ATTACHMENT B

FLORAL SPECIES LIST

LEGEND: Floral Species List

IND=U.S. Fish and Wildlife Service Wetland Indicator Status (Connecticut):

Symbol	Category	Definition
OBL	Obligate Hydrophyte	Nearly always occurs in wetlands(>99%).
FACW	Facultative Wetland	Usually occurs in wetlands (>66-99%).
FAC	Facultative	Commonly occurs in both wetlands (>33-66%) and in uplands.
FACU	Facultative Upland	Usually occurs in upland, but may occasionally in wetland (>1-33%).
UPL	Obligate Upland	Occurs in wetlands in another region but occurs almost always in nonwetlands
NI	No Indicator	Insufficient information to determine an indicator status.

A positive (+) or a negative (-) symbol was used with the Facultative Indicator categories to more specifically define the regional frequency of occurrence in wetlands. The positive symbol indicates a frequency toward the higher end of the category (more frequently found in wetlands), and a negative symbol indicates a frequency toward the lower end of the category (less frequently found in wetlands).

HABITAT (Plant Community)

1- Black Oak- Chestnut Oak/Black Huckleberry Community
2- Northern Red- Oak Black Oak/ Blue Ridge Blueberry Community
3- Eastern Red Cedar/Poverty Oatgrass Community
4- Red Maple/Northern Spicebush Community
5- Red Maple/ Common Winterberry /Highbush Blueberry Community
6- Buttonbush Semi-permanently Flooded Shrubland

Note: Habitat designations indicate the community(ies) a particular species occupies on the project property, which may or may not reflect the typical condition for the species as a whole.

Scientific Plant Names (Plant Taxonomy) undergo periodic revisions. The National Plant Database (http://plants.USDA.gov/) was the authority used to determine the names in this list.

Invasive non-native species are derived from CT Invasive Plant List (produced by the Connecticut Invasive Plants Council) Connecticut Public Act No. 03-136

Floral Species List: New Britain Reservoir Study

New Britain, Connecticut

SCIENTIFIC NAME	COMMON NAME	IND	HABITAT	
STRATUM Trees				
Acer rubrum	Red Maple	FAC	2,4,5,6	
Acer saccharum	Sugar Maple		1,2	
Amelanchier arborea	Downy Serviceberry	FAC-	3	
Betula lenta	Black Birch	FACU	1,2,3	
Betula papyrifera	White or Paper Birch	FACU	3	
Carya ovata	Shagbark Hickory	FACU-	1,2	
Carya tomentosa	Mockernut Hickory		1,2	
Cornus florida	Flowering Dogwood	FACU-	3	
Fagus grandifolia	American Beech	FACU	1,2	
Juniperus virginiana	Eastern Red Cedar	FACU	1,2,3	
Liriodendron tulipifera	Tulip-tree	FACU	2	
Nyssa sylvatica	Black Tupelo	FAC	4,5,6	
Ostrya virginiana	Hop-hornbeam	FACU-	1,2	
Pinus rigida	Pitch Pine	FACU	3	
Pinus strobus	Eastern White Pine	FACU	1,2,3	
Quercus alba	White Oak	FACU-	1,2,3	
Quercus coccinea	Scarlet Oak		1,2,3	
Quercus prinus	Chestnut Oak		1,2,3	
Quercus rubra	Red Oak	FACU-	2	
Quercus stellata	Post Oak	FACU	3	
Quercus velutina	Black Oak		1,2,3	
Sassafras albidum	Sassafras	FACU-	2	
Tsuga canadensis	Eastern Hemlock	FACU	1,2,3	
Ulmus americana	American Elm	FACW-	2	

SCIENTIFIC NAME	COMMON NAME	IND	HABITAT	
STRATUM Shrubs				
Berberis thunbergii	Japanese Barberry	FACU	2	invasive
Cephalanthus occidentalis	Buttonbush	OBL	6	
Clethra alnifolia	Sweet Pepperbush	FAC+	4	
Comptonia peregrina	Sweet Fern		3	
Hamamelis virginiana	Witch Hazel	FAC-	2	
Juniperus communis	Common Juniper		3	
Juniperus sp. (cult.)	juniper		4	
Kalmia latifolia	Mountain Laurel	FACU	3	
Lindera benzoin	Spicebush	FACW-	4	
Quercus ilicifolia	Bear Oak		3	syn. Scrub Oak
Rosa multiflora	Multiflora Rose	FACU	2	invasive
Rubus allegheniensis	Allegheny Blackberry		2	
Rubus hispidus	Bristly Dewberry	FACW	2	
Rubus occidentalis	Black Raspberry		2	
Rubus phoenicolasius	Wineberry		2	potentially invasive
Vaccinium angustifolium	Lowbush Blueberry	FACU-	3	
Vaccinium corymbosum	Highbush Blueberry	FACW-	4,5,6	
Vaccinium pallidum	Blue Ridge Blueberry		1,2,3	syn. Early Lowbush Blueberry
Viburnum acerifolium	Maple-leaved Viburnum		1,2,3	
Viburnum dentatum var. lucid	Southern Arrowwood	FACW-	2,5	syn. Viburnum recognitum
STRATUM Vines				
Celastrus orbiculatus	Asiatic Bittersweet		2	invasive
Parthenocissus quinquefolia	Virginia Creeper	FACU	1,2,3	
Smilax rotundifolia	Common Greenbrier	FAC	2	
Toxicodendron radicans	Poison Ivy	FAC	1,2,3	
Vitis labrusca	Fox Grape	FACU	2	
STRATUM Herbs				
Adiantum pedatum	Maidenhair Fern	FAC-	2,4	

SCIENTIFIC NAME	COMMON NAME	IND	HABITAT	
Agalinis tenuifolia	Slender False-Foxglove	FAC	3	
Anemone quinquefolia	Wood Anemone	FACU	2	
Anemonella thalictroides	Rue Anemone		2	
Antennaria plantaginifolia	Woman's Tobacco		3	sy. Plantain-leaved Pussytoes
Apocynum androsaemifolium	Spreading Dogbane		3	
Apocynum cannabinum	Indian Hemp	FACU	3	
Aquilegia canadensis	Red Columbine		3	
Arabis laevigata	Smooth Rock Cress		1,3	
Arisaema triphyllum	Swp Jack-in-the-Pulpit	FACW-	2,4	
Aristida dichotoma	Churchmouse Threeawn		3	
Artemisia vulgaris	Common Mugwort		3	invasive
Asclepias syriaca	Common Milkweed		3	
Asplenium platyneuron	Ebony Spleenwort	FACU	2,3	
Athyrium filix-femina	Subarctic Lady-fern	FAC	4	
Baptisia tinctoria	False Indigo		2	
Brachyelytrum erectum	Short Husk Grass		1,2	
Carex crinita	Fringed Sedge	OBL	4	
Carex gracillima	Graceful Sedge	FACU+	2	
Carex hirsutella	Fuzzy Wuzzy Sedge		2	
Carex intumescens	Bladder Sedge	FACW+	2,4	
Carex laxiculmis	Spreading Sedge		2	
Carex laxiflora	Loose-flowered Sedge	FACU+	2	
Carex lurida	Shallow Sedge	OBL	4	
Carex pensylvanica	Pennsylvania Sedge		1,2,3	
Carex retroflexa	Reflexed Sedge	FACU	2	
Carex squarrosa	Squarrose Sedge	FACW	4	
Carex stricta	Tussock Sedge	OBL	4	
Carex swanii	Swan's Sedge	FACU	1,2,3	
Carex virescens	Ribbed Sedge		1,2	
Carex vulpinoidea	Fox Sedge	OBL	2	

SCIENTIFIC NAME	COMMON NAME	IND	HABITAT	
Centaurea stoebe	Spotted Knapweed		3	ssp. micranthos, invasive
Chimaphila maculata	Striped Wintergreen		1,2,3	
Cinna arundinacea	Stout Wood-Reedgrass	FACW+	2,4	
Circaea lutetiana	Enchanter's Nightshade		2	syn.Circaea quadrisulcata
Cirsium vulgare	Bull Thistle	FACU-	3	
Cladonia sp.	reindeer moss		3	lichen
Comandra umbellata	Bastard Toadflax	FACU-	3	
Conyza canadensis	Horseweed		3	
Coronilla varia	Crownvetch		3	introduced
Corydalis sempervirens	Rock Harlequin		1,3	
Danthonia spicata	Poverty-grass	FACU	1,2,3	syn. Poverty Oat Grass
Daucus carota	Queen Annes's Lace		3	
Dennstaedtia punctilobula	Hay-scented Fern		1,2	
Dianthus armeria	Deptford Pink		3	
Dicanthelium clandestinum	Deer-tongue Grass		3	syn. Panicum clandestinum
Dicanthelium latifolium	Broadleaf Rosette Grass		2	syn. Panicum latifolium
Dichantelium depaueratum	Starved Rosette Paniegrass		2,3	
Dichanthelium acuminatum	Western Paniegrass		3	syn. Panicum lanuginosum
Digitaria sp.	crab grass		3	
Dryopteris marginalis	Marginal Wood-fern	FACU-	1,2,3	
Echium vulgare	Common Viper's Bugloss		3	introduced
Elschotzia ciliata	Crested Late Summer Mint		3	introduced
Elymus hystrix	Eastern Bottlebrush Grass		3	
Erechtites hieracifolia	Fireweed or Pilewort	FACU	1,2,3	
Erythronium americanum	Dog-tooth Violet		2	
Eurybia divaricata	White Wood Aster		1,2,3	syn. Aster divaricatus
Festuca ovina	Fine Fescue		3	
Galium palustre	Marsh Bedstraw	OBL	4	
Gaylussacia baccata	Black Huckleberry	FACU	1,2,3	
Geranium maculatum	Spotted Cranesbill	FACU	2	

SCIENTIFIC NAME	COMMON NAME	IND	HABITAT	
Geranium robertianum	Herb Robert		2,3	
Hackelia virginiana	Virginia Stickseed	FACU	3	
Hedeoma pulegioides	American Pennyroyal		3	
Hepatica americana	Round-lobed Hepatica		1	
Hieracium venosum	Rattlesnakeweed		1,3	
Huperzia appressa	Fir Clubmoss		3	Special Concern Species
Hypericum canadense	Canadian St. John's Wort	FACW	2	
Hypericum gentianoides	Pineweed		3	
Hypericum perforatum	Common St. John's Wort		3	
Hypoxis hirsuta	Yellow Star-grass	FAC	1,2	
Ionactis linariifolius	Flaxleaf Whitetop Aster		3	syn. Stiff Aster
Juncus effusus	Soft Rush	FACW+	4	
Juncus tenuis	Path Rush	FAC-	2	
Krigia virginica	Dwarf Dandelion		2,3	
Lactuca scariola	Prickly Lettuce		3	
Lapsana communis	Nipplewort		3	
Lechea intermedia	Largepod Pinweed		3	
Lespedeza capitata	Round-headed Bush-clover	FACU-	3	
Lespedeza intermedia	Wand Bush-clover		3	
Lespedeza procumbens	Trailing Bushclover		2	
Linaria canadensis	Blue Toadflax		3	
Linaria vulgaris	Butter-and-eggs		3	
Linum virginianum	Virginia Yellow Flax		2	
Lobelia inflata	Indian Tobacco	FACU	2,3	
Luzula multiflora	Common Woodrush	FACU	2	
Lysimachia quadrifolia	Whorled Loosestrife	FACU	2	
Maianthemum canadense	Canada Mayflower	FAC-	1,2,3,4	
Maianthemum racemosum	False Solomon's Seal	FACU-	2	ssp. Racemosum
Melampyrum lineare	Cow-wheat	FACU	3	
Melilotus alba	White Sweet Clover	FACU-	3	

SCIENTIFIC NAME	COMMON NAME	IND	HABITAT	
Microstegium vimineum	Japanese Stiltgrass		2,3,4	invasive
Mitchella repens	Partridgeberry	FACU	1,2	
Montropa hypopithys	Pinesap		3	
Muhlenbergia schreberi	Nimble-will	FAC	2	
Onoclea sensibilis	Sensitive Fern	FACW	4,5,6	
Osmunda cinnamomea	Cinnamon Fern	FACW	4,5,6	
Osmunda claytoniana	Interrupted Fern	FAC	2	
Osmunda regalis	Royal Fern	OBL	4,5,6	
Oxalis stricta	Common Yellow Oxalis		3	syn. Oxalis europaea
Panicum capillare	Witch-grass	FAC-	3	
Phalaris arundinacea	Reed Canary Grass	FACW+	4	invasive
Phegopteris hexagonoptera	Broad Beech Fern	FAC	2	
Phragmites australis	Common Reed	FACW	2,4	invasive
Poa compressa	Canada Bluegrass	FACU	3	invasive
Poa pratensis	Kentucky Blue Grass	FACU	2	
Polygala verticillata	Whorled Milkkwort		3	
Polygonatum pubescens	Hairy Solomon's Seal		1,2,3	
Polygonella articulata	Coastal Jointweed		3	
Polygonum aviculare	Creeping Knotweed		3	cosmopolitan weed
Polygonum pensylvanicum	Pennsylvania Smartweed	FACW	2	
Polygonum scandens	Hedge Cornbind	FAC	3	
Polypodium virginianum	Common Polypody		1,3	
Polystichum acrostichoides	Christmas Fern	FACU-	1,2,3	
Polytrichum commune	Haircap Moss		1,3	
Potentilla canadensis	Dwarf Cinquefoil		2	
Pycnanthemum tenuifolium	Narrow-lvd Mtn-mint	FACW	3	
Rumex acetosella	Field Sorrel		3	potentially invasive
Saxifraga virginiensis	Virginia Saxifrage	FAC-	1,3	syn.Micranthes virginiensis
Schizachyrium scoparium	Little Bluestem		3	
Scirpus hattorianus	Mosquito Bulrush	NI	2	

SCIENTIFIC NAME	COMMON NAME	IND	HABITAT	
Setaria faberii	Giant Foxtail		3	
Setaria sp.	millet-grass		3	
Sisyrinchium montanum	Strict Blue-eyed Grass	FAC	2	
Solanum dulcamara	European Bittersweet	FAC-	2	potentially invasive
Solanum nigrum	Black Nightshade	FACU-	2	
Solidago bicolor	Silverrod		3	
Solidago caesia	Wreath Goldenrod	FACU	2,3	syn. Blue-stemmed Goldenrod
Solidago nemoralis	Gray Goldenrod		3	
Specularia perfoliata	Venus's Looking-glass		2	
Sphagnum sp.	peat moss		4	
Symphyotrichum racemosum	White Old Field Aster	FAC	3	syn. Aster vimineus
Symplocarpus foetidus	Skunk Cabbage	OBL	4,5,6	
Taraxacum officinale	Common Dandelion	FACU-	3	
Thelypteris noveboracensis	New York Fern	FAC	2,4	
Trifolium arvense	Rabbit-foot Clover		3	
Veronica officinalis	Common Speedwell	FACU-	2	
Viola fimbriatula	Ovate-leaved Violet		1,3	
Viola palmata	Early Blue Violet		2	
Viola pubescens var. pubescen	Downy Yellow Violet	FACU	2	syn. Viola pensylvanica

ATTACHMENT C

WETLAND FUNCTIONS AND VALUES SUMMARY FORMS

DEFINITIONS OF WETLAND FUNCTIONS AND VALUES

The Highway Methodology Workbook Supplement, Wetland Functions and Values: A Descriptive Approach **issued by the US Army Corps of Engineers New England District (ACOE NED)**

(1) Groundwater Recharge/Discharge – This function considers the potential for a wetland to serve as a groundwater recharge and/or discharge area. It refers to the fundamental interaction between wetlands and aquifers (not necessarily public water supply aquifers), regardless of the size or importance of either.

(2) Floodwater Storage – This function considers the effectiveness of the wetland in reducing flood damage by water retention for long periods following precipitation events and the gradual release of floodwaters. It adds to the stability of the wetland ecological system or its buffering characteristics and provides social or economic value relative to erosion and/or flood prone areas.

(3) Fish and Shellfish Habitat – This function considers the effectiveness of seasonal or permanent watercourses associated with the wetland in question for fish habitat.

(4) Sediment/Toxicant/Pathogen Retention – This function reduces or prevents degradation of downstream water quality. It relates to the effectiveness of the wetland as a trap for sediments, toxicants or pathogens in runoff from surrounding uplands, or eroding upstream wetlands and/or watercourses.

(5) Nutrient Removal/Retention/Transformation – This function considers the effectiveness of the wetland as a trap for nutrients in runoff water from surrounding uplands or contiguous wetlands, and the ability of the wetland to process these nutrients into other forms or trophic levels. One aspect of this function is to prevent ill effects of nutrients entering aquifers or surface waters such as ponds, lakes, streams, rivers or estuaries.

(6) Production Export-- This function relates to the effectiveness of the wetland to produce food or usable products for humans, or other living organisms.

(7) Sediment/Shoreline Stabilization-- This function relates to the effectiveness of a wetland to stabilize stream banks and shorelines against erosion.

(8) Wetland Wildlife Habitat – This function considers the effectiveness of the wetland to provide habitat for various types and populations of animals typically associated with wetlands and the wetland edge. Both resident and/or migrating species must be considered.

(9) Recreational Value – This value considers the suitability of the wetland and associated watercourses to provide recreational opportunities such as hiking, canoeing, boating, fishing, hunting and other active or passive recreational activities.

(10) Educational/Scientific Value – This value considers the suitability of the wetland as a site for an "outdoor classroom" or as a location for scientific study or research.

(11) Uniqueness – This value considers the effectiveness of the wetland or its associated water body to provide certain special values. These may include archeological sites, critical habitat for endangered species, its overall health and appearance, its role in the ecological system of the area, its relative importance as a typical wetland class for this geographic location.

(12) Visual Quality/Aesthetics-- This value relates to the visual and aesthetic qualities of the wetland.

(13) Threatened or Endangered Species Habitat-- This value relates to the effectiveness of the wetland or associated water bodies to support threatened or endangered species.

Wetland Function-Value Evaluation Summary

Total area of wetland Ca. 1.5 ac. Human Made? No Is wetland part of a wildlife corridor? Yes or a "habitat island"? ____

Adjacent land use Forested/Traprock Quarry Distance to nearest roadway or other development Approx. 3,000ft

Dominant wetland systems present PFO1C (PSS1C dom Wetland 2) Contiguous undeveloped buffer zone present Yes

Is the wetland a separate hydraulic system? Yes If not, where does the wetland lie in the drainage basin? ____

How many Tributaries contribute to the wetland? None Wildlife & vegetation diversity/abundance (see wetland description)

Wetland ID Wetlands 1, 2, 3

Latitude ____ Longitude ____

Prepared by Eric Davison Date 11/8/17

Proposed wetland activities

Type: Quarry

Corps manual wetland delineation

Completed? Y ____ N X

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)	Principal Function(s)/Values(s)	Comments
Fish and Shellfish Habitat (freshwater)		N			
Wildlife Habitat	Y		1,2,3,4,5,7,8,9,10,11,13,14, 15,16,17,18,19,20,22	Y	These wetlands are productive vernal pools that supports the State-listed Jefferson Salamander and Spotted Turtle
Production Export	Y		1,2,4,5,7,8	Y	These are vernal pools with high biomass of amphibians and insects
Floodflow Alteration	Y		5,6,7,8,9,18		Major limiting factor is that these wetlands are small and isolated
Groundwater Recharge/Discharge	Y		6		Groundwater study by LBG indicates little groundwater component – wetlands are primarily runoff driven hydrology (i.e., perched wetlands)
Sediment/Toxicant/Pathogen Retention	Y		3,4,5,8,9		No potential sources present; organic soils and dense/structurally diverse vegetation are capable of retention; limiting factor is the wetlands isolation
Nutrient Removal/Retention/Transformation	Y		2,3,5,6,7,8,9,10,11		Limiting factors include lack of current source and wetlands isolation
Sediment/Shoreline Stabilization	n/a				No association with intermittent or perennial streams
Recreation	N		5,12		The wetland offers no recreational uses
Educational/Scientific Value	Y		1,2,4,5,13,14	Y	These are productive vernal pools that could be used for educational purposes
Uniqueness/Heritage	Y		5,10,13,16,17,19,27,28	Y	Traprock ridge vernal pools that support Jefferson Salamander are considered unique in CT
Visual Quality/Aesthetics	Y		2,3,5,6,7,8,11,12		Open water vernal pools are visible from adjacent uplands
State-listed Species Habitat	Y			Y	These wetlands support two special-concern species, the Jefferson Salamander and Spotted Turtle

Wetland Function-Value Evaluation Summary

Total area of wetland Ca. 6 ac. (onsite) Human Made? No Is wetland part of a wildlife corridor? Yes or a "habitat Island"? ____

Adjacent land use Forested/Traprock Quarry Distance to nearest roadway or other development Approx. 2,000ft

Dominant wetland systems present PFO1E Contiguous undeveloped buffer zone present Yes

Is the wetland a separate hydraulic system? No If not, where does the wetland lie in the drainage basin? Upper

How many Tributaries contribute to the wetland? None (headwater) Wildlife & vegetation diversity/abundance (see wetland description)

Wetland ID Wetlands 4 & 5

Latitude ____ Longitude ____

Prepared by Eric Davison Date 11/8/17

Proposed wetland activities

Type: Quarry

Corps manual wetland delineation

Completed? Y ____ N X

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)	Principal Function(s)/Values(s)	Comments
Fish and Shellfish Habitat (freshwater)		N			
Wildlife Habitat	Y		1,2,3,4,5,7,8,9,10,11,13,14,15,16,17,18,19,20,22	Y	These wetlands are productive vernal pools that supports the State-listed Jefferson Salamander and Spotted Turtle
Production Export	Y		1,2,4,5,7,8	Y	These wetlands contain embedded vernal pools with high biomass of amphibians and insects
Floodflow Alteration	Y		2,3,5,6,7,8,9,11,13,15	Y	These are headwater wetlands capable of temporary storage of surface runoff
Groundwater Recharge/Discharge	Y		7,10,13,14	Y	Groundwater slope wetlands with discharge present, particularly in eastern portions of the wetland
Sediment/Toxicant/Pathogen Retention	Y		3,4,5,6,7,8,9,10,12,13,14		No sources currently present, limited impoundment/storage capacity due to sloping topography
Nutrient Removal/Retention/Transformation	Y		3,5,6,7,10,11,12,13,14		No sources currently present
Sediment/Shoreline Stabilization	Y		2,7,14		
Recreation		N	5,6,7		No significant recreational uses present
Educational/Scientific Value	Y		2,4,5,13,14		Vernal pool present which could be used for scientific study
Uniqueness/Heritage		N	5,10,16,17,18,19		Wetland not considered locally or regionally unique
Visual Quality/Aesthetics	Y		5,7,8,11,12		Most of the wetland looks visibly like the surrounding uplands
Threatened or Endangered Species Habitat		N			No state or federal-listed species found within these wetlands

Wetland Function-Value Evaluation Summary

Total area of wetland Ca. 6 ac. (onsite) Human Made? No Is wetland part of a wildlife corridor? Yes or a "habitat Island"? ____

Adjacent land use Forested/Traprock Quarry Distance to nearest roadway or other development Approx. 2,000ft

Dominant wetland systems present PFO1B Contiguous undeveloped buffer zone present Yes

Is the wetland a separate hydraulic system? Yes If not, where does the wetland lie in the drainage basin? N/A

How many Tributaries contribute to the wetland? None Wildlife & vegetation diversity/abundance (see wetland description)

Wetland ID Wetlands 6 through 10

Latitude ____ Longitude ____

Prepared by Eric Davison Date 11/8/17

Proposed wetland activities

Type: Quarry

Corps manual wetland delineation

Completed? Y ____ N X

Function/Value	Suitability Y	Suitability N	Rationale (Reference #)	Principal Function(s)/Values(s)	Comments
Fish and Shellfish Habitat (freshwater)		N			
Wildlife Habitat		N	1,3,4,5,7		No wetland-dependent wildlife habitat present due to hydrology
Production Export	Y				Marginally suitable; low density/diversity of vegetation; no wetland dependent wildlife habitat (e.g., no vernal pools)
Floodflow Alteration	Y		3,9		Marginally suitable; isolated wetlands with little volume storage capacity due to lack of significant depressional topography
Groundwater Recharge/Discharge		N			Perched wetlands fed by surface runoff and rainfall
Sediment/Toxicant/Pathogen Retention		N	8,9		No depressional topography, little herb and shrub cover, wetlands are isolated
Nutrient Removal/Retention/Transformation		N			No depressional topography, little herb and shrub cover, wetlands are isolated
Sediment/Shoreline Stabilization		N			These wetlands are isolated
Recreation		N	7		Not suitable for recreational activities
Educational/Scientific Value	Y		2,4,13,14		Of marginal interest from an educational/scientific perspective
Uniqueness/Heritage		N	10,16,17		Wetlands are not locally or regionally unique
Visual Quality/Aesthetics		N	5,7,10,11,12		Much of these wetland areas look visibly similar to the surrounding uplands
Threatened or Endangered Species Habitat		N			No listed species habitat present

Water Quality and Treatment Review for Proposed Quarry Reservoir

(Tighe & Bond)

Water Quality and Treatment Review for Proposed Quarry Reservoir on New Britain-Owned Watershed Land

TO: Jim Ericson, Lenard Engineering

FROM: John McClellan, Tighe and Bond
Peter Galant, Tighe and Bond
Heather Doolittle, Tighe & Bond

DATE: December 14, 2017

Background

This memorandum presents the results of our review of potential drinking water quality and treatment impacts of the proposed development of a reservoir on City of New Britain Class I and II water company-owned land by Tilcon Connecticut, Inc. (Tilcon). The proposed development would create a surface water reservoir through excavation over the course of a 40-year lease. The reservoir would ultimately be used for storage by the New Britain Water Department. Under the proposed 40-year lease, Tilcon would expand its existing crushed stone mining and related quarry operations onto a portion of the adjacent, currently undeveloped, wooded 131-acre parcel. Two large areas on the New Britain parcel would not be disturbed: approximately 40 acres along the western boundary of the site and 7.4 acres in the southeast corner of the parcel which contains a natural gas pipeline. The stone from the remaining area would be mined over the course of the 40-year lease, resulting in a 2.3-billion-gallon reservoir for future use by NBWD. The new reservoir would be supplied by stormwater runoff from the quarry, and flood-skimming from Copper Mine Brook.

The objective of this study is to characterize the water quality in the proposed reservoir and identify any characteristics that would negatively impact the existing New Britain Water Department treatment process or compromise its ability to provide high-quality water to its customers. As part of this evaluation, Tighe & Bond reviewed water quality from existing reservoirs, quarry surface water, and Copper Mine Brook, as well as the New Britain water treatment process and effluent water quality. A water sample was collected by Tighe & Bond from a small surface water body at the site containing stormwater runoff from the quarry. This sample is assumed to be representative of surface water present in new reservoir prior to dilution by Copper Mine Brook flood-skimmed water.

The proposed development is in Plainville, CT, upstream of the Shuttle Meadow and Wasel Reservoirs. The New Britain Shuttle Meadow Water Treatment Plant (WTP) would treat the water from the proposed reservoir. The WTP currently withdraws water from the Shuttle Meadow and Wasel reservoirs to supply 9 MGD on average to the City of New Britain.

The WTP was constructed in 2004. Treatment operations include ozonation for primary disinfection; coagulation with polyaluminum chloride (PACl); 3-stage flocculation; sedimentation in a plate settling basin; filtration through GAC and sand media; chlorination with sodium hypochlorite; pH and alkalinity adjustment with calcium carbonate (for corrosion control); and fluoridation. Powdered activated carbon (PAC), and carbon dioxide feed systems are also available if needed. This a full, modern, treatment process designed to treat water from multiple sources and capable of removing a wide range of contaminants and handling variations in water quality.

Water Quality Review

The data reviewed includes:

- Existing source water quality
- Relative source contribution
- Copper Mine Brook water quality
- Existing quarry surface water quality
- WTP effluent water quality

The WTP primarily withdraws water from the Shuttle Meadow and Wasel Reservoirs, with the Whigville Reservoir used as a supplemental source when necessary. Table 1 shows average contribution by source from January 2011 to November 2015. Figure 1 shows average monthly treatment plant withdrawal by source.

TABLE 1

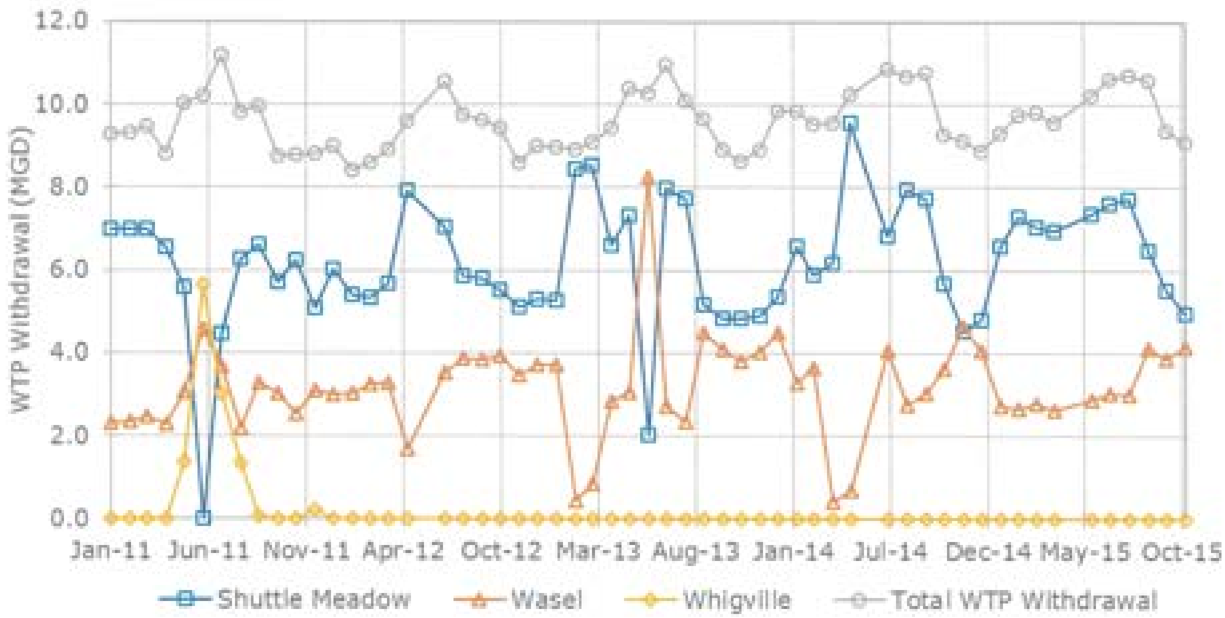
Relative Raw Water Contribution by Source

	Average WTP Withdrawal (MGD)[1]	Percent of Total
Shuttle Meadow Reservoir	6.152	65%
Wasel Reservoir	3.189	33%
Whigville Reservoir	0.209	2%
Total	9.550	

1. Data from Jan 2011-Nov 2015

FIGURE 1

Average Monthly Treatment Plant Withdrawal by Source



Water quality of the existing reservoirs is summarized in Table 2. Table 2 also includes water quality from the White Bridge Pump Station, which pumps water from Copper Mine Brook. The proposed new reservoir will contain flood-skimmed water from Copper Mine Brook. Water quality in the brook is expected to be representative of water flowing into the proposed reservoir.

TABLE 2

2016 Minimum, Maximum, and Average Source Water Quality from Monthly Monitoring Data

		Shuttle Meadow Reservoir	**Wasel Reservoir**	**Whigville Reservoir**	**White Bridge Pump Station (Copper Mine Brook)**
pH	Min	7.3	7.3	6.7	6.8
	Max	8.5	7.7	7.5	7.5
	Avg	7.5	7.6	7.1	7.1
Alkalinity (mg/L)	Min	16	22	6	17
	Max	23	33	13	37
	Avg	19	27	9	23
Hardness (mg/L)	Min	32	38	12	32
	Max	42	48	40	66
	Avg	39	43	23	50
Iron (mg/L)	Min	0.04	0.02	0.01	0.07
	Max	0.18	0.11	1.41	0.32
	Avg	0.09	0.05	0.26	0.17
Manganese (mg/L)	Min	0.022	0.019	0.017	0.030
	Max	0.166	0.218	0.071	0.246
	Avg	0.067	0.057	0.034	0.068
Turbidity (NTU)	Min	0.93	0.91	0.82	0.43
	Max	4.16	4.21	1.89	4.10
	Avg	2.12	1.76	1.09	1.65
Color	Min	5	13	15	3
	Max	33	45	30	55
	Avg	22	23	23	29

Copper Mine Brook water quality (from White Bridge Pump Station) is comparable to the existing reservoirs. However, Copper Mine Brook water will only be discharged to the new reservoir when water level in the brook is above DEEP minimum streamflow requirements. High streamflows, and especially flood water, is typically more turbulent than normal flow, carrying greater total suspended solids (TSS). High TSS can impact treatment, and may result in more frequent filter backwashing and increased residual solids production. High TSS may not be a treatment issue if the residence time in the new reservoir is long enough for settling to occur. In any case, it is unlikely that high raw water TSS would impact finished water quality.

The second major source of water for the new reservoir is runoff from the surrounding land. Surface water at the quarry was sampled in 2011, as part of an NPDES permit application, and again on May 23, 2017 by Tighe & Bond, as part of this study. The surface water bodies sampled are supplied primarily by stormwater runoff at the site and have been evaluated as representative of the future reservoir. Water quality results from the quarry samples are presented in Table 3.

TABLE 3

Lab Analysis of Representative Quarry Surface Water

Analyte	2011 Result	2017 Result
Chemical Oxygen Demand	14 mg/L	NA
Total Organic Carbon	NA	0.79 mg/L
Alkalinity	NA	82 mg/L
Total Suspended Solids	12 mg/L	14 mg/L
Total Phosphorus	<0.10 mg/L	NA
Nitrate	0.54 mg/L	4.2 mg/L
Total Kjeldahl Nitrogen	<1.0 mg/L	0.22 mg/L
pH	7.9 s.u.	8.1 s.u.
Total Copper	<0.04 mg/L	NA
Total Lead	<0.013 mg/L	<0.001 mg/L
Total Zinc	<0.02 mg/L	NA
Total Chromium	<0.01 mg/L	<0.004 mg/L
Surfactants	<0.05 mg/L	NA
Total Aluminum	<0.10 mg/L	0.86 mg/L
Total Boron	0.694 mg/L	0.310 mg/L
Total Molybdenum	<0.05 mg/L	0.0035 mg/L
Total Sulfur	33.4 mg/L	7.4 mg/L
Total Tungsten	NA	<0.002 mg/L
Perchlorate	0.13 μg/L	<4.0 μg/L
Volatile Organics (EPA Method 3501C)	ND on all Reported Analytes	1.45 μg/L 1,2,4-trichlorobenzene; ND on all other reported analytes
Semivolatile Organics (EPA Method 8270D)	NA	ND on all Reported Analytes
Nitroaromatics and Nitroamines (EPA Method 8330B)	NA	ND on all Reported Analytes

(1) NA: Not Analyzed; ND: Below the method detectable limit

(2) For complete laboratory results and methods, refer to the Appendix.

The representative quarry samples taken in both 2011 and 2017 showed concentrations below the detection limits for most constituents measured. The following were detected:

- Organic Content: Chemical Oxygen Demand was measured at 14 mg/L in 2011. This is a parameter reflecting the total amount of oxidizable organic matter present. This parameter is not normally used in drinking water process control and there is no regulatory limit, but based on a published correlation with total organic carbon (TOC)[1], this COD value corresponds to a TOC of approximately 2.3 mg/L. TOC in the 2017 sample was 0.79 mg/L. Both measures of organic content are in the typical range for a natural surface water and are not considered a concern from a treatment standpoint.

- Perchlorate was measured at 0.13 µg/L in 2011 and below the method detectable limit of 4.0 µg/L in 2017. Perchlorate is used in blasting operations at the quarry, and has been shown to have adverse health effects. The EPA has not established a maximum contaminant level (MCL) for perchlorate in drinking water. However, in 2011 it was determined to meet the criteria for regulation as a contaminant under the Safe Drinking Water Act and the EPA is in the process of developing a national regulation. Several states have already adopted drinking water standards for perchlorate, including MCLs in Massachusetts and California at 2 µg/L and 6 µg/L, respectively. Connecticut does not currently regulate perchlorate in drinking water, and the concentration in the 2011 quarry sample is well below the other state MCLs. While both samples were analyzed using EPA methods for perchlorate in drinking water, the analytical method used in 2011 had a lower detectable limit than the analytical method used in 2017 (0.05 µg/L vs. 4.0 µg/L). The presence of perchlorate should continue to be monitored, but is not anticipated to be present in concentrations high enough to be a concern.

- Total sulfur in the quarry water was measured at a concentration of 33.4 mg/L in 2011 and 7.4 mg/L in 2017. In the list of analytes detected, provided by Tilcon as part of the 2011 NPDES permit application, it was indicated that there was no known presence of sulfate, sulfide, or sulfite. This statement appears to be inconsistent with the reported total sulfur concentration value, as the expected predominant form in a surface water exposed to the atmosphere is sulfate. In any case, the concentration would be well below the Secondary Maximum Contaminant Level for sulfate of 250 mg/L, so this contaminant is not considered to be a concern.

- Boron was identified at 0.694 mg/L in 2011 and at 0.310 mg/L in 2017. Boron is typically found in groundwater from bedrock weathering. Boron measured in the quarry water is likely due to bedrock exposure. There is no EPA regulatory limit for boron, but EPA has established a lifetime Health Advisory level of 5 mg/L. This is a guideline below which adverse health effects are not expected from long-term exposure. Since the measured concentration is well below the Health Advisory concentration, boron is not expected to be an issue.

- The 2017 sample detected 1,2,4-trichlorobenzene at 1.45 µg/L. This compound was below the method detectable limit in the 2011 sample. 1,2,4-trichlorobenzene is a volatile organic compound found in dielectric compounds and heat-transfer mediums. The EPA has set an MCL of 0.07 mg/L (70 µg/L) for 1,2,4-trichlorobenzene in drinking water, and recommended treatment for this compound is filtration through GAC. Since the concentration of 1,2,4-trichlorobenzene is well below the MCL, and the treatment plant operates GAC filters, this compound is not anticipated to present an issue. However, VOCs should continue to be monitored in the future.

The 2017 water sample was analyzed for nitroaromatics and nitroamines, chemicals specifically associated with blasting practices. A complete list of chemicals analyzed for is included in the Appendix. No nitroaromatics or nitroamines were measured above the method detectable limit (EPA Method 8330B).

The proposed reservoir will hold 2.3 billion gallons and will have depth of over 100 feet when full. We reviewed physical parameters and water budgets for three other New England reservoirs[2,3] for comparison and note that the proposed reservoir will be significantly deeper than typical. As a result, we expect that the proposed reservoir will be susceptible to stratification, which may result in variations in water quality at different depths. One potential water quality impact would be low dissolved oxygen in the deep strata, which could result in mobilization of metals such as iron and manganese from the sediments. Although these constituents are treatable with the existing treatment process, if present in sufficient concentration they could increase the effort and cost of treatment. Therefore, a multi-level inlet structure for withdrawing water from the reservoir is recommended to control the quality of water being drawn, and to allow for usage during both high and low reservoir levels.

The average water retention time in the three comparison reservoirs ranges from approximately 8 months to approximately 5 years. An average daily withdrawal and/or release of approximately 1 MG would be required to keep the retention time in the proposed reservoir within this range, although we have no reason to believe that longer retention time would necessarily be detrimental from a water quality standpoint. Since there is no natural outlet, an outlet structure should be constructed with the ability to perform routine releases from the reservoir, either to the treatment plant or Shuttle Meadow Reservoir. Controlled releases from a reservoir can be an effective management strategy from both a storage and water quality standpoint by providing greater control of hydraulic residence time and stratification in the reservoir.

Plant effluent target pH is 9.5 for corrosion control treatment (Figure 2). The data reviewed in this evaluation did not indicate any significant changes to raw water quality that would impact the existing treatment process. However, when the new source is added, NBWD should closely monitor pH, chlorine residual, and any changes in treatment process performance for unforeseen changes.

FIGURE 2

2015 Treatment Plant Effluent pH

Summary-Potential Impacts and Treatment Considerations

The water quality data reviewed in this evaluation did not identify any significant differences between the existing reservoirs and samples assumed to be representative of the proposed reservoir. Modifications to the Shuttle Meadow WTP facilities or operations are therefore not anticipated to be needed to treat water from the proposed reservoir. However, water quality at the quarry should continue to be monitored, particularly for pH, metals, alkalinity, hardness, perchlorate, boron, sulfur, and VOCs. The reservoir should be equipped with a multi-level inlet structure and a release structure capable of both routine and emergency releases. Special attention should be payed to treatment process performance and influent and effluent water quality when the proposed source is being utilized to identify any unforeseen changes that could negatively impact plant operation and effluent water quality. Blending water from the proposed reservoir with existing sources will help to minimize the risk of treatment issues and is recommended.

Reference:

1. Dubber, D. and Gray, N. F. Replacement of chemical oxidant demand (COD) with total organic carbon (TOC) for monitoring wastewater treatment performance to minimize disposal of toxic analytical waster. *Journal of Environmental Science and Health, Part A. Toxic/hazardous Substances and Environmental Engineering* 2010 Oct., 45(12):1595-1600

2. Dudley, R. *Water Budget for Lake Auburn Maine, May 1, 200 through April 30, 2003,* USGS, 2004

3. The MDC, data for the Barkhamsted and Nepaug Reservoirs provided to Tighe & Bond, 2010

J:\N\N0916 New Britain OnCall\04 - Quarry Environmental Report\Report_Evaluation\WQ Treatment Eval Memo-rev 12-13-17.doc

Tighe&Bond

APPENDIX A

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica St. Louis
13715 Rider Trail North
Earth City, MO 63045
Tel: (314)298-8566

TestAmerica Job ID: 160-22501-1
Client Project/Site: Blasting Impacted Surface Water

For:
Tighe & Bond
53 Southampton Road
Westfield, Massachusetts 01085

Attn: Heather Doolittle

Authorized for release by:
6/8/2017 5:17:57 PM

Jayna Awalt, Project Manager II
(314)298-8566
jayna.awalt@testamericainc.com

LINKS

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Visit us at: www.testamericainc.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Job ID: 160-22501-1

Laboratory: TestAmerica St. Louis

Narrative

CASE NARRATIVE

Client: Tighe & Bond

Project: Blasting Impacted Surface Water

Report Number: 160-22501-1

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

TestAmerica St. Louis attests to the validity of the laboratory data generated by TestAmerica facilities reported herein. All analyses performed by TestAmerica facilities were done using established laboratory SOPs that incorporate QA/QC procedures described in the application methods. TestAmerica's operations groups have reviewed the data for compliance with the laboratory QA/QC plan, and data have been found to be compliant with laboratory protocols unless otherwise noted below.

The test results in this report meet all NELAP requirements for parameters for which accreditation is required or available. Any exceptions to NELAP requirements are noted in this report. Pursuant to NELAP, this report may not be reproduced, except in full, without the written approval of the laboratory.

Calculations are performed before rounding to avoid round-off errors in calculated results.

All holding times were met and proper preservation noted for the methods performed on these samples, unless otherwise detailed in the individual sections below.

All solid sample results for Chemistry analyses are reported on an "as received" basis unless otherwise indicated by the presence of a % solids value in the method header. All soil/sediment sample results for radiochemistry analyses are based upon sample as dried and disaggregated with the exception of tritium, carbon-14, and iodine-129 by gamma spectroscopy unless requested as wet weight by the client."

This laboratory report is confidential and is intended for the sole use of TestAmerica and its client.

RECEIPT
The samples were received on 05/24/2017; the samples arrived in good condition, properly preserved and on ice. The temperature of the coolers at receipt was 0.9 C.

pH was received outside hold time as this is a field parameter that expires in the field.

VOLATILE ORGANIC COMPOUNDS (GC MS)
Sample SW-1 (160-22501-1) was analyzed for volatile organic compounds (GC MS) in accordance with EPA SW-846 Method 8260C. The samples were analyzed on 05/27/2017.

Analytical Batch: 310973
1,2,4-Trichlorobenzene was detected in method blank MB 160-310973/8 at a level that was above the method detection limit but below the reporting limit. The value should be considered an estimate, and has been flagged. If the associated sample reported a result above the MDL and/or RL, the result has been flagged. Refer to the QC report for details.

Job ID: 160-22501-1 (Continued)

Laboratory: TestAmerica St. Louis (Continued)

The following compounds did not meet the minimum relative response factor limits in the continuing calibration verification (CCV) associated with batch 160-310973: Acetone, Methyl acetate and 2-Butanone (MEK). A low-level LOQV was analyzed at the reporting limit (5ug/L) and the affected analytes were detected. Target analytes recovering above the reporting limit will be qualified and reported. (CCVIS 160-310973/4)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

SEMIVOLATILE ORGANIC COMPOUNDS (GC MS)
Sample SW-1 (160-22501-1) was analyzed for semivolatile organic compounds (GC MS) in accordance with EPA SW-846 Method 8270D. The samples were prepared on 05/26/2017 and analyzed on 06/04/2017.

Analytical Batch: 311802
The LCS/MS/MSD spike recoveries for several analytes are outside the lower QC limits. There is insufficient sample volume to re-prepare and re-analyze. Results are provided with this narrative. SW-1 (160-22501-1), (LCS 160-310833/2-A), (MB 160-310833/1-A), (160-22493-D-1-A), (160-22493-E-1-A MS) and (160-22493-F-1-A MSD)

MS/MSD surrogate recoveries are outside QC limits. Sample surrogate recoveries are within QC limits; therefore, the data has been reported. (160-22493-E-1-A MS) and (160-22493-F-1-A MSD)

The CCV spike recovery for 2,2-oxybis[1-chloropropane] is outside the lower QC limits. A low level check standard was analyzed at the RL and the analyte was detected in the low level. This compound was ND for the affected samples; therefore this excursion did not affect the data results. No further action is required.SW-1 (160-22501-1), (CCVIS 160-311802/6), (LCS 160-310833/2-A) and (MB 160-310833/1-A)

The CCV surrogate recovery for 2,4,6-Tribromophenol is outside the upper QC limits. The sample surrogates associated with this CCV were within the acceptable QC limits. Results are provided with this narrative.SW-1 (160-22501-1), (CCVIS 160-311802/6), (LCS 160-310833/2-A), (MB 160-310833/1-A), (160-22493-E-1-A MS) and (160-22493-F-1-A MSD)

The continuing calibration verification (CCV) associated with batch 160-311802 recovered above the upper control limit for Hexachlorobenzene, Hexachlorobutadiene, and Hexachlorocyclopentadiene. The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The following sample is impacted: (CCVIS 160-311802/6).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

PERCHLORATE
Sample SW-1 (160-22501-1) was analyzed for perchlorate in accordance with EPA Method 314.0. The samples were analyzed on 05/30/2017.

The following matrix spike (MS) and matrix spike duplicate (MSD) recoveries were outside control limits (43% & 48%) in Perchlorate batch 160-311177: (160-22378-C-3 MS) and (160-22378-C-3 MSD) Sample matrix interference is evident in the visual observation of the sample chromatograms. Results are reported, as the associated laboratory control sample (LCS) recovery was within acceptance limits.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

NITROAROMATICS AND NITRAMINES (HPLC)
Sample SW-1 (160-22501-1) was analyzed for Nitroaromatics and Nitramines (HPLC) in accordance with EPA SW-846 Method 8330B. The samples were prepared on 05/25/2017 and analyzed on 06/01/2017 and 06/02/2017.

Analytical Batch: 311410
The matrix spike / matrix spike duplicate (MS/MSD) recoveries and precision for preparation batch 160-310680 and analytical batch 160-311410 were outside control limits. Sample matrix interference and/or non-homogeneity are suspected because the associated laboratory control sample (LCS) %recoveries were within acceptance limits.

The continuing calibration verification (CCV) associated with batch 160-311410 recovered below the lower control limit for Tetryl. The sample associated with this CCV was non-detects for the affected analyte; therefore, the data have been reported. The following samples are impacted: SW-1 (160-22501-1), (CCV 160-311410/15) and (CCVRT 160-311410/4).

Job ID: 160-22501-1 (Continued)

Laboratory: TestAmerica St. Louis (Continued)

The following analytes recovered outside the upper control limits for the LCS associated with preparation batch 160-310680 and analytical batch 160-311410: 2,4-Dinitrotoluene and 2,6-Dinitrotoluene. There were no detections for these analytes in any of the associated client samples. Qualified results have been reported. (LCS 160-310680/4-A)

Analytical Batch: 311412
The laboratory control sample (LCS) for preparation batch 160-310680 and analytical batch 160-311412 recovered outside control limits for the following analytes: 2,4,6-Trinitrotoluene. These analytes were biased high in the LCS and were not detected in the associated samples; therefore, the data have been reported. (LCS 160-310680/2-A)

The matrix spike duplicate (MSD) recovery for Tetryl in preparation batch 160-310680 and analytical batch 160-311412 was outside control limits. Sample matrix interference and/or non-homogeneity are suspected because the associated laboratory control sample (LCS) recovery was within acceptance limits.

The matrix spike / matrix spike duplicate (MS/MSD) precision for Tetryl in preparation batch 160-310680 and analytical batch 160-311412 was outside control limits. Sample matrix interference is suspected. (160-22501-B-1-A MS) and (160-22501-B-1-B MSD)

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

TOTAL METALS (ICP)
Sample SW-1 (160-22501-1) was analyzed for total metals (ICP) in accordance with EPA SW-846 Method 6010C. The samples were prepared on 06/02/2017 and analyzed on 06/05/2017.

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

METALS (ICPMS)
Sample SW-1 (160-22501-1) was analyzed for Metals (ICPMS) in accordance with EPA SW-846 Methods 6020A. The samples were prepared on 06/02/2017 and analyzed on 06/05/2017.

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

PH
Sample SW-1 (160-22501-1) was analyzed for pH in accordance with EPA Method 150.1. The samples were analyzed on 05/25/2017.

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

TOTAL SUSPENDED SOLIDS
Sample SW-1 (160-22501-1) was analyzed for total suspended solids in accordance with EPA Method 160.2. The samples were analyzed on 05/26/2017.

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

ANIONS, ION CHROMATOGRAPHY
Sample SW-1 (160-22501-1) was analyzed for Anions, Ion Chromatography in accordance with EPA Method 300.0. The samples were analyzed on 05/24/2017.

Analytical Batch: 310288
The following samples in Anion batch 160-310288 were diluted to bring the concentrations of Nitrate within the calibration range: SW-1 (160-22501-1). Elevated reporting limits (RLs) are provided.

The following matrix spike (MS) recovered outside control limits for Nitrite (80%) in Anion batch 160-310288: (160-22501-D-1 MS) Sample matrix interference is suspected because the associated laboratory control sample (LCS) recovery was within acceptance limits.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Job ID: 160-22501-1 (Continued)

Laboratory: TestAmerica St. Louis (Continued)

ALKALINITY

Sample SW-1 (160-22501-1) was analyzed for alkalinity in accordance with EPA Method 310.1. The samples were analyzed on 06/02/2017.

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

TOTAL KJELDAHL NITROGEN

Sample SW-1 (160-22501-1) was analyzed for total kjeldahl nitrogen in accordance with EPA Method 351.2. The samples were prepared on 05/26/2017 and analyzed on 05/30/2017.

Analytical Batch: 311375

The following matrix spike (MS) recovery for TKN preparation batch 160-310944 and analytical batch 160-311375 was outside control limits: (160-22501-F-1-C MS). Sample matrix interference is suspected because the associated laboratory control sample (LCS) recovery was within acceptance limits.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

TOTAL ORGANIC CARBON

Sample SW-1 (160-22501-1) was analyzed for total organic carbon in accordance with EPA Method 415.1. The samples were analyzed on 06/05/2017.

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

TestAmerica St. Louis
13715 Rider Trail North
Earth City, MO 63045
Phone (314) 298-8566 Fax (314) 298-8757

Chain of Custody Record

TestAmerica

Client Information	Sampler: Heather Doolittle	Lab PM: Awalt, Jayna K	Carrier Tracking No(s): Westfield	COC No: 160-5335-2690.1
Client Contact: Heather Doolittle	Phone: 413 572 3284	E-Mail: jayna.awalt@testamericainc.com		Page: Page 1 of 1
Company: Tighe & Bond				Job #:
Address: 53 Southampton Road	Due Date Requested:			
City: Westfield	TAT Requested (days):			
State, Zip: MA, 01085				
Phone: 413 572 3284	PO #: Purchase Order Requested			
Email: hadoolittle@tighebond.com	WO #:			
Project Name: Blasting Impacted Surface Water	Project #: 16006297			
Site: Tilcon New Britain CT	SSOW#:			

Analysis Requested

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	310.1 - Alkalinity	415.1 - TOC	150.1, 180.2, Calcd, 300_ORGFMS, 314.0	351.2 - Nitrogen, Total Kjeldahl	6010C, 6020A	8260C - VOCs (GC/MS)	8270D, 8330B	Total Number of containers	Special Instructions/Note:
			Preservation Code:				N	S	N	S	D	A	N		
SW-1	5/23/17	8:45	G	Water	N		X	X	X	X	X	X	X	10	

Preservation Codes:
A - HCL, B - NaOH, C - Zn Acetate, D - Nitric Acid, E - NaHSO4, F - MeOH, G - Amchlor, H - Ascorbic Acid, I - Ice, J - DI Water, K - EDTA, L - EDA
M - Hexane, N - None, O - AsNaO2, P - Na2O4S, Q - Na2SO3, R - Na2S2O3, S - H2SO4, T - TSP Dodecahydrate, U - Acetone, V - MCAA, W - pH 4-5, Z - other (specify)
Other:

160-22501 Chain of Custody

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown ☐ Radiological

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ Return To Client ☒ Disposal By Lab ☐ Archive For ____ Months

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by: | Date: | Time: | Method of Shipment:

Relinquished by	Date/Time	Company	Received by	Date/Time	Company
Heather Doolittle	5/23/17 0845	Tighe&Bond	[signature]	5/23/17 1702	TAL
			[signature]	5-24-17 0750	TASTL

Custody Seals Intact: Δ Yes Δ No | Custody Seal No.: | Cooler Temperature(s) °C and Other Remarks:

Login Sample Receipt Checklist

Client: Tighe & Bond

Job Number: 160-22501-1

Login Number: 22501
List Number: 1
Creator: Daniels, Brian J

List Source: TestAmerica St. Louis

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	False	COC was not relinquished by shipping lab.
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

Definitions/Glossary

Qualifiers

GC/MS VOA

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

GC/MS Semi VOA

Qualifier	Qualifier Description
F1	MS and/or MSD Recovery is outside acceptance limits.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.
X	Surrogate is outside control limits
F2	MS/MSD RPD exceeds control limits
*	LCS or LCSD is outside acceptance limits.

HPLC/IC

Qualifier	Qualifier Description
F1	MS and/or MSD Recovery is outside acceptance limits.
*	LCS or LCSD is outside acceptance limits.
F2	MS/MSD RPD exceeds control limits

Metals

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

General Chemistry

Qualifier	Qualifier Description
HF	Field parameter with a holding time of 15 minutes. Test performed by laboratory at client's request.
F1	MS and/or MSD Recovery is outside acceptance limits.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)

Glossary (Continued)

Abbreviation	These commonly used abbreviations may or may not be present in this report.
TEQ	Toxicity Equivalent Quotient (Dioxin)

Method Summary

Method	Method Description	Protocol	Laboratory
8260C	Volatile Organic Compounds by GC/MS	SW846	TAL SL
8270D	Semivolatile Organic Compounds (GC/MS)	SW846	TAL SL
300.0	Anions, Ion Chromatography	MCAWW	TAL SL
314.0	Perchlorate (IC)	EPA	TAL SL
8330B	Nitroaromatics and Nitramines (HPLC)	SW846	TAL SL
6010C	Metals (ICP)	SW846	TAL SL
6020A	Metals (ICP/MS)	SW846	TAL SL
150.1	pH (Electrometric)	MCAWW	TAL SL
160.2	Solids, Total Suspended (TSS)	MCAWW	TAL SL
310.1	Alkalinity	MCAWW	TAL SL
351.2	Nitrogen, Total Kjeldahl	MCAWW	TAL SL
415.1	TOC	MCAWW	TAL SL

Protocol References:

EPA = US Environmental Protection Agency

MCAWW = "Methods For Chemical Analysis Of Water And Wastes", EPA-600/4-79-020, March 1983 And Subsequent Revisions.

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL SL = TestAmerica St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

Sample Summary

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
160-22501-1	SW-1	Water	05/23/17 08:45	05/24/17 07:50

Client Sample ID: SW-1

Lab Sample ID: 160-22501-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Nitrate - DL	4.2		0.40	0.14	mg/L	20		300.0	Total/NA
Boron	310		100	25	ug/L	1		6010C	Total/NA
Sulfur	7400		5000	1500	ug/L	1		6010C	Total/NA
Aluminum	860		50	20	ug/L	2		6020A	Total/NA
Molybdenum	3.5	J	5.0	2.0	ug/L	2		6020A	Total/NA
pH	8.1	HF	0.1	0.1	SU	1		150.1	Total/NA
Total Suspended Solids	14		4.0	4.0	mg/L	1		160.2	Total/NA
Alkalinity	82		5.0	0.54	mg/L	1		310.1	Total/NA
Nitrogen, Kjeldahl	0.22	J F1	0.50	0.22	mg/L	1		351.2	Total/NA
Total Organic Carbon	0.79	J	1.0	0.72	mg/L	1		415.1	Total/NA

This Detection Summary does not include radiochemical test results.

Client Sample ID: SW-1

Lab Sample ID: 160-22501-1

Date Collected: 05/23/17 08:45

Matrix: Water

Date Received: 05/24/17 07:50

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1-Trichloroethane	ND		5.0	0.29	ug/L			05/27/17 20:19	1
1,1,2,2-Tetrachloroethane	ND		5.0	0.43	ug/L			05/27/17 20:19	1
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		5.0	0.25	ug/L			05/27/17 20:19	1
1,1,2-Trichloroethane	ND		5.0	0.57	ug/L			05/27/17 20:19	1
1,1-Dichloroethane	ND		5.0	0.39	ug/L			05/27/17 20:19	1
1,1-Dichloroethene	ND		5.0	0.37	ug/L			05/27/17 20:19	1
1,2,4-Trichlorobenzene	ND		5.0	0.55	ug/L			05/27/17 20:19	1
1,2-Dibromo-3-Chloropropane	ND		10	1.2	ug/L			05/27/17 20:19	1
1,2-Dichlorobenzene	ND		5.0	0.28	ug/L			05/27/17 20:19	1
1,2-Dichloroethane	ND		5.0	0.37	ug/L			05/27/17 20:19	1
1,2-Dichloropropane	ND		5.0	0.32	ug/L			05/27/17 20:19	1
1,3-Dichlorobenzene	ND		5.0	0.23	ug/L			05/27/17 20:19	1
1,4-Dichlorobenzene	ND		5.0	0.35	ug/L			05/27/17 20:19	1
2-Butanone (MEK)	ND		20	0.39	ug/L			05/27/17 20:19	1
2-Hexanone	ND		20	0.59	ug/L			05/27/17 20:19	1
4-Methyl-2-pentanone (MIBK)	ND		20	0.33	ug/L			05/27/17 20:19	1
Acetone	ND		20	6.7	ug/L			05/27/17 20:19	1
Benzene	ND		5.0	0.25	ug/L			05/27/17 20:19	1
Bromoform	ND		5.0	0.37	ug/L			05/27/17 20:19	1
Bromomethane	ND		10	0.40	ug/L			05/27/17 20:19	1
Carbon disulfide	ND		5.0	0.37	ug/L			05/27/17 20:19	1
Carbon tetrachloride	ND		5.0	0.36	ug/L			05/27/17 20:19	1
Chlorobenzene	ND		5.0	0.38	ug/L			05/27/17 20:19	1
Dibromochloromethane	ND		5.0	0.33	ug/L			05/27/17 20:19	1
Chloroethane	ND		10	0.38	ug/L			05/27/17 20:19	1
Chloroform	ND		5.0	0.15	ug/L			05/27/17 20:19	1
Chloromethane	ND		10	0.55	ug/L			05/27/17 20:19	1
cis-1,2-Dichloroethene	ND		5.0	0.16	ug/L			05/27/17 20:19	1
cis-1,3-Dichloropropene	ND		5.0	0.34	ug/L			05/27/17 20:19	1
Cyclohexane	ND		10	0.36	ug/L			05/27/17 20:19	1
Bromodichloromethane	ND		5.0	0.25	ug/L			05/27/17 20:19	1
Dichlorodifluoromethane	ND		10	0.45	ug/L			05/27/17 20:19	1
Ethylbenzene	ND		5.0	0.30	ug/L			05/27/17 20:19	1
1,2-Dibromoethane (EDB)	ND		5.0	0.44	ug/L			05/27/17 20:19	1
Isopropylbenzene	ND		5.0	0.26	ug/L			05/27/17 20:19	1
Methyl acetate	ND		25	2.3	ug/L			05/27/17 20:19	1
Methyl tert-butyl ether	ND		5.0	0.40	ug/L			05/27/17 20:19	1
Methylcyclohexane	ND		10	0.26	ug/L			05/27/17 20:19	1
Methylene Chloride	ND		5.0	1.7	ug/L			05/27/17 20:19	1
m-Xylene & p-Xylene	ND		5.0	0.57	ug/L			05/27/17 20:19	1
o-Xylene	ND		5.0	0.32	ug/L			05/27/17 20:19	1
Styrene	ND		5.0	0.35	ug/L			05/27/17 20:19	1
Tetrachloroethene	ND		5.0	0.28	ug/L			05/27/17 20:19	1
Toluene	ND		5.0	1.0	ug/L			05/27/17 20:19	1
trans-1,2-Dichloroethene	ND		5.0	0.18	ug/L			05/27/17 20:19	1
trans-1,3-Dichloropropene	ND		5.0	0.35	ug/L			05/27/17 20:19	1
Trichloroethene	ND		5.0	0.29	ug/L			05/27/17 20:19	1
Trichlorofluoromethane	ND		5.0	0.22	ug/L			05/27/17 20:19	1
Vinyl chloride	ND		5.0	0.43	ug/L			05/27/17 20:19	1

Client Sample ID: SW-1

Date Collected: 05/23/17 08:45
Date Received: 05/24/17 07:50

Lab Sample ID: 160-22501-1
Matrix: Water

Method: 8260C - Volatile Organic Compounds by GC/MS (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Xylenes, Total	ND		10	0.85	ug/L			05/27/17 20:19	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*102*		*80 - 129*		*05/27/17 20:19*	*1*
Dibromofluoromethane (Surr)	*105*		*80 - 121*		*05/27/17 20:19*	*1*
4-Bromofluorobenzene (Surr)	*96*		*71 - 139*		*05/27/17 20:19*	*1*
1,2-Dichloroethane-d4 (Surr)	*105*		*76 - 121*		*05/27/17 20:19*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Acenaphthylene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Anthracene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Benzo[a]anthracene	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Benzo[b]fluoranthene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Benzo[k]fluoranthene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Benzo[g,h,i]perylene	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Benzo[a]pyrene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Bis(2-chloroethoxy)methane	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Bis(2-chloroethyl)ether	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Bis(2-ethylhexyl) phthalate	ND	*	23	4.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
4-Bromophenyl phenyl ether	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Butyl benzyl phthalate	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Carbazole	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
4-Chloroaniline	ND		23	4.7	ug/L		05/26/17 10:02	06/04/17 00:04	1
4-Chloro-3-methylphenol	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
2-Chloronaphthalene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
2-Chlorophenol	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
4-Chlorophenyl phenyl ether	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Chrysene	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Dibenz(a,h)anthracene	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Dibenzofuran	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Di-n-butyl phthalate	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
1,2-Dichlorobenzene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
1,3-Dichlorobenzene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
1,4-Dichlorobenzene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
3,3'-Dichlorobenzidine	ND		120	3.0	ug/L		05/26/17 10:02	06/04/17 00:04	1
2,4-Dichlorophenol	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Diethyl phthalate	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
2,4-Dimethylphenol	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Dimethyl phthalate	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
4,6-Dinitro-2-methylphenol	ND		23	2.9	ug/L		05/26/17 10:02	06/04/17 00:04	1
2,4-Dinitrophenol	ND	*	120	4.7	ug/L		05/26/17 10:02	06/04/17 00:04	1
2,4-Dinitrotoluene	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
2,6-Dinitrotoluene	ND		23	5.0	ug/L		05/26/17 10:02	06/04/17 00:04	1
Di-n-octyl phthalate	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Fluoranthene	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Fluorene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Hexachlorobenzene	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Hexachlorobutadiene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1

Client Sample ID: SW-1
Date Collected: 05/23/17 08:45
Date Received: 05/24/17 07:50

Lab Sample ID: 160-22501-1
Matrix: Water

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Hexachlorocyclopentadiene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Hexachloroethane	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Indeno[1,2,3-cd]pyrene	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Isophorone	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
2-Methylnaphthalene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
2-Methylphenol	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
3 & 4 Methylphenol	ND		47	4.7	ug/L		05/26/17 10:02	06/04/17 00:04	1
Naphthalene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
2-Nitroaniline	ND	*	23	2.6	ug/L		05/26/17 10:02	06/04/17 00:04	1
3-Nitroaniline	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
4-Nitroaniline	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Nitrobenzene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
2-Nitrophenol	ND	*	23	3.5	ug/L		05/26/17 10:02	06/04/17 00:04	1
4-Nitrophenol	ND	*	23	4.7	ug/L		05/26/17 10:02	06/04/17 00:04	1
N-Nitrosodi-n-propylamine	ND	*	23	3.5	ug/L		05/26/17 10:02	06/04/17 00:04	1
bis (2-chloroisopropyl) ether	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Pentachlorophenol	ND	*	120	3.0	ug/L		05/26/17 10:02	06/04/17 00:04	1
Phenanthrene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Phenol	ND	*	23	4.7	ug/L		05/26/17 10:02	06/04/17 00:04	1
Pyrene	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
1,2,4-Trichlorobenzene	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
2,4,5-Trichlorophenol	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
2,4,6-Trichlorophenol	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Aniline	ND		23	3.0	ug/L		05/26/17 10:02	06/04/17 00:04	1
1,4-Dioxane	ND		23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1
Benzyl alcohol	ND		23	7.0	ug/L		05/26/17 10:02	06/04/17 00:04	1
Pyridine	ND		47	4.7	ug/L		05/26/17 10:02	06/04/17 00:04	1
Diphenylamine	ND	*	23	2.3	ug/L		05/26/17 10:02	06/04/17 00:04	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorophenol (Surr)	*42*		*15 - 59*	*05/26/17 10:02*	*06/04/17 00:04*	*1*
2,4,6-Tribromophenol (Surr)	*82*		*37 - 120*	*05/26/17 10:02*	*06/04/17 00:04*	*1*
Nitrobenzene-d5 (Surr)	*50*		*50 - 101*	*05/26/17 10:02*	*06/04/17 00:04*	*1*
Phenol-d5 (Surr)	*30*		*10 - 50*	*05/26/17 10:02*	*06/04/17 00:04*	*1*
Terphenyl-d14 (Surr)	*61*		*21 - 97*	*05/26/17 10:02*	*06/04/17 00:04*	*1*
2-Fluorobiphenyl (Surr)	*55*		*43 - 108*	*05/26/17 10:02*	*06/04/17 00:04*	*1*

Method: 300.0 - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Nitrite	ND	F1	0.020	0.0070	mg/L			05/24/17 21:47	1

Method: 300.0 - Anions, Ion Chromatography - DL

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Nitrate	**4.2**		0.40	0.14	mg/L			05/24/17 22:14	20

Method: 314.0 - Perchlorate (IC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perchlorate	ND		12	4.0	ug/L			05/30/17 21:50	1

Client Sample ID: SW-1
Date Collected: 05/23/17 08:45
Date Received: 05/24/17 07:50

Lab Sample ID: 160-22501-1
Matrix: Water

Method: 8330B - Nitroaromatics and Nitramines (HPLC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,3,5-Trinitrobenzene	ND		0.20	0.057	ug/L		05/25/17 14:11	06/01/17 14:06	1
1,3-Dinitrobenzene	ND		0.20	0.10	ug/L		05/25/17 14:11	06/01/17 14:06	1
2,4,6-Trinitrotoluene	ND	*	0.20	0.080	ug/L		05/25/17 14:11	06/02/17 01:05	1
2,4-Dinitrotoluene	ND		0.20	0.081	ug/L		05/25/17 14:11	06/01/17 14:06	1
2,6-Dinitrotoluene	ND		0.20	0.13	ug/L		05/25/17 14:11	06/01/17 14:06	1
2-Amino-4,6-dinitrotoluene	ND		0.20	0.12	ug/L		05/25/17 14:11	06/01/17 14:06	1
2-Nitrotoluene	ND		0.50	0.095	ug/L		05/25/17 14:11	06/01/17 14:06	1
3-Nitrotoluene	ND		0.20	0.12	ug/L		05/25/17 14:11	06/01/17 14:06	1
4-Amino-2,6-dinitrotoluene	ND		0.20	0.12	ug/L		05/25/17 14:11	06/02/17 01:05	1
4-Nitrotoluene	ND		0.50	0.14	ug/L		05/25/17 14:11	06/01/17 14:06	1
HMX	ND		0.20	0.11	ug/L		05/25/17 14:11	06/01/17 14:06	1
Nitrobenzene	ND		0.20	0.082	ug/L		05/25/17 14:11	06/01/17 14:06	1
Nitroglycerin	ND		1.0	0.54	ug/L		05/25/17 14:11	06/01/17 14:06	1
PETN	ND		2.0	0.61	ug/L		05/25/17 14:11	06/01/17 14:06	1
RDX	ND		0.20	0.094	ug/L		05/25/17 14:11	06/01/17 14:06	1
Tetryl	ND	F1 F2	0.20	0.059	ug/L		05/25/17 14:11	06/02/17 01:05	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dinitrobenzene (Surr)	*92*		*81 - 113*	*05/25/17 14:11*	*06/01/17 14:06*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	**310**		100	25	ug/L		06/02/17 10:34	06/05/17 23:33	1
Sulfur	**7400**		5000	1500	ug/L		06/02/17 10:34	06/05/17 23:33	1

Method: 6020A - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	**860**		50	20	ug/L		06/02/17 10:35	06/05/17 18:30	2
Chromium	ND		10	4.0	ug/L		06/02/17 10:35	06/05/17 18:30	2
Lead	ND		3.0	1.0	ug/L		06/02/17 10:35	06/05/17 18:30	2
Molybdenum	**3.5**	**J**	5.0	2.0	ug/L		06/02/17 10:35	06/05/17 18:30	2
Tungsten	ND		5.0	2.0	ug/L		06/02/17 10:35	06/05/17 18:30	2

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
pH	**8.1**	**HF**	0.1	0.1	SU			05/25/17 01:51	1
Total Suspended Solids	**14**		4.0	4.0	mg/L			05/26/17 06:26	1
Alkalinity	**82**		5.0	0.54	mg/L			06/02/17 20:37	1
Nitrogen, Kjeldahl	**0.22**	**J F1**	0.50	0.22	mg/L		05/26/17 14:05	05/30/17 21:23	1
Total Organic Carbon	**0.79**	**J**	1.0	0.72	mg/L			06/05/17 23:37	1

Method: 8260C - Volatile Organic Compounds by GC/MS

Lab Sample ID: MB 160-310973/8
Matrix: Water
Analysis Batch: 310973

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,1,1-Trichloroethane	ND		5.0	0.29	ug/L			05/27/17 16:34	1
1,1,2,2-Tetrachloroethane	ND		5.0	0.43	ug/L			05/27/17 16:34	1
1,1,2-Trichloro-1,2,2-trifluoroethane	ND		5.0	0.25	ug/L			05/27/17 16:34	1
1,1,2-Trichloroethane	ND		5.0	0.57	ug/L			05/27/17 16:34	1
1,1-Dichloroethane	ND		5.0	0.39	ug/L			05/27/17 16:34	1
1,1-Dichloroethene	ND		5.0	0.37	ug/L			05/27/17 16:34	1
1,2,4-Trichlorobenzene	1.45	J	5.0	0.55	ug/L			05/27/17 16:34	1
1,2-Dibromo-3-Chloropropane	ND		10	1.2	ug/L			05/27/17 16:34	1
1,2-Dichlorobenzene	ND		5.0	0.28	ug/L			05/27/17 16:34	1
1,2-Dichloroethane	ND		5.0	0.37	ug/L			05/27/17 16:34	1
1,2-Dichloropropane	ND		5.0	0.32	ug/L			05/27/17 16:34	1
1,3-Dichlorobenzene	ND		5.0	0.23	ug/L			05/27/17 16:34	1
1,4-Dichlorobenzene	ND		5.0	0.35	ug/L			05/27/17 16:34	1
2-Butanone (MEK)	ND		20	0.39	ug/L			05/27/17 16:34	1
2-Hexanone	ND		20	0.59	ug/L			05/27/17 16:34	1
4-Methyl-2-pentanone (MIBK)	ND		20	0.33	ug/L			05/27/17 16:34	1
Acetone	ND		20	6.7	ug/L			05/27/17 16:34	1
Benzene	ND		5.0	0.25	ug/L			05/27/17 16:34	1
Bromoform	ND		5.0	0.37	ug/L			05/27/17 16:34	1
Bromomethane	ND		10	0.40	ug/L			05/27/17 16:34	1
Carbon disulfide	ND		5.0	0.37	ug/L			05/27/17 16:34	1
Carbon tetrachloride	ND		5.0	0.36	ug/L			05/27/17 16:34	1
Chlorobenzene	ND		5.0	0.38	ug/L			05/27/17 16:34	1
Dibromochloromethane	ND		5.0	0.33	ug/L			05/27/17 16:34	1
Chloroethane	ND		10	0.38	ug/L			05/27/17 16:34	1
Chloroform	ND		5.0	0.15	ug/L			05/27/17 16:34	1
Chloromethane	ND		10	0.55	ug/L			05/27/17 16:34	1
cis-1,2-Dichloroethene	ND		5.0	0.16	ug/L			05/27/17 16:34	1
cis-1,3-Dichloropropene	ND		5.0	0.34	ug/L			05/27/17 16:34	1
Cyclohexane	ND		10	0.36	ug/L			05/27/17 16:34	1
Bromodichloromethane	ND		5.0	0.25	ug/L			05/27/17 16:34	1
Dichlorodifluoromethane	ND		10	0.45	ug/L			05/27/17 16:34	1
Ethylbenzene	ND		5.0	0.30	ug/L			05/27/17 16:34	1
1,2-Dibromoethane (EDB)	ND		5.0	0.44	ug/L			05/27/17 16:34	1
Isopropylbenzene	ND		5.0	0.26	ug/L			05/27/17 16:34	1
Methyl acetate	ND		25	2.3	ug/L			05/27/17 16:34	1
Methyl tert-butyl ether	ND		5.0	0.40	ug/L			05/27/17 16:34	1
Methylcyclohexane	ND		10	0.26	ug/L			05/27/17 16:34	1
Methylene Chloride	ND		5.0	1.7	ug/L			05/27/17 16:34	1
m-Xylene & p-Xylene	ND		5.0	0.57	ug/L			05/27/17 16:34	1
o-Xylene	ND		5.0	0.32	ug/L			05/27/17 16:34	1
Styrene	ND		5.0	0.35	ug/L			05/27/17 16:34	1
Tetrachloroethene	ND		5.0	0.28	ug/L			05/27/17 16:34	1
Toluene	ND		5.0	1.0	ug/L			05/27/17 16:34	1
trans-1,2-Dichloroethene	ND		5.0	0.18	ug/L			05/27/17 16:34	1
trans-1,3-Dichloropropene	ND		5.0	0.35	ug/L			05/27/17 16:34	1
Trichloroethene	ND		5.0	0.29	ug/L			05/27/17 16:34	1
Trichlorofluoromethane	ND		5.0	0.22	ug/L			05/27/17 16:34	1

Method: 8260C - Volatile Organic Compounds by GC/MS (Continued)

Lab Sample ID: MB 160-310973/8
Matrix: Water
Analysis Batch: 310973

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Vinyl chloride	ND		5.0	0.43	ug/L			05/27/17 16:34	1
Xylenes, Total	ND		10	0.85	ug/L			05/27/17 16:34	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Toluene-d8 (Surr)	*100*		*80 - 129*		*05/27/17 16:34*	*1*
Dibromofluoromethane (Surr)	*98*		*80 - 121*		*05/27/17 16:34*	*1*
4-Bromofluorobenzene (Surr)	*94*		*71 - 139*		*05/27/17 16:34*	*1*
1,2-Dichloroethane-d4 (Surr)	*98*		*76 - 121*		*05/27/17 16:34*	*1*

Lab Sample ID: LCS 160-310973/5
Matrix: Water
Analysis Batch: 310973

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1,1-Trichloroethane	50.0	51.3		ug/L		103	76 - 120
1,1,2,2-Tetrachloroethane	50.0	49.8		ug/L		100	80 - 120
1,1,2-Trichloroethane	50.0	47.8		ug/L		96	80 - 120
1,1-Dichloroethane	50.0	50.5		ug/L		101	80 - 120
1,1-Dichloroethene	50.0	50.8		ug/L		102	77 - 126
1,2,4-Trichlorobenzene	50.0	51.2		ug/L		102	80 - 120
1,2-Dibromo-3-Chloropropane	50.0	50.6		ug/L		101	77 - 125
1,2-Dichlorobenzene	50.0	49.4		ug/L		99	80 - 120
1,2-Dichloroethane	50.0	48.3		ug/L		97	69 - 124
1,2-Dichloropropane	50.0	48.5		ug/L		97	80 - 120
1,3-Dichlorobenzene	50.0	50.3		ug/L		101	80 - 120
1,4-Dichlorobenzene	50.0	49.7		ug/L		99	80 - 120
2-Butanone (MEK)	50.0	51.3		ug/L		103	70 - 130
2-Hexanone	50.0	47.9		ug/L		96	64 - 136
4-Methyl-2-pentanone (MIBK)	50.0	51.6		ug/L		103	76 - 129
Acetone	50.0	47.1		ug/L		94	63 - 131
Benzene	50.0	49.2		ug/L		98	80 - 120
Bromoform	50.0	48.1		ug/L		96	80 - 120
Bromomethane	50.0	44.2		ug/L		88	57 - 139
Carbon disulfide	50.0	50.4		ug/L		101	79 - 126
Carbon tetrachloride	50.0	52.1		ug/L		104	73 - 123
Chlorobenzene	50.0	49.7		ug/L		99	80 - 120
Dibromochloromethane	50.0	49.8		ug/L		100	80 - 120
Chloroethane	50.0	45.7		ug/L		91	52 - 140
Chloroform	50.0	49.6		ug/L		99	80 - 120
Chloromethane	50.0	42.4		ug/L		85	70 - 127
cis-1,2-Dichloroethene	50.0	49.4		ug/L		99	80 - 120
cis-1,3-Dichloropropene	50.0	49.4		ug/L		99	80 - 122
Cyclohexane	50.0	50.8		ug/L		102	80 - 120
Bromodichloromethane	50.0	49.5		ug/L		99	80 - 120
Dichlorodifluoromethane	50.0	40.2		ug/L		80	62 - 140
Ethylbenzene	50.0	48.6		ug/L		97	80 - 120
1,2-Dibromoethane (EDB)	50.0	49.6		ug/L		99	80 - 120
Isopropylbenzene	50.0	52.3		ug/L		105	80 - 121

Method: 8260C - Volatile Organic Compounds by GC/MS (Continued)

Lab Sample ID: LCS 160-310973/5
Matrix: Water
Analysis Batch: 310973

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Methyl acetate	250	262		ug/L		105	80 - 127
Methyl tert-butyl ether	50.0	50.2		ug/L		100	80 - 120
Methylcyclohexane	50.0	50.9		ug/L		102	80 - 120
Methylene Chloride	50.0	50.2		ug/L		100	80 - 120
m-Xylene & p-Xylene	50.0	50.7		ug/L		101	80 - 120
o-Xylene	50.0	51.9		ug/L		104	80 - 125
Styrene	50.0	51.1		ug/L		102	80 - 120
Tetrachloroethene	50.0	52.3		ug/L		105	80 - 120
Toluene	50.0	50.3		ug/L		101	80 - 120
trans-1,2-Dichloroethene	50.0	51.1		ug/L		102	80 - 120
trans-1,3-Dichloropropene	50.0	49.2		ug/L		98	80 - 130
Trichloroethene	50.0	49.1		ug/L		98	73 - 120
Trichlorofluoromethane	50.0	49.9		ug/L		100	74 - 130
Vinyl chloride	50.0	48.4		ug/L		97	51 - 140
Xylenes, Total	100	103		ug/L		103	80 - 121

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
Toluene-d8 (Surr)	*104*		*80 - 129*
Dibromofluoromethane (Surr)	*103*		*80 - 121*
4-Bromofluorobenzene (Surr)	*96*		*71 - 139*
1,2-Dichloroethane-d4 (Surr)	*102*		*76 - 121*

Lab Sample ID: LCSD 160-310973/6
Matrix: Water
Analysis Batch: 310973

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
1,1,1-Trichloroethane	50.0	51.1		ug/L		102	76 - 120	0	20
1,1,2,2-Tetrachloroethane	50.0	51.0		ug/L		102	80 - 120	2	20
1,1,2-Trichloroethane	50.0	49.3		ug/L		99	80 - 120	3	20
1,1-Dichloroethane	50.0	49.4		ug/L		99	80 - 120	2	20
1,1-Dichloroethene	50.0	49.0		ug/L		98	77 - 126	4	20
1,2,4-Trichlorobenzene	50.0	53.2		ug/L		106	80 - 120	4	20
1,2-Dibromo-3-Chloropropane	50.0	54.4		ug/L		109	77 - 125	7	20
1,2-Dichlorobenzene	50.0	50.3		ug/L		101	80 - 120	2	20
1,2-Dichloroethane	50.0	49.3		ug/L		99	69 - 124	2	20
1,2-Dichloropropane	50.0	47.8		ug/L		96	80 - 120	2	20
1,3-Dichlorobenzene	50.0	50.2		ug/L		100	80 - 120	0	20
1,4-Dichlorobenzene	50.0	49.8		ug/L		100	80 - 120	0	20
2-Butanone (MEK)	50.0	52.3		ug/L		105	70 - 130	2	20
2-Hexanone	50.0	52.6		ug/L		105	64 - 136	9	20
4-Methyl-2-pentanone (MIBK)	50.0	54.9		ug/L		110	76 - 129	6	20
Acetone	50.0	48.7		ug/L		97	63 - 131	3	20
Benzene	50.0	48.1		ug/L		96	80 - 120	2	20
Bromoform	50.0	50.0		ug/L		100	80 - 120	4	20
Bromomethane	50.0	45.2		ug/L		90	57 - 139	2	20
Carbon disulfide	50.0	48.5		ug/L		97	79 - 126	4	20
Carbon tetrachloride	50.0	51.2		ug/L		102	73 - 123	2	20

Method: 8260C - Volatile Organic Compounds by GC/MS (Continued)

Lab Sample ID: LCSD 160-310973/6
Matrix: Water
Analysis Batch: 310973

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Chlorobenzene	50.0	49.8		ug/L		100	80 - 120	0	20
Dibromochloromethane	50.0	51.0		ug/L		102	80 - 120	2	20
Chloroethane	50.0	45.8		ug/L		92	52 - 140	0	20
Chloroform	50.0	49.3		ug/L		99	80 - 120	1	20
Chloromethane	50.0	41.0		ug/L		82	70 - 127	3	20
cis-1,2-Dichloroethene	50.0	48.3		ug/L		97	80 - 120	2	20
cis-1,3-Dichloropropene	50.0	49.6		ug/L		99	80 - 122	0	20
Cyclohexane	50.0	49.5		ug/L		99	80 - 120	3	20
Bromodichloromethane	50.0	48.9		ug/L		98	80 - 120	1	20
Dichlorodifluoromethane	50.0	39.3		ug/L		79	62 - 140	2	20
Ethylbenzene	50.0	49.2		ug/L		98	80 - 120	1	20
1,2-Dibromoethane (EDB)	50.0	50.6		ug/L		101	80 - 120	2	20
Isopropylbenzene	50.0	52.8		ug/L		106	80 - 121	1	20
Methyl acetate	250	268		ug/L		107	80 - 127	2	20
Methyl tert-butyl ether	50.0	51.5		ug/L		103	80 - 120	2	20
Methylcyclohexane	50.0	49.7		ug/L		99	80 - 120	3	20
Methylene Chloride	50.0	49.4		ug/L		99	80 - 120	2	20
m-Xylene & p-Xylene	50.0	50.7		ug/L		101	80 - 120	0	20
o-Xylene	50.0	52.5		ug/L		105	80 - 125	1	20
Styrene	50.0	50.9		ug/L		102	80 - 120	0	20
Tetrachloroethene	50.0	50.7		ug/L		101	80 - 120	3	20
Toluene	50.0	50.1		ug/L		100	80 - 120	0	20
trans-1,2-Dichloroethene	50.0	49.7		ug/L		99	80 - 120	3	20
trans-1,3-Dichloropropene	50.0	50.3		ug/L		101	80 - 130	2	20
Trichloroethene	50.0	49.4		ug/L		99	73 - 120	1	20
Trichlorofluoromethane	50.0	49.7		ug/L		99	74 - 130	0	20
Vinyl chloride	50.0	46.0		ug/L		92	51 - 140	5	20
Xylenes, Total	100	103		ug/L		103	80 - 121	1	20

Surrogate	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
Toluene-d8 (Surr)	*102*		*80 - 129*
Dibromofluoromethane (Surr)	*102*		*80 - 121*
4-Bromofluorobenzene (Surr)	*96*		*71 - 139*
1,2-Dichloroethane-d4 (Surr)	*99*		*76 - 121*

Lab Sample ID: 160-22536-A-4 MS
Matrix: Water
Analysis Batch: 310973

Client Sample ID: Matrix Spike
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
1,1,1-Trichloroethane	ND		50.0	51.3		ug/L		103	74 - 123
1,1,2,2-Tetrachloroethane	ND		50.0	51.5		ug/L		103	60 - 150
1,1,2-Trichloroethane	ND		50.0	50.4		ug/L		101	70 - 134
1,1-Dichloroethane	ND		50.0	50.6		ug/L		101	80 - 120
1,1-Dichloroethene	ND		50.0	49.1		ug/L		98	66 - 137
1,2,4-Trichlorobenzene	ND		50.0	49.5		ug/L		99	72 - 129
1,2-Dibromo-3-Chloropropane	ND		50.0	51.0		ug/L		102	58 - 148
1,2-Dichlorobenzene	ND		50.0	50.8		ug/L		102	80 - 124

Method: 8260C - Volatile Organic Compounds by GC/MS (Continued)

Lab Sample ID: 160-22536-A-4 MS
Matrix: Water
Analysis Batch: 310973

Client Sample ID: Matrix Spike
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
1,2-Dichloroethane	ND		50.0	52.4		ug/L		105	56 - 136
1,2-Dichloropropane	ND		50.0	50.7		ug/L		101	80 - 123
1,3-Dichlorobenzene	ND		50.0	50.6		ug/L		101	80 - 120
1,4-Dichlorobenzene	ND		50.0	50.0		ug/L		100	80 - 120
2-Butanone (MEK)	ND		50.0	51.8		ug/L		104	58 - 143
2-Hexanone	ND		50.0	47.6		ug/L		95	47 - 150
4-Methyl-2-pentanone (MIBK)	ND		50.0	49.7		ug/L		99	53 - 150
Acetone	ND		50.0	48.2		ug/L		96	52 - 138
Benzene	ND		50.0	50.3		ug/L		101	80 - 120
Bromoform	ND		50.0	49.9		ug/L		100	65 - 133
Bromomethane	ND		50.0	45.4		ug/L		91	53 - 146
Carbon disulfide	ND		50.0	48.6		ug/L		97	69 - 139
Carbon tetrachloride	ND		50.0	51.0		ug/L		102	70 - 126
Chlorobenzene	ND		50.0	51.0		ug/L		102	80 - 120
Dibromochloromethane	ND		50.0	52.6		ug/L		105	68 - 133
Chloroethane	ND		50.0	42.5		ug/L		85	59 - 144
Chloroform	ND		50.0	51.5		ug/L		103	80 - 120
Chloromethane	ND		50.0	41.9		ug/L		84	61 - 137
cis-1,2-Dichloroethene	ND		50.0	51.5		ug/L		103	80 - 124
cis-1,3-Dichloropropene	ND		50.0	53.2		ug/L		106	67 - 130
Cyclohexane	ND		50.0	49.5		ug/L		99	70 - 143
Bromodichloromethane	ND		50.0	51.8		ug/L		104	71 - 128
Dichlorodifluoromethane	ND		50.0	38.2		ug/L		76	65 - 140
Ethylbenzene	ND		50.0	49.0		ug/L		98	80 - 121
1,2-Dibromoethane (EDB)	ND		50.0	51.9		ug/L		104	65 - 138
Isopropylbenzene	ND		50.0	51.8		ug/L		104	78 - 138
Methyl acetate	ND		250	271		ug/L		108	57 - 150
Methyl tert-butyl ether	ND		50.0	53.4		ug/L		107	64 - 137
Methylcyclohexane	ND		50.0	49.5		ug/L		99	71 - 133
Methylene Chloride	ND		50.0	51.7		ug/L		103	80 - 120
m-Xylene & p-Xylene	ND		50.0	50.5		ug/L		101	80 - 123
o-Xylene	ND		50.0	51.8		ug/L		104	80 - 129
Styrene	ND		50.0	52.3		ug/L		105	44 - 150
Tetrachloroethene	ND		50.0	50.7		ug/L		101	66 - 132
Toluene	ND		50.0	49.5		ug/L		99	75 - 134
trans-1,2-Dichloroethene	ND		50.0	50.3		ug/L		101	79 - 121
trans-1,3-Dichloropropene	ND		50.0	51.6		ug/L		103	68 - 143
Trichloroethene	1.7	J	50.0	52.4		ug/L		101	63 - 120
Trichlorofluoromethane	ND		50.0	46.6		ug/L		93	53 - 150
Vinyl chloride	ND		50.0	46.8		ug/L		94	54 - 140
Xylenes, Total	ND		100	102		ug/L		102	80 - 124

Surrogate	*MS %Recovery*	*MS Qualifier*	*Limits*
Toluene-d8 (Surr)	*102*		*80 - 129*
Dibromofluoromethane (Surr)	*107*		*80 - 121*
4-Bromofluorobenzene (Surr)	*99*		*71 - 139*
1,2-Dichloroethane-d4 (Surr)	*106*		*76 - 121*

Method: 8260C - Volatile Organic Compounds by GC/MS (Continued)

Lab Sample ID: 160-22536-A-4 MSD
Matrix: Water
Analysis Batch: 310973

Client Sample ID: Matrix Spike Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
1,1,1-Trichloroethane	ND		50.0	55.9		ug/L		112	74 - 123	9	20
1,1,2,2-Tetrachloroethane	ND		50.0	50.2		ug/L		100	60 - 150	2	20
1,1,2-Trichloroethane	ND		50.0	51.2		ug/L		102	70 - 134	2	20
1,1-Dichloroethane	ND		50.0	53.4		ug/L		107	80 - 120	5	20
1,1-Dichloroethene	ND		50.0	54.9		ug/L		110	66 - 137	11	20
1,2,4-Trichlorobenzene	ND		50.0	53.5		ug/L		107	72 - 129	8	20
1,2-Dibromo-3-Chloropropane	ND		50.0	52.2		ug/L		104	58 - 148	2	20
1,2-Dichlorobenzene	ND		50.0	52.4		ug/L		105	80 - 124	3	20
1,2-Dichloroethane	ND		50.0	53.0		ug/L		106	56 - 136	1	20
1,2-Dichloropropane	ND		50.0	53.1		ug/L		106	80 - 123	5	20
1,3-Dichlorobenzene	ND		50.0	52.4		ug/L		105	80 - 120	3	20
1,4-Dichlorobenzene	ND		50.0	52.2		ug/L		104	80 - 120	4	20
2-Butanone (MEK)	ND		50.0	50.2		ug/L		100	58 - 143	3	20
2-Hexanone	ND		50.0	47.5		ug/L		95	47 - 150	0	20
4-Methyl-2-pentanone (MIBK)	ND		50.0	50.1		ug/L		100	53 - 150	1	20
Acetone	ND		50.0	48.1		ug/L		96	52 - 138	0	20
Benzene	ND		50.0	53.2		ug/L		106	80 - 120	6	20
Bromoform	ND		50.0	49.9		ug/L		100	65 - 133	0	20
Bromomethane	ND		50.0	47.0		ug/L		94	53 - 146	3	20
Carbon disulfide	ND		50.0	54.0		ug/L		108	69 - 139	10	20
Carbon tetrachloride	ND		50.0	55.2		ug/L		110	70 - 126	8	20
Chlorobenzene	ND		50.0	53.4		ug/L		107	80 - 120	5	20
Dibromochloromethane	ND		50.0	52.8		ug/L		106	68 - 133	0	20
Chloroethane	ND		50.0	47.2		ug/L		94	59 - 144	11	20
Chloroform	ND		50.0	54.1		ug/L		108	80 - 120	5	20
Chloromethane	ND		50.0	43.3		ug/L		87	61 - 137	3	20
cis-1,2-Dichloroethene	ND		50.0	53.8		ug/L		108	80 - 124	4	20
cis-1,3-Dichloropropene	ND		50.0	54.3		ug/L		109	67 - 130	2	20
Cyclohexane	ND		50.0	53.0		ug/L		106	70 - 143	7	20
Bromodichloromethane	ND		50.0	55.6		ug/L		111	71 - 128	7	20
Dichlorodifluoromethane	ND		50.0	41.0		ug/L		82	65 - 140	7	20
Ethylbenzene	ND		50.0	52.1		ug/L		104	80 - 121	6	20
1,2-Dibromoethane (EDB)	ND		50.0	51.8		ug/L		104	65 - 138	0	20
Isopropylbenzene	ND		50.0	55.2		ug/L		110	78 - 138	6	20
Methyl acetate	ND		250	267		ug/L		107	57 - 150	2	20
Methyl tert-butyl ether	ND		50.0	54.0		ug/L		108	64 - 137	1	20
Methylcyclohexane	ND		50.0	53.2		ug/L		106	71 - 133	7	20
Methylene Chloride	ND		50.0	55.7		ug/L		111	80 - 120	8	20
m-Xylene & p-Xylene	ND		50.0	53.3		ug/L		107	80 - 123	5	20
o-Xylene	ND		50.0	54.4		ug/L		109	80 - 129	5	20
Styrene	ND		50.0	53.7		ug/L		107	44 - 150	3	20
Tetrachloroethene	ND		50.0	53.5		ug/L		107	66 - 132	5	20
Toluene	ND		50.0	52.5		ug/L		105	75 - 134	6	20
trans-1,2-Dichloroethene	ND		50.0	55.1		ug/L		110	79 - 121	9	20
trans-1,3-Dichloropropene	ND		50.0	52.6		ug/L		105	68 - 143	2	20
Trichloroethene	1.7	J	50.0	55.7		ug/L		108	63 - 120	6	20
Trichlorofluoromethane	ND		50.0	51.4		ug/L		103	53 - 150	10	20
Vinyl chloride	ND		50.0	49.0		ug/L		98	54 - 140	5	20

Method: 8260C - Volatile Organic Compounds by GC/MS (Continued)

Lab Sample ID: 160-22536-A-4 MSD
Matrix: Water
Analysis Batch: 310973

Client Sample ID: Matrix Spike Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Xylenes, Total	ND		100	108		ug/L		108	80 - 124	5	20

Surrogate	*MSD %Recovery*	*MSD Qualifier*	*Limits*
Toluene-d8 (Surr)	*103*		*80 - 129*
Dibromofluoromethane (Surr)	*109*		*80 - 121*
4-Bromofluorobenzene (Surr)	*97*		*71 - 139*
1,2-Dichloroethane-d4 (Surr)	*107*		*76 - 121*

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Lab Sample ID: MB 160-310833/1-A
Matrix: Water
Analysis Batch: 311802

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 310833

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Acenaphthene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Acenaphthylene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Anthracene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Benzo[a]anthracene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Benzo[b]fluoranthene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Benzo[k]fluoranthene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Benzo[g,h,i]perylene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Benzo[a]pyrene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Bis(2-chloroethoxy)methane	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Bis(2-chloroethyl)ether	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Bis(2-ethylhexyl) phthalate	ND		10	1.9	ug/L		05/26/17 09:15	06/03/17 15:23	1
4-Bromophenyl phenyl ether	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Butyl benzyl phthalate	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Carbazole	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
4-Chloroaniline	ND		10	2.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
4-Chloro-3-methylphenol	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
2-Chloronaphthalene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
2-Chlorophenol	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
4-Chlorophenyl phenyl ether	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Chrysene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Dibenz(a,h)anthracene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Dibenzofuran	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Di-n-butyl phthalate	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
1,2-Dichlorobenzene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
1,3-Dichlorobenzene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
1,4-Dichlorobenzene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
3,3'-Dichlorobenzidine	ND		50	1.3	ug/L		05/26/17 09:15	06/03/17 15:23	1
2,4-Dichlorophenol	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Diethyl phthalate	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
2,4-Dimethylphenol	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Dimethyl phthalate	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
4,6-Dinitro-2-methylphenol	ND		10	1.3	ug/L		05/26/17 09:15	06/03/17 15:23	1
2,4-Dinitrophenol	ND		50	2.0	ug/L		05/26/17 09:15	06/03/17 15:23	1

Client: Tighe & Bond
Project/Site: Blasting Impacted Surface Water

TestAmerica Job ID: 160-22501-1

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: MB 160-310833/1-A
Matrix: Water
Analysis Batch: 311802

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 310833

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
2,4-Dinitrotoluene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
2,6-Dinitrotoluene	ND		10	2.2	ug/L		05/26/17 09:15	06/03/17 15:23	1
Di-n-octyl phthalate	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Fluoranthene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Fluorene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Hexachlorobenzene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Hexachlorobutadiene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Hexachlorocyclopentadiene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Hexachloroethane	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Indeno[1,2,3-cd]pyrene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Isophorone	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
2-Methylnaphthalene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
2-Methylphenol	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
3 & 4 Methylphenol	ND		20	2.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Naphthalene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
2-Nitroaniline	ND		10	1.1	ug/L		05/26/17 09:15	06/03/17 15:23	1
3-Nitroaniline	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
4-Nitroaniline	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Nitrobenzene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
2-Nitrophenol	ND		10	1.5	ug/L		05/26/17 09:15	06/03/17 15:23	1
4-Nitrophenol	ND		10	2.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
N-Nitrosodi-n-propylamine	ND		10	1.5	ug/L		05/26/17 09:15	06/03/17 15:23	1
bis (2-chloroisopropyl) ether	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Pentachlorophenol	ND		50	1.3	ug/L		05/26/17 09:15	06/03/17 15:23	1
Phenanthrene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Phenol	ND		10	2.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Pyrene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
1,2,4-Trichlorobenzene	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
2,4,5-Trichlorophenol	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
2,4,6-Trichlorophenol	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Aniline	ND		10	1.3	ug/L		05/26/17 09:15	06/03/17 15:23	1
1,4-Dioxane	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Benzyl alcohol	ND		10	3.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Pyridine	ND		20	2.0	ug/L		05/26/17 09:15	06/03/17 15:23	1
Diphenylamine	ND		10	1.0	ug/L		05/26/17 09:15	06/03/17 15:23	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
2-Fluorophenol (Surr)	*32*		*15 - 59*	*05/26/17 09:15*	*06/03/17 15:23*	*1*
2,4,6-Tribromophenol (Surr)	*75*		*37 - 120*	*05/26/17 09:15*	*06/03/17 15:23*	*1*
Nitrobenzene-d5 (Surr)	*53*		*50 - 101*	*05/26/17 09:15*	*06/03/17 15:23*	*1*
Phenol-d5 (Surr)	*18*		*10 - 50*	*05/26/17 09:15*	*06/03/17 15:23*	*1*
Terphenyl-d14 (Surr)	*61*		*21 - 97*	*05/26/17 09:15*	*06/03/17 15:23*	*1*
2-Fluorobiphenyl (Surr)	*54*		*43 - 108*	*05/26/17 09:15*	*06/03/17 15:23*	*1*

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 160-310833/2-A
Matrix: Water
Analysis Batch: 311802

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 310833

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Acenaphthene	100	45.1	*	ug/L		45	58 - 108
Acenaphthylene	100	48.4	*	ug/L		48	59 - 110
Anthracene	100	57.7	*	ug/L		58	59 - 106
Benzo[a]anthracene	100	59.0		ug/L		59	56 - 105
Benzo[b]fluoranthene	100	46.7	*	ug/L		47	58 - 109
Benzo[k]fluoranthene	100	46.8	*	ug/L		47	54 - 109
Benzo[g,h,i]perylene	100	52.3		ug/L		52	50 - 119
Benzo[a]pyrene	100	47.0	*	ug/L		47	54 - 109
Bis(2-chloroethoxy)methane	100	48.8	*	ug/L		49	59 - 110
Bis(2-chloroethyl)ether	100	41.5	*	ug/L		42	58 - 109
Bis(2-ethylhexyl) phthalate	100	55.5	*	ug/L		56	58 - 111
4-Bromophenyl phenyl ether	100	63.9		ug/L		64	62 - 98
Butyl benzyl phthalate	100	56.4		ug/L		56	56 - 111
Carbazole	100	57.3		ug/L		57	56 - 101
4-Chloroaniline	100	62.5		ug/L		62	43 - 97
4-Chloro-3-methylphenol	100	59.5		ug/L		60	51 - 102
2-Chloronaphthalene	100	37.8	*	ug/L		38	58 - 109
2-Chlorophenol	100	49.2		ug/L		49	47 - 97
4-Chlorophenyl phenyl ether	100	56.7	*	ug/L		57	59 - 110
Chrysene	100	57.7		ug/L		58	55 - 107
Dibenz(a,h)anthracene	100	51.6		ug/L		52	52 - 118
Dibenzofuran	100	51.3	*	ug/L		51	57 - 106
Di-n-butyl phthalate	100	61.2		ug/L		61	60 - 105
1,2-Dichlorobenzene	100	20.8	*	ug/L		21	50 - 99
1,3-Dichlorobenzene	100	19.3	*	ug/L		19	55 - 99
1,4-Dichlorobenzene	100	19.8	*	ug/L		20	47 - 99
3,3'-Dichlorobenzidine	100	57.9		ug/L		58	50 - 105
2,4-Dichlorophenol	100	56.8		ug/L		57	55 - 104
Diethyl phthalate	100	61.8		ug/L		62	58 - 113
2,4-Dimethylphenol	100	55.0		ug/L		55	53 - 99
Dimethyl phthalate	100	61.9		ug/L		62	60 - 114
4,6-Dinitro-2-methylphenol	100	56.6		ug/L		57	56 - 118
2,4-Dinitrophenol	100	47.9	J *	ug/L		48	53 - 119
2,4-Dinitrotoluene	100	64.4		ug/L		64	57 - 117
2,6-Dinitrotoluene	100	62.3		ug/L		62	59 - 117
Di-n-octyl phthalate	100	58.4	*	ug/L		58	59 - 113
Fluoranthene	100	62.8		ug/L		63	56 - 113
Fluorene	100	55.4	*	ug/L		55	61 - 113
Hexachlorobenzene	100	71.5		ug/L		72	57 - 113
Hexachlorobutadiene	100	24.0	*	ug/L		24	52 - 102
Hexachlorocyclopentadiene	100	23.4	*	ug/L		23	40 - 120
Hexachloroethane	100	16.8	*	ug/L		17	52 - 102
Indeno[1,2,3-cd]pyrene	100	53.6		ug/L		54	49 - 120
Isophorone	100	45.4	*	ug/L		45	56 - 101
2-Methylnaphthalene	100	32.0	*	ug/L		32	54 - 101
2-Methylphenol	100	42.7		ug/L		43	40 - 96
3 & 4 Methylphenol	100	43.8		ug/L		44	40 - 87
Naphthalene	100	28.6	*	ug/L		29	54 - 98

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: LCS 160-310833/2-A
Matrix: Water
Analysis Batch: 311802

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 310833

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
2-Nitroaniline	100	50.6	*	ug/L		51	57 - 120
3-Nitroaniline	100	69.7		ug/L		70	47 - 113
4-Nitroaniline	100	66.7		ug/L		67	51 - 119
Nitrobenzene	100	44.6	*	ug/L		45	59 - 110
2-Nitrophenol	100	56.8	*	ug/L		57	58 - 111
4-Nitrophenol	100	18.7	*	ug/L		19	20 - 47
N-Nitrosodi-n-propylamine	100	45.3	*	ug/L		45	59 - 115
bis (2-chloroisopropyl) ether	100	24.8	*	ug/L		25	49 - 97
Pentachlorophenol	100	44.7	J *	ug/L		45	49 - 115
Phenanthrene	100	58.2	*	ug/L		58	59 - 110
Phenol	100	19.3	*	ug/L		19	20 - 69
Pyrene	100	55.3		ug/L		55	55 - 105
1,2,4-Trichlorobenzene	100	23.9	*	ug/L		24	56 - 100
2,4,5-Trichlorophenol	100	60.5		ug/L		60	56 - 113
2,4,6-Trichlorophenol	100	61.3		ug/L		61	47 - 116
Diphenylamine	100	57.3	*	ug/L		57	58 - 102

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
2-Fluorophenol (Surr)	*30*		*15 - 59*
2,4,6-Tribromophenol (Surr)	*79*		*37 - 120*
Nitrobenzene-d5 (Surr)	*51*		*50 - 101*
Phenol-d5 (Surr)	*18*		*10 - 50*
Terphenyl-d14 (Surr)	*59*		*21 - 97*
2-Fluorobiphenyl (Surr)	*56*		*43 - 108*

Lab Sample ID: 160-22493-E-1-A MS
Matrix: Water
Analysis Batch: 311802

Client Sample ID: Matrix Spike
Prep Type: Total/NA
Prep Batch: 310833

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Acenaphthene	ND	* F1 F2	115	44.5	F1	ug/L		39	63 - 103
Acenaphthylene	ND	* F1 F2	115	47.3	F1	ug/L		41	64 - 105
Anthracene	ND	* F1 F2	115	48.3	F1	ug/L		42	64 - 101
Benzo[a]anthracene	ND	F1 F2	115	49.9	F1	ug/L		43	55 - 116
Benzo[b]fluoranthene	ND	* F1 F2	115	40.4	F1	ug/L		35	56 - 119
Benzo[k]fluoranthene	ND	* F1 F2	115	39.4	F1	ug/L		34	54 - 110
Benzo[g,h,i]perylene	ND	F1 F2	115	45.2	F1	ug/L		39	40 - 127
Benzo[a]pyrene	ND	* F1 F2	115	39.9	F1	ug/L		35	55 - 109
Bis(2-chloroethoxy)methane	ND	* F1 F2	115	38.9	F1	ug/L		34	64 - 105
Bis(2-chloroethyl)ether	ND	* F1 F2	115	31.8	F1	ug/L		28	63 - 104
Bis(2-ethylhexyl) phthalate	ND	* F1 F2	115	46.0	F1	ug/L		40	53 - 125
4-Bromophenyl phenyl ether	ND	F1 F2	115	57.0	F1	ug/L		50	64 - 108
Butyl benzyl phthalate	ND	F1 F2	115	48.8	F1	ug/L		42	56 - 128
Carbazole	ND	F1 F2	115	49.0	F1	ug/L		43	62 - 106
4-Chloroaniline	ND		115	57.4		ug/L		50	48 - 92
4-Chloro-3-methylphenol	ND	F1 F2	115	54.1	F1	ug/L		47	51 - 105
2-Chloronaphthalene	ND	* F1 F2	115	43.4	F1	ug/L		38	63 - 104
2-Chlorophenol	ND	F1	115	38.7	F1	ug/L		34	52 - 92

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: 160-22493-E-1-A MS
Matrix: Water
Analysis Batch: 311802

Client Sample ID: Matrix Spike
Prep Type: Total/NA
Prep Batch: 310833

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
4-Chlorophenyl phenyl ether	ND	* F1 F2	115	50.8	F1	ug/L		44	64 - 105
Chrysene	ND	F1 F2	115	49.2	F1	ug/L		43	56 - 115
Dibenz(a,h)anthracene	ND	F1 F2	115	45.2	F1	ug/L		39	44 - 128
Dibenzofuran	ND	* F1 F2	115	47.4	F1	ug/L		41	62 - 101
Di-n-butyl phthalate	ND	F1 F2	115	52.5	F1	ug/L		46	62 - 109
1,2-Dichlorobenzene	ND	* F1 F2	115	26.2	F1	ug/L		23	62 - 97
1,3-Dichlorobenzene	ND	* F1	115	22.5	F1	ug/L		20	60 - 94
1,4-Dichlorobenzene	ND	* F1	115	23.9	F1	ug/L		21	60 - 94
3,3'-Dichlorobenzidine	ND	F1 F2	115	39.1	J F1	ug/L		34	43 - 117
2,4-Dichlorophenol	ND	F1 F2	115	47.7	F1	ug/L		42	60 - 99
Diethyl phthalate	ND	F1 F2	115	53.4	F1	ug/L		47	63 - 108
2,4-Dimethylphenol	ND	F1 F2	115	48.3	F1	ug/L		42	54 - 97
Dimethyl phthalate	ND	F1 F2	115	52.3	F1	ug/L		46	65 - 109
4,6-Dinitro-2-methylphenol	ND	F1 F2	115	49.9	F1	ug/L		43	61 - 113
2,4-Dinitrophenol	ND	* F2	115	46.9	J	ug/L		41	20 - 131
2,4-Dinitrotoluene	ND	F1 F2	115	55.2	F1	ug/L		48	62 - 112
2,6-Dinitrotoluene	ND	F1 F2	115	52.9	F1	ug/L		46	64 - 112
Di-n-octyl phthalate	ND	* F1 F2	115	48.6	F1	ug/L		42	54 - 128
Fluoranthene	ND	F1 F2	115	52.9	F1	ug/L		46	61 - 108
Fluorene	ND	* F1 F2	115	49.0	F1	ug/L		43	66 - 108
Hexachlorobenzene	ND	F1 F2	115	60.6	F1	ug/L		53	62 - 108
Hexachlorobutadiene	ND	* F1 F2	115	33.9	F1	ug/L		30	57 - 97
Hexachlorocyclopentadiene	ND	* F2	115	35.7		ug/L		31	16 - 115
Hexachloroethane	ND	* F1	115	20.3	F1	ug/L		18	57 - 97
Indeno[1,2,3-cd]pyrene	ND	F1 F2	115	44.8	F1	ug/L		39	42 - 131
Isophorone	ND	* F1 F2	115	37.0	F1	ug/L		32	48 - 106
2-Methylnaphthalene	ND	* F1 F2	115	41.5	F1	ug/L		36	64 - 99
2-Methylphenol	ND	F1 F2	115	38.6	F1	ug/L		34	39 - 83
3 & 4 Methylphenol	ND	F1 F2	115	41.4	F1	ug/L		36	39 - 82
Naphthalene	ND	* F1 F2	115	38.0	F1	ug/L		33	63 - 98
2-Nitroaniline	ND	* F1 F2	115	43.3	F1	ug/L		38	62 - 115
3-Nitroaniline	ND		115	74.0		ug/L		64	52 - 108
4-Nitroaniline	ND	F1 F2	115	60.7	F1	ug/L		53	56 - 114
Nitrobenzene	ND	* F1 F2	115	37.3	F1	ug/L		33	64 - 105
2-Nitrophenol	ND	* F1 F2	115	45.8	F1	ug/L		40	64 - 106
4-Nitrophenol	ND	* F2	115	26.9		ug/L		23	15 - 42
N-Nitrosodi-n-propylamine	ND	* F1 F2	115	36.5	F1	ug/L		32	64 - 110
bis (2-chloroisopropyl) ether	ND	* F1 F2	115	22.4	F1	ug/L		20	54 - 102
Pentachlorophenol	ND	* F1 F2	115	40.5	J F1	ug/L		35	54 - 110
Phenanthrene	ND	* F1 F2	115	49.6	F1	ug/L		43	64 - 105
Phenol	ND	* F1	115	ND	F1	ug/L		0	15 - 70
Pyrene	ND	F1 F2	115	46.5	F1	ug/L		40	57 - 118
1,2,4-Trichlorobenzene	ND	* F1 F2	115	34.9	F1	ug/L		30	61 - 95
2,4,5-Trichlorophenol	ND	F1 F2	115	50.7	F1	ug/L		44	61 - 108
2,4,6-Trichlorophenol	ND	F1 F2	115	52.0	F1	ug/L		45	61 - 108
Diphenylamine	ND	* F1 F2	115	48.2	F1	ug/L		42	63 - 97

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: 160-22493-E-1-A MS
Matrix: Water
Analysis Batch: 311802

Client Sample ID: Matrix Spike
Prep Type: Total/NA
Prep Batch: 310833

Surrogate	MS %Recovery	MS Qualifier	Limits
2-Fluorophenol (Surr)	22		15 - 59
2,4,6-Tribromophenol (Surr)	61		37 - 120
Nitrobenzene-d5 (Surr)	34	X	50 - 101
Phenol-d5 (Surr)	17		10 - 50
Terphenyl-d14 (Surr)	45		21 - 97
2-Fluorobiphenyl (Surr)	41	X	43 - 108

Lab Sample ID: 160-22493-F-1-A MSD
Matrix: Water
Analysis Batch: 311802

Client Sample ID: Matrix Spike Duplicate
Prep Type: Total/NA
Prep Batch: 310833

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Acenaphthene	ND	* F1 F2	105	30.2	F1 F2	ug/L		29	63 - 103	38	20
Acenaphthylene	ND	* F1 F2	105	32.2	F1 F2	ug/L		31	64 - 105	38	20
Anthracene	ND	* F1 F2	105	33.4	F1 F2	ug/L		32	64 - 101	36	20
Benzo[a]anthracene	ND	F1 F2	105	34.7	F1 F2	ug/L		33	55 - 116	36	20
Benzo[b]fluoranthene	ND	* F1 F2	105	28.0	F1 F2	ug/L		27	56 - 119	36	20
Benzo[k]fluoranthene	ND	* F1 F2	105	28.0	F1 F2	ug/L		27	54 - 110	34	20
Benzo[g,h,i]perylene	ND	F1 F2	105	30.6	F1 F2	ug/L		29	40 - 127	39	20
Benzo[a]pyrene	ND	* F1 F2	105	27.6	F1 F2	ug/L		26	55 - 109	36	20
Bis(2-chloroethoxy)methane	ND	* F1 F2	105	26.4	F1 F2	ug/L		25	64 - 105	38	20
Bis(2-chloroethyl)ether	ND	* F1 F2	105	24.2	F1 F2	ug/L		23	63 - 104	27	20
Bis(2-ethylhexyl) phthalate	ND	* F1 F2	105	30.2	F1 F2	ug/L		29	53 - 125	41	20
4-Bromophenyl phenyl ether	ND	F1 F2	105	38.3	F1 F2	ug/L		36	64 - 108	39	20
Butyl benzyl phthalate	ND	F1 F2	105	34.2	F1 F2	ug/L		33	56 - 128	35	20
Carbazole	ND	F1 F2	105	33.7	F1 F2	ug/L		32	62 - 106	37	20
4-Chloroaniline	ND		105	56.9		ug/L		54	48 - 92	1	20
4-Chloro-3-methylphenol	ND	F1 F2	105	39.1	F1 F2	ug/L		37	51 - 105	32	20
2-Chloronaphthalene	ND	* F1 F2	105	29.8	F1 F2	ug/L		28	63 - 104	37	20
2-Chlorophenol	ND	F1	105	32.7	F1	ug/L		31	52 - 92	17	20
4-Chlorophenyl phenyl ether	ND	* F1 F2	105	35.1	F1 F2	ug/L		33	64 - 105	37	20
Chrysene	ND	F1 F2	105	34.3	F1 F2	ug/L		33	56 - 115	36	20
Dibenz(a,h)anthracene	ND	F1 F2	105	30.9	F1 F2	ug/L		29	44 - 128	38	20
Dibenzofuran	ND	* F1 F2	105	32.2	F1 F2	ug/L		31	62 - 101	38	20
Di-n-butyl phthalate	ND	F1 F2	105	36.1	F1 F2	ug/L		34	62 - 109	37	20
1,2-Dichlorobenzene	ND	* F1 F2	105	20.5	F1 F2	ug/L		20	62 - 97	24	20
1,3-Dichlorobenzene	ND	* F1	105	19.4	F1	ug/L		19	60 - 94	15	20
1,4-Dichlorobenzene	ND	* F1	105	19.6	F1	ug/L		19	60 - 94	20	20
3,3'-Dichlorobenzidine	ND	F1 F2	105	28.0	J F1 F2	ug/L		27	43 - 117	33	20
2,4-Dichlorophenol	ND	F1 F2	105	34.9	F1 F2	ug/L		33	60 - 99	31	20
Diethyl phthalate	ND	F1 F2	105	35.7	F1 F2	ug/L		34	63 - 108	40	20
2,4-Dimethylphenol	ND	F1 F2	105	35.4	F1 F2	ug/L		34	54 - 97	31	20
Dimethyl phthalate	ND	F1 F2	105	35.8	F1 F2	ug/L		34	65 - 109	37	20
4,6-Dinitro-2-methylphenol	ND	F1 F2	105	35.6	F1 F2	ug/L		34	61 - 113	33	20
2,4-Dinitrophenol	ND	* F2	105	33.6	J F2	ug/L		32	20 - 131	33	20
2,4-Dinitrotoluene	ND	F1 F2	105	37.1	F1 F2	ug/L		35	62 - 112	39	20
2,6-Dinitrotoluene	ND	F1 F2	105	35.9	F1 F2	ug/L		34	64 - 112	38	20
Di-n-octyl phthalate	ND	* F1 F2	105	31.3	F1 F2	ug/L		30	54 - 128	43	20

Method: 8270D - Semivolatile Organic Compounds (GC/MS) (Continued)

Lab Sample ID: 160-22493-F-1-A MSD
Matrix: Water
Analysis Batch: 311802

Client Sample ID: Matrix Spike Duplicate
Prep Type: Total/NA
Prep Batch: 310833

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Fluoranthene	ND	F1 F2	105	36.9	F1 F2	ug/L		35	61 - 108	35	20
Fluorene	ND	* F1 F2	105	33.2	F1 F2	ug/L		32	66 - 108	39	20
Hexachlorobenzene	ND	F1 F2	105	42.5	F1 F2	ug/L		40	62 - 108	35	20
Hexachlorobutadiene	ND	* F1 F2	105	26.1	F1 F2	ug/L		25	57 - 97	26	20
Hexachlorocyclopentadiene	ND	* F2	105	24.4	F2	ug/L		23	16 - 115	38	20
Hexachloroethane	ND	* F1	105	17.4	F1	ug/L		17	57 - 97	15	20
Indeno[1,2,3-cd]pyrene	ND	F1 F2	105	31.2	F1 F2	ug/L		30	42 - 131	36	20
Isophorone	ND	* F1 F2	105	25.4	F1 F2	ug/L		24	48 - 106	37	20
2-Methylnaphthalene	ND	* F1 F2	105	28.7	F1 F2	ug/L		27	64 - 99	36	20
2-Methylphenol	ND	F1 F2	105	30.6	F1 F2	ug/L		29	39 - 83	23	20
3 & 4 Methylphenol	ND	F1 F2	105	33.1	F1 F2	ug/L		32	39 - 82	22	20
Naphthalene	ND	* F1 F2	105	26.2	F1 F2	ug/L		25	63 - 98	37	20
2-Nitroaniline	ND	* F1 F2	105	30.1	F1 F2	ug/L		29	62 - 115	36	20
3-Nitroaniline	ND		105	60.5		ug/L		58	52 - 108	20	20
4-Nitroaniline	ND	F1 F2	105	45.2	F1 F2	ug/L		43	56 - 114	29	20
Nitrobenzene	ND	* F1 F2	105	26.2	F1 F2	ug/L		25	64 - 105	35	20
2-Nitrophenol	ND	* F1 F2	105	32.7	F1 F2	ug/L		31	64 - 106	33	20
4-Nitrophenol	ND	* F2	105	20.4	F2	ug/L		19	15 - 42	27	20
N-Nitrosodi-n-propylamine	ND	* F1 F2	105	24.9	F1 F2	ug/L		24	64 - 110	38	20
bis (2-chloroisopropyl) ether	ND	* F1 F2	105	15.7	F1 F2	ug/L		15	54 - 102	35	20
Pentachlorophenol	ND	* F1 F2	105	28.1	J F1 F2	ug/L		27	54 - 110	36	20
Phenanthrene	ND	* F1 F2	105	34.0	F1 F2	ug/L		32	64 - 105	37	20
Phenol	ND	* F1	105	16.3		ug/L		16	15 - 70	NC	20
Pyrene	ND	F1 F2	105	32.3	F1 F2	ug/L		31	57 - 118	36	20
1,2,4-Trichlorobenzene	ND	* F1 F2	105	24.4	F1 F2	ug/L		23	61 - 95	35	20
2,4,5-Trichlorophenol	ND	F1 F2	105	35.9	F1 F2	ug/L		34	61 - 108	34	20
2,4,6-Trichlorophenol	ND	F1 F2	105	35.6	F1 F2	ug/L		34	61 - 108	38	20
Diphenylamine	ND	* F1 F2	105	32.7	F1 F2	ug/L		31	63 - 97	38	20

Surrogate	*MSD %Recovery*	*MSD Qualifier*	*Limits*
2-Fluorophenol (Surr)	*23*		*15 - 59*
2,4,6-Tribromophenol (Surr)	*46*		*37 - 120*
Nitrobenzene-d5 (Surr)	*26*	*X*	*50 - 101*
Phenol-d5 (Surr)	*15*		*10 - 50*
Terphenyl-d14 (Surr)	*35*		*21 - 97*
2-Fluorobiphenyl (Surr)	*31*	*X*	*43 - 108*

Method: 300.0 - Anions, Ion Chromatography

Lab Sample ID: MB 160-310288/9
Matrix: Water
Analysis Batch: 310288

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Nitrate	ND		0.020	0.0070	mg/L			05/24/17 15:55	1
Nitrite	ND		0.020	0.0070	mg/L			05/24/17 15:55	1

Method: 300.0 - Anions, Ion Chromatography (Continued)

Lab Sample ID: LCS 160-310288/10
Matrix: Water
Analysis Batch: 310288

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Nitrate	0.400	0.394		mg/L		99	90 - 110
Nitrite	0.160	0.156		mg/L		98	90 - 110

Lab Sample ID: 160-22501-1 MS
Matrix: Water
Analysis Batch: 310288

Client Sample ID: SW-1
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Nitrite	ND	F1	0.100	0.0797	F1	mg/L		80	90 - 110

Lab Sample ID: 160-22501-1 DU
Matrix: Water
Analysis Batch: 310288

Client Sample ID: SW-1
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Nitrite	ND	F1	ND		mg/L		NC	20

Method: 300.0 - Anions, Ion Chromatography - DL

Lab Sample ID: 160-22501-1 MS
Matrix: Water
Analysis Batch: 310288

Client Sample ID: SW-1
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Nitrate - DL	4.2		8.00	11.7		mg/L		93	90 - 110

Lab Sample ID: 160-22501-1 DU
Matrix: Water
Analysis Batch: 310288

Client Sample ID: SW-1
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Nitrate - DL	4.2		4.11		mg/L		3	20

Method: 314.0 - Perchlorate (IC)

Lab Sample ID: MB 160-311177/11
Matrix: Water
Analysis Batch: 311177

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perchlorate	ND		12	4.0	ug/L			05/30/17 20:59	1

Lab Sample ID: LCS 160-311177/12
Matrix: Water
Analysis Batch: 311177

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Perchlorate	50.0	47.7		ug/L		95	85 - 115

Method: 314.0 - Perchlorate (IC) - DL

Lab Sample ID: 160-22378-C-3 MS
Matrix: Water
Analysis Batch: 311177

Client Sample ID: Matrix Spike
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Perchlorate - DL	ND	F1	2500	1070	F1	ug/L		43	80 - 120

Lab Sample ID: 160-22378-C-3 MSD
Matrix: Water
Analysis Batch: 311177

Client Sample ID: Matrix Spike Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Perchlorate - DL	ND	F1	2500	1190	F1	ug/L		48	80 - 120	11	15

Method: 8330B - Nitroaromatics and Nitramines (HPLC)

Lab Sample ID: MB 160-310680/1-A
Matrix: Water
Analysis Batch: 311410

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 310680

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
1,3,5-Trinitrobenzene	ND		0.20	0.057	ug/L		05/25/17 14:11	06/01/17 11:49	1
1,3-Dinitrobenzene	ND		0.20	0.10	ug/L		05/25/17 14:11	06/01/17 11:49	1
2,4-Dinitrotoluene	ND		0.20	0.081	ug/L		05/25/17 14:11	06/01/17 11:49	1
2,6-Dinitrotoluene	ND		0.20	0.13	ug/L		05/25/17 14:11	06/01/17 11:49	1
2-Amino-4,6-dinitrotoluene	ND		0.20	0.12	ug/L		05/25/17 14:11	06/01/17 11:49	1
2-Nitrotoluene	ND		0.50	0.095	ug/L		05/25/17 14:11	06/01/17 11:49	1
3-Nitrotoluene	ND		0.20	0.12	ug/L		05/25/17 14:11	06/01/17 11:49	1
4-Nitrotoluene	ND		0.50	0.14	ug/L		05/25/17 14:11	06/01/17 11:49	1
HMX	ND		0.20	0.11	ug/L		05/25/17 14:11	06/01/17 11:49	1
Nitrobenzene	ND		0.20	0.082	ug/L		05/25/17 14:11	06/01/17 11:49	1
Nitroglycerin	ND		1.0	0.54	ug/L		05/25/17 14:11	06/01/17 11:49	1
PETN	ND		2.0	0.61	ug/L		05/25/17 14:11	06/01/17 11:49	1
RDX	ND		0.20	0.094	ug/L		05/25/17 14:11	06/01/17 11:49	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dinitrobenzene (Surr)	*96*		*81 - 113*	*05/25/17 14:11*	*06/01/17 11:49*	*1*

Lab Sample ID: MB 160-310680/1-A
Matrix: Water
Analysis Batch: 311412

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 310680

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
2,4,6-Trinitrotoluene	ND		0.20	0.080	ug/L		05/25/17 14:11	06/01/17 22:00	1
4-Amino-2,6-dinitrotoluene	ND		0.20	0.12	ug/L		05/25/17 14:11	06/01/17 22:00	1
Tetryl	ND		0.20	0.059	ug/L		05/25/17 14:11	06/01/17 22:00	1

Lab Sample ID: LCS 160-310680/2-A
Matrix: Water
Analysis Batch: 311410

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 310680

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,3,5-Trinitrobenzene	4.00	4.08		ug/L		102	74 - 114

Method: 8330B - Nitroaromatics and Nitramines (HPLC) (Continued)

Lab Sample ID: LCS 160-310680/2-A
Matrix: Water
Analysis Batch: 311410

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 310680

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
1,3-Dinitrobenzene	4.00	4.15		ug/L		104	83 - 117
2,4-Dinitrotoluene	4.00	4.03		ug/L		101	76 - 113
2,6-Dinitrotoluene	4.00	4.09		ug/L		102	67 - 121
2-Amino-4,6-dinitrotoluene	4.00	4.07		ug/L		102	67 - 120
2-Nitrotoluene	4.00	3.78		ug/L		95	66 - 128
3-Nitrotoluene	4.00	4.26		ug/L		107	69 - 129
4-Nitrotoluene	4.00	3.98		ug/L		100	70 - 120
HMX	4.00	4.07		ug/L		102	63 - 112
Nitrobenzene	4.00	3.91		ug/L		98	75 - 120
Nitroglycerin	10.0	7.82		ug/L		78	40 - 122
PETN	9.99	9.71		ug/L		97	71 - 136
RDX	4.00	4.05		ug/L		101	75 - 115

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dinitrobenzene (Surr)	*100*		*81 - 113*

Lab Sample ID: LCS 160-310680/2-A
Matrix: Water
Analysis Batch: 311412

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 310680

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
2,4,6-Trinitrotoluene	4.00	4.65	*	ug/L		116	64 - 115
4-Amino-2,6-dinitrotoluene	4.00	4.53		ug/L		113	66 - 140
Tetryl	4.00	4.48		ug/L		112	41 - 124

Lab Sample ID: 160-22501-1 MS
Matrix: Water
Analysis Batch: 311410

Client Sample ID: SW-1
Prep Type: Total/NA
Prep Batch: 310680

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
1,3,5-Trinitrobenzene	ND		4.00	3.49		ug/L		87	64 - 124
1,3-Dinitrobenzene	ND		4.00	3.78		ug/L		95	66 - 131
2,4-Dinitrotoluene	ND		4.00	3.72		ug/L		93	65 - 125
2,6-Dinitrotoluene	ND		4.00	3.78		ug/L		94	57 - 129
2-Amino-4,6-dinitrotoluene	ND		4.00	3.84		ug/L		96	65 - 123
2-Nitrotoluene	ND		4.00	3.61		ug/L		90	35 - 149
3-Nitrotoluene	ND		4.00	4.13		ug/L		103	59 - 119
4-Nitrotoluene	ND		4.00	3.79		ug/L		95	58 - 123
HMX	ND		4.00	3.78		ug/L		95	34 - 150
Nitrobenzene	ND		4.00	3.62		ug/L		91	57 - 126
Nitroglycerin	ND		10.0	7.24		ug/L		72	45 - 130
PETN	ND		9.99	8.68		ug/L		87	56 - 128
RDX	ND		4.00	3.94		ug/L		98	53 - 138

Surrogate	*MS %Recovery*	*MS Qualifier*	*Limits*
1,2-Dinitrobenzene (Surr)	*99*		*81 - 113*

Method: 8330B - Nitroaromatics and Nitramines (HPLC) (Continued)

Lab Sample ID: 160-22501-1 MS
Matrix: Water
Analysis Batch: 311412

Client Sample ID: SW-1
Prep Type: Total/NA
Prep Batch: 310680

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
2,4,6-Trinitrotoluene	ND	*	4.00	3.72		ug/L		93	50 - 138
4-Amino-2,6-dinitrotoluene	ND		4.00	4.53		ug/L		113	60 - 134
Tetryl	ND	F1 F2	4.00	1.75		ug/L		44	35 - 140

Lab Sample ID: 160-22501-1 MSD
Matrix: Water
Analysis Batch: 311410

Client Sample ID: SW-1
Prep Type: Total/NA
Prep Batch: 310680

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
1,3,5-Trinitrobenzene	ND		4.00	3.47		ug/L		87	64 - 124	1	20
1,3-Dinitrobenzene	ND		4.00	3.95		ug/L		99	66 - 131	4	20
2,4-Dinitrotoluene	ND		4.00	3.90		ug/L		97	65 - 125	5	20
2,6-Dinitrotoluene	ND		4.00	4.10		ug/L		102	57 - 129	8	20
2-Amino-4,6-dinitrotoluene	ND		4.00	4.02		ug/L		101	65 - 123	5	20
2-Nitrotoluene	ND		4.00	3.76		ug/L		94	35 - 149	4	20
3-Nitrotoluene	ND		4.00	4.47		ug/L		112	59 - 119	8	20
4-Nitrotoluene	ND		4.00	4.05		ug/L		101	58 - 123	7	20
HMX	ND		4.00	4.06		ug/L		101	34 - 150	7	20
Nitrobenzene	ND		4.00	3.78		ug/L		95	57 - 126	4	20
Nitroglycerin	ND		9.99	7.07		ug/L		71	45 - 130	2	30
PETN	ND		9.98	9.74		ug/L		98	56 - 128	12	20
RDX	ND		4.00	4.11		ug/L		103	53 - 138	4	20

Surrogate	*MSD %Recovery*	*MSD Qualifier*	*Limits*
1,2-Dinitrobenzene (Surr)	93		*81 - 113*

Lab Sample ID: 160-22501-1 MSD
Matrix: Water
Analysis Batch: 311412

Client Sample ID: SW-1
Prep Type: Total/NA
Prep Batch: 310680

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
2,4,6-Trinitrotoluene	ND	*	4.00	3.67		ug/L		92	50 - 138	1	20
4-Amino-2,6-dinitrotoluene	ND		4.00	4.55		ug/L		114	60 - 134	0	20
Tetryl	ND	F1 F2	4.00	1.03	F1 F2	ug/L		26	35 - 140	52	20

Method: 6010C - Metals (ICP)

Lab Sample ID: MB 160-311732/1-A
Matrix: Water
Analysis Batch: 312048

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 311732

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Boron	ND		100	25	ug/L		06/02/17 10:34	06/05/17 23:24	1
Sulfur	ND		5000	1500	ug/L		06/02/17 10:34	06/05/17 23:24	1

Method: 6010C - Metals (ICP) (Continued)

Lab Sample ID: LCS 160-311732/2-A
Matrix: Water
Analysis Batch: 312048

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 311732

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Boron	200	189		ug/L		94	80 - 120
Sulfur	10000	9090		ug/L		91	80 - 120

Lab Sample ID: 160-22501-1 MS
Matrix: Water
Analysis Batch: 312048

Client Sample ID: SW-1
Prep Type: Total/NA
Prep Batch: 311732

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Boron	310		200	495		ug/L		92	75 - 125
Sulfur	7400		10000	17200		ug/L		98	75 - 125

Lab Sample ID: 160-22501-1 MSD
Matrix: Water
Analysis Batch: 312048

Client Sample ID: SW-1
Prep Type: Total/NA
Prep Batch: 311732

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Boron	310		200	501		ug/L		95	75 - 125	1	20
Sulfur	7400		10000	17000		ug/L		96	75 - 125	1	20

Method: 6020A - Metals (ICP/MS)

Lab Sample ID: MB 160-311733/1-A
Matrix: Water
Analysis Batch: 312039

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 311733

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Aluminum	ND		50	20	ug/L		06/02/17 10:35	06/05/17 18:16	2
Chromium	ND		10	4.0	ug/L		06/02/17 10:35	06/05/17 18:16	2
Lead	ND		3.0	1.0	ug/L		06/02/17 10:35	06/05/17 18:16	2
Molybdenum	ND		5.0	2.0	ug/L		06/02/17 10:35	06/05/17 18:16	2
Tungsten	ND		5.0	2.0	ug/L		06/02/17 10:35	06/05/17 18:16	2

Lab Sample ID: LCS 160-311733/2-A
Matrix: Water
Analysis Batch: 312039

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 311733

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	10000	9110		ug/L		91	80 - 120
Chromium	1000	1010		ug/L		101	80 - 120
Lead	1000	972		ug/L		97	80 - 120
Molybdenum	500	489		ug/L		98	80 - 120
Tungsten	1000	1040		ug/L		104	80 - 120

Lab Sample ID: 160-22501-1 MS
Matrix: Water
Analysis Batch: 312039

Client Sample ID: SW-1
Prep Type: Total/NA
Prep Batch: 311733

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Aluminum	860		10000	10100		ug/L		92	75 - 125

Method: 6020A - Metals (ICP/MS) (Continued)

Lab Sample ID: 160-22501-1 MS
Matrix: Water
Analysis Batch: 312039

Client Sample ID: SW-1
Prep Type: Total/NA
Prep Batch: 311733

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Chromium	ND		1000	1000		ug/L		100	75 - 125
Lead	ND		1000	974		ug/L		97	75 - 125
Molybdenum	3.5	J	500	504		ug/L		100	75 - 125
Tungsten	ND		1000	1050		ug/L		105	75 - 125

Lab Sample ID: 160-22501-1 MSD
Matrix: Water
Analysis Batch: 312039

Client Sample ID: SW-1
Prep Type: Total/NA
Prep Batch: 311733

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Aluminum	860		10000	10000		ug/L		92	75 - 125	0	20
Chromium	ND		1000	1020		ug/L		102	75 - 125	2	20
Lead	ND		1000	995		ug/L		99	75 - 125	2	20
Molybdenum	3.5	J	500	502		ug/L		100	75 - 125	0	20
Tungsten	ND		1000	1050		ug/L		105	75 - 125	0	20

Method: 150.1 - pH (Electrometric)

Lab Sample ID: LCS 160-310423/5
Matrix: Water
Analysis Batch: 310423

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
pH	7.00	7.0		SU		100	99.0 - 101.0

Lab Sample ID: 160-22495-H-1 DU
Matrix: Water
Analysis Batch: 310423

Client Sample ID: Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
pH	7.4		7.4		SU		0.5	5

Method: 160.2 - Solids, Total Suspended (TSS)

Lab Sample ID: MB 160-310722/1
Matrix: Water
Analysis Batch: 310722

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Suspended Solids	ND		4.0	4.0	mg/L			05/26/17 06:26	1

Lab Sample ID: LCS 160-310722/2
Matrix: Water
Analysis Batch: 310722

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Suspended Solids	500	498		mg/L		100	78 - 124

Method: 160.2 - Solids, Total Suspended (TSS) (Continued)

Lab Sample ID: 160-22437-G-2 DU
Matrix: Water
Analysis Batch: 310722

Client Sample ID: Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Total Suspended Solids	ND		ND		mg/L		NC	5

Method: 310.1 - Alkalinity

Lab Sample ID: MB 160-311788/1
Matrix: Water
Analysis Batch: 311788

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Alkalinity	ND		5.0	0.54	mg/L			06/02/17 19:58	1

Lab Sample ID: HLCS 160-311788/3
Matrix: Water
Analysis Batch: 311788

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	HLCS Result	HLCS Qualifier	Unit	D	%Rec	%Rec. Limits
Alkalinity	400	368		mg/L		92	90 - 110

Lab Sample ID: LCS 160-311788/2
Matrix: Water
Analysis Batch: 311788

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Alkalinity	200	186		mg/L		93	90 - 110

Lab Sample ID: 160-22564-A-4 MS
Matrix: Water
Analysis Batch: 311788

Client Sample ID: Matrix Spike
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Alkalinity	2.0	J	100	96.0		mg/L		94	80 - 120

Lab Sample ID: 160-22564-A-4 DU
Matrix: Water
Analysis Batch: 311788

Client Sample ID: Duplicate
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Alkalinity	2.0	J	2.00	J	mg/L		0	20

Method: 351.2 - Nitrogen, Total Kjeldahl

Lab Sample ID: MB 160-310944/7-A
Matrix: Water
Analysis Batch: 311375

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 310944

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Nitrogen, Kjeldahl	ND		0.50	0.22	mg/L		05/26/17 14:05	05/30/17 21:09	1

Method: 351.2 - Nitrogen, Total Kjeldahl (Continued)

Lab Sample ID: LCS 160-310944/8-A
Matrix: Water
Analysis Batch: 311375

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 310944

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Nitrogen, Kjeldahl	2.50	2.40		mg/L		96	90 - 110

Lab Sample ID: 160-22501-1 MS
Matrix: Water
Analysis Batch: 311375

Client Sample ID: SW-1
Prep Type: Total/NA
Prep Batch: 310944

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Nitrogen, Kjeldahl	0.22	J F1	2.50	2.14	F1	mg/L		77	90 - 110

Lab Sample ID: 160-22501-1 DU
Matrix: Water
Analysis Batch: 311375

Client Sample ID: SW-1
Prep Type: Total/NA
Prep Batch: 310944

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Nitrogen, Kjeldahl	0.22	J F1	ND		mg/L		NC	20

Method: 415.1 - TOC

Lab Sample ID: MB 160-312064/4
Matrix: Water
Analysis Batch: 312064

Client Sample ID: Method Blank
Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Organic Carbon	ND		1.0	0.72	mg/L			06/05/17 20:44	1

Lab Sample ID: LCS 160-312064/5
Matrix: Water
Analysis Batch: 312064

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon	10.0	9.75		mg/L		98	90 - 110

Lab Sample ID: 160-22501-1 MS
Matrix: Water
Analysis Batch: 312064

Client Sample ID: SW-1
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Total Organic Carbon	0.79	J	5.00	5.85		mg/L		101	76 - 120

Lab Sample ID: 160-22501-1 DU
Matrix: Water
Analysis Batch: 312064

Client Sample ID: SW-1
Prep Type: Total/NA

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Total Organic Carbon	0.79	J	0.740	J	mg/L		6	20

GC/MS VOA

Analysis Batch: 310973

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	8260C	
MB 160-310973/8	Method Blank	Total/NA	Water	8260C	
LCS 160-310973/5	Lab Control Sample	Total/NA	Water	8260C	
LCSD 160-310973/6	Lab Control Sample Dup	Total/NA	Water	8260C	
160-22536-A-4 MS	Matrix Spike	Total/NA	Water	8260C	
160-22536-A-4 MSD	Matrix Spike Duplicate	Total/NA	Water	8260C	

GC/MS Semi VOA

Prep Batch: 310833

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	3510C	
MB 160-310833/1-A	Method Blank	Total/NA	Water	3510C	
LCS 160-310833/2-A	Lab Control Sample	Total/NA	Water	3510C	
160-22493-E-1-A MS	Matrix Spike	Total/NA	Water	3510C	
160-22493-F-1-A MSD	Matrix Spike Duplicate	Total/NA	Water	3510C	

Analysis Batch: 311802

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	8270D	310833
MB 160-310833/1-A	Method Blank	Total/NA	Water	8270D	310833
LCS 160-310833/2-A	Lab Control Sample	Total/NA	Water	8270D	310833
160-22493-E-1-A MS	Matrix Spike	Total/NA	Water	8270D	310833
160-22493-F-1-A MSD	Matrix Spike Duplicate	Total/NA	Water	8270D	310833

HPLC/IC

Analysis Batch: 310288

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	300.0	
160-22501-1 - DL	SW-1	Total/NA	Water	300.0	
MB 160-310288/9	Method Blank	Total/NA	Water	300.0	
LCS 160-310288/10	Lab Control Sample	Total/NA	Water	300.0	
160-22501-1 MS	SW-1	Total/NA	Water	300.0	
160-22501-1 MS - DL	SW-1	Total/NA	Water	300.0	
160-22501-1 DU	SW-1	Total/NA	Water	300.0	
160-22501-1 DU - DL	SW-1	Total/NA	Water	300.0	

Prep Batch: 310680

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	8330-Prep	
MB 160-310680/1-A	Method Blank	Total/NA	Water	8330-Prep	
LCS 160-310680/2-A	Lab Control Sample	Total/NA	Water	8330-Prep	
160-22501-1 MS	SW-1	Total/NA	Water	8330-Prep	
160-22501-1 MSD	SW-1	Total/NA	Water	8330-Prep	

Analysis Batch: 311177

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	314.0	
MB 160-311177/11	Method Blank	Total/NA	Water	314.0	

HPLC/IC (Continued)

Analysis Batch: 311177 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCS 160-311177/12	Lab Control Sample	Total/NA	Water	314.0	
160-22378-C-3 MS - DL	Matrix Spike	Total/NA	Water	314.0	
160-22378-C-3 MSD - DL	Matrix Spike Duplicate	Total/NA	Water	314.0	

Analysis Batch: 311410

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	8330B	310680
MB 160-310680/1-A	Method Blank	Total/NA	Water	8330B	310680
LCS 160-310680/2-A	Lab Control Sample	Total/NA	Water	8330B	310680
160-22501-1 MS	SW-1	Total/NA	Water	8330B	310680
160-22501-1 MSD	SW-1	Total/NA	Water	8330B	310680

Analysis Batch: 311412

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	8330B	310680
MB 160-310680/1-A	Method Blank	Total/NA	Water	8330B	310680
LCS 160-310680/2-A	Lab Control Sample	Total/NA	Water	8330B	310680
160-22501-1 MS	SW-1	Total/NA	Water	8330B	310680
160-22501-1 MSD	SW-1	Total/NA	Water	8330B	310680

Metals

Prep Batch: 311732

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	3010A	
MB 160-311732/1-A	Method Blank	Total/NA	Water	3010A	
LCS 160-311732/2-A	Lab Control Sample	Total/NA	Water	3010A	
160-22501-1 MS	SW-1	Total/NA	Water	3010A	
160-22501-1 MSD	SW-1	Total/NA	Water	3010A	

Prep Batch: 311733

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	3010A	
MB 160-311733/1-A	Method Blank	Total/NA	Water	3010A	
LCS 160-311733/2-A	Lab Control Sample	Total/NA	Water	3010A	
160-22501-1 MS	SW-1	Total/NA	Water	3010A	
160-22501-1 MSD	SW-1	Total/NA	Water	3010A	

Analysis Batch: 312039

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	6020A	311733
MB 160-311733/1-A	Method Blank	Total/NA	Water	6020A	311733
LCS 160-311733/2-A	Lab Control Sample	Total/NA	Water	6020A	311733
160-22501-1 MS	SW-1	Total/NA	Water	6020A	311733
160-22501-1 MSD	SW-1	Total/NA	Water	6020A	311733

Analysis Batch: 312048

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	6010C	311732
MB 160-311732/1-A	Method Blank	Total/NA	Water	6010C	311732

Metals (Continued)

Analysis Batch: 312048 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCS 160-311732/2-A	Lab Control Sample	Total/NA	Water	6010C	311732
160-22501-1 MS	SW-1	Total/NA	Water	6010C	311732
160-22501-1 MSD	SW-1	Total/NA	Water	6010C	311732

General Chemistry

Analysis Batch: 310423

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	150.1	
LCS 160-310423/5	Lab Control Sample	Total/NA	Water	150.1	
160-22495-H-1 DU	Duplicate	Total/NA	Water	150.1	

Analysis Batch: 310722

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	160.2	
MB 160-310722/1	Method Blank	Total/NA	Water	160.2	
LCS 160-310722/2	Lab Control Sample	Total/NA	Water	160.2	
160-22437-G-2 DU	Duplicate	Total/NA	Water	160.2	

Prep Batch: 310944

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	351.2	
MB 160-310944/7-A	Method Blank	Total/NA	Water	351.2	
LCS 160-310944/8-A	Lab Control Sample	Total/NA	Water	351.2	
160-22501-1 MS	SW-1	Total/NA	Water	351.2	
160-22501-1 DU	SW-1	Total/NA	Water	351.2	

Analysis Batch: 311375

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	351.2	310944
MB 160-310944/7-A	Method Blank	Total/NA	Water	351.2	310944
LCS 160-310944/8-A	Lab Control Sample	Total/NA	Water	351.2	310944
160-22501-1 MS	SW-1	Total/NA	Water	351.2	310944
160-22501-1 DU	SW-1	Total/NA	Water	351.2	310944

Analysis Batch: 311788

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	310.1	
MB 160-311788/1	Method Blank	Total/NA	Water	310.1	
HLCS 160-311788/3	Lab Control Sample	Total/NA	Water	310.1	
LCS 160-311788/2	Lab Control Sample	Total/NA	Water	310.1	
160-22564-A-4 MS	Matrix Spike	Total/NA	Water	310.1	
160-22564-A-4 DU	Duplicate	Total/NA	Water	310.1	

Analysis Batch: 312064

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1	SW-1	Total/NA	Water	415.1	
MB 160-312064/4	Method Blank	Total/NA	Water	415.1	
LCS 160-312064/5	Lab Control Sample	Total/NA	Water	415.1	
160-22501-1 MS	SW-1	Total/NA	Water	415.1	

General Chemistry (Continued)

Analysis Batch: 312064 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
160-22501-1 DU	SW-1	Total/NA	Water	415.1	

Method: 8260C - Volatile Organic Compounds by GC/MS

Matrix: Water **Prep Type: Total/NA**

Percent Surrogate Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	TOL (80-129)	DBFM (80-121)	BFB (71-139)	12DCE (76-121)
160-22501-1	SW-1	102	105	96	105
160-22536-A-4 MS	Matrix Spike	102	107	99	106
160-22536-A-4 MSD	Matrix Spike Duplicate	103	109	97	107
LCS 160-310973/5	Lab Control Sample	104	103	96	102
LCSD 160-310973/6	Lab Control Sample Dup	102	102	96	99
MB 160-310973/8	Method Blank	100	98	94	98

Surrogate Legend

TOL = Toluene-d8 (Surr)
DBFM = Dibromofluoromethane (Surr)
BFB = 4-Bromofluorobenzene (Surr)
12DCE = 1,2-Dichloroethane-d4 (Surr)

Method: 8270D - Semivolatile Organic Compounds (GC/MS)

Matrix: Water **Prep Type: Total/NA**

Percent Surrogate Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	2FP (15-59)	TBP (37-120)	NBZ (50-101)	PHL (10-50)	TPH (21-97)	FBP (43-108)
160-22493-E-1-A MS	Matrix Spike	22	61	34 X	17	45	41 X
160-22493-F-1-A MSD	Matrix Spike Duplicate	23	46	26 X	15	35	31 X
160-22501-1	SW-1	42	82	50	30	61	55
LCS 160-310833/2-A	Lab Control Sample	30	79	51	18	59	56
MB 160-310833/1-A	Method Blank	32	75	53	18	61	54

Surrogate Legend

2FP = 2-Fluorophenol (Surr)
TBP = 2,4,6-Tribromophenol (Surr)
NBZ = Nitrobenzene-d5 (Surr)
PHL = Phenol-d5 (Surr)
TPH = Terphenyl-d14 (Surr)
FBP = 2-Fluorobiphenyl (Surr)

Method: 8330B - Nitroaromatics and Nitramines (HPLC)

Matrix: Water **Prep Type: Total/NA**

Percent Surrogate Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	12DNB1 (81-113)
160-22501-1	SW-1	92
160-22501-1 MS	SW-1	99
160-22501-1 MSD	SW-1	93
LCS 160-310680/2-A	Lab Control Sample	100
MB 160-310680/1-A	Method Blank	96

Surrogate Legend

12DNB = 1,2-Dinitrobenzene (Surr)

- Tilcon Quarry Expansion Air Quality and Noise Considerations (Tighe & Bond)

Lenard Engineering, Inc.
Civil, Environmental & Hydrogeological Consultants

23-09161-03
December 5, 2017

Jim Ericson, PE
Vice President
Lenard Engineering, Inc.
2210 Main Street
P.O. Box 1088

Re: **Tilcon Quarry Expansion**
Air Quality and Noise Considerations

Dear Mr. Ericson:

It is our understanding that Tilcon Quarry (Tilcon) located at 642 Black Rock Avenue in New Britain, Connecticut is seeking to expand its existing gravel mine footprint, shown in Figure 1, along Route 72 in Plainville onto a 131 acre parcel to the south that is owned by the City of New Britain. For decades, Tilcon has mined gravel from the quarry on the Plainville line and has gradually been moving the rock-blasting operations toward the outer perimeter of its property. The proposed expansion would allow Tilcon to operate for an additional 40 years by acquiring the mineral rights from the City of New Britain. In return, Tilcon plans to donate adjacent, undeveloped parcels as open space to New Britain, Plainville and Southington. Additionally, at the conclusion of the mining, Tilcon will return the quarried portion of the 131 acres to the City of New Britain as a reservoir.

The primary activities currently conducted at the site consist of the production of asphalt paving materials, concrete, stone quarrying, and aggregate processing. The materials produced at the site by Tilcon (asphalt, concrete, and aggregate materials) are sold to independent contractors or used by Tilcon for off- site projects. In addition, the site has the capability of operating several portable construction machinery which are used throughout Tilcon's Connecticut sites subject to demand.

The intent of this letter is to address potential air quality and noise concerns that may arise as part of the expansion.

Air Quality

Air emissions are regulated by the United States Environmental Protection Agency (USEPA) and the State of Connecticut Department of Energy and Environmental Protection (CTDEEP). The CTDEEP has been delegated by the USEPA to enforce the majority of air quality regulations subject to Tilcon.

The air pollution emitting equipment currently in operation are described in detail below.

Stone Quarry and Aggregate Processing Plant

Traprock (igneous basalt) is separated from the quarry walls by drilling and blasting, then transported to the processing plant. The rock is crushed with primary, secondary, tertiary, and/or fine crushers, and screened into specific ASTM aggregate size categories. Wet suppression is utilized throughout the process to reduce the emissions of fugitive particulate. Baghouses are used on the secondary and tertiary crushers to further reduce emissions. Fugitive emissions are generated from stockpile wind erosion as well.

Drum Mixer

The facility operates an Astec drum mix counter flow bituminous concrete plant at this site. This unit has the capacity to produce 600 tons of bituminous concrete per hour. Bituminous concrete is a heated mixture of well-graded aggregate and liquid asphalt cement. Aggregate is discharged from a set of graded bins and conveyed into a heated drum dryer. Once the aggregate is dried, it is conveyed within the drum dryer to an area removed from the burner flame zone and exhaust gases, where it is combined with the liquid asphalt cement, aggregate, and reclaimed asphalt product and discharged to either a waiting truck or to a storage silo for later distribution.

An air scavenger system is in place to collect emissions from each of the primary aggregate transfer points and from the dryer. These emissions are processed through a knockout box and a baghouse to collect particulate emissions. Collected particulate is returned to the process for reuse as aggregate. Emissions are primarily combustion products, in addition to particulate matter from the handling of aggregate.

Ready-Mix Concrete Plant

The facility operates a ready-mix concrete plant, which has a rated capacity of 15 cubic yards per batch. Concrete is formed from the mixture of water, cement, sand and stone aggregate. The bulk cement is delivered to the plant by truck and loaded pneumatically into a silo topped with two baghouses to retain the cement within the silo. Sand and stone aggregates are selected from the graded bins and transferred by conveyor to elevated bins, which discharge to weigh hoppers. From these hoppers, the sand and stone aggregates are fed sequentially into a tilter mixer, combined with cement and water, and discharged into waiting trucks. The only emission constituent identified to be emitted from the ready-mix concrete plant is particulate matter. Particulate matter emissions are collected at the discharge points into the tilter mixer and the mixer trucks, and are controlled by an additional baghouse. The ready-mix concrete plant is operating under CTDEEP Air Permit Registration No.133.

Vehicle Spray Booth

The vehicle maintenance spray booth utilizes an electrostatic spray gun for repainting the on- and off-road vehicle fleets. The spray booth can hold one vehicle at a time, and the vehicles are left to dry in place, usually overnight; therefore, only one vehicle can be coated per day. Coating usage varies depending upon the size of the vehicle, but the average usage is about 5.5 gallons total comprising primer, thinner, and paint per vehicle. A particulate filter controls the exhaust from the spray booth.

Miscellaneous Combustion Equipment

Tilcon operates a variety of combustion sources that utilize either natural gas or No. 2 Fuel Oil. A complete inventory of this equipment is included in Table 2 later in this document.

Portable Equipment

Lastly, Tilcon operates several portable diesel powered aggregate processing plants which can be relocated to any site in Connecticut within 15 days written notice to the CTDEEP. These emission units include the following:

- EMU101 - Portable Nordberg Model 300 Cone Crusher which is operated under Permit to Construct 192-29-164-02.

- EMU601 - Portable DC Double Deck Vibratory Screening Plant, which is operated under RCSA 22a-174-3b.
- EMU701 - Portable Sandvik QI440 Impactor Plant, which is operated under RCSA 22a-174-3b.

Existing Permits

The facility currently operates in accordance with a variety of permits, general permits and in accordance with permit-by-rule conditions. Table 1 includes a compliance summary for identified operations at the facility.

TABLE 1
AIR COMPLIANCE SUMMARY
TILCON QUARRY

Equipment / Activity	Type	Number or Citation	Notes
General Permit to Limit Potential Emissions	General Permit	No. 146-0021-GPLPE	Limits facility emissions to 80% of Title V Thresholds
Astec Counterflow Drum Mix Bituminous Concrete Plant	New Source Review Permit	No. 146-0041	Individual Permit
Astec Counterflow Drum Mix Bituminous Concrete Plant	New Source Performance Standard	40 CFR 60, Subpart I	Standards of Performance for Hot Mix Asphalt Facilities
15 Yard Ready Mix Concrete Plant	Registration	No. 0133	Registration
Stone Crushing and Processing	Registration	No. 0136	Registration
Paint Spray Booth	Permit-By-Rule	22a-174-3b	CT Exemption from Permitting
Portable Norberg Cone Crusher	New Source Performance Standard	40 CFR 60, Subpart OOO	Standards of Performance for Nonmetallic Mineral Processing Plants
Portable Norberg Cone Crusher	State Permit to Construct	No. 192-29-164-02	State Permit to Construct
Portable Vibratory Screening Plant	New Source Performance Standard	40 CFR 60, Subpart OOO	Standards of Performance for Nonmetallic Mineral Processing Plants
Portable Vibratory Screening Plant	Permit to Construct	22a-174-3b	CT Exemption from Permitting
Portable Impactor Plant	New Source Performance Standard	40 CFR 60, Subpart OOO	Standards of Performance for Nonmetallic Mineral Processing Plants
Portable Impactor Plant	Permit-By-Rule	22a-174-3b	CT Exemption from Permitting
Emergency Generators	National Emission Standards for Hazardous Air Pollutants	40 CFR 63, Subpart ZZZZ	Standards for Emergency Generators
Emergency Generators	Permit-By-Rule	22a-174-3c	CT Exemption from Permitting

Future Activities

Although the footprint of the quarry area would expand south of the existing boundary, operations and processing rates of production equipment at the facility will not be altered in any way by the expansion. A portable rock crusher may be relocated further south as the quarry expands, but will remain on the Tilcon property. No impacts to the existing permits or to the potential emissions as a result of the expansion are anticipated to be required as a result of this project.

Air permitting applicability is dependent upon potential emissions at both an individual unit level and at a facility wide level. Potential emissions at the facility are outlined in Table 2 below. These potential emissions are based upon the US EPA's AP-42 emission factors. The quarry expansion will require no amendments to the existing emission unit permits in place at the facility or to the General Permit to Limit Potential Emissions (GPLPE) at the facility. Furthermore, all emission sources will continue to operate in accordance with the operational and recordkeeping requirements specified by the equipment manufacturers and the CTDEEP in the aforementioned permits, registrations and permits by rule. Best Management Practices to limit dust from the facility including roadway sweeping, water spray and restrictive vehicle speed limits will remain in place.

TABLE 2
POTENTIAL EMISSIONS SUMMARY
TILCON QUARRY

GEU No.	EU No.	Description	PM 2.5 Tons	PM 10 Tons	SOx Tons	NOx Tons	VOC Tons	Co Tons	Pb Tons	GHG Tons
N/A	3	15 Yard Ready Mix Concrete Plant	17.81	17.81	-	-	-	-	-	-
N/A	4	Vehicle Maintenance Spray Booth	-	-	-	-	8.74	-	-	-
N/A	5	Stone Crushing and Processing	0.44	10.38	-	-	-	-	-	-
N/A	33	Emergency Generator	0.33	0.33	0.70	3.48	0.66	1.90	0.00	375.22
N/A	34	Onan-Cummins Generator	0.00	0.02	0.15	0.75	0.04	0.10	0.00	89.95
N/A	35	Astec RDB-12050 Counterflow Drum Mix Bituminous Concrete Plant	9.93	10.38	11.50	14.96	14.45	58.70	0.00	15,013.78
N/A	101	Portable Nordberg Cone Crusher	0.33	2.21	0.35	14.36	2.04	17.79	0.00	1,162.15
N/A	601	Portable Vibratory Screening Plant	0.39	3.22	0.19	6.89	1.31	1.31	0.00	563.22
N/A	701	Portable Impactor Plant	1.05	1.05	0.99	14.99	1.19	3.23	0.00	563.22
1	11	Office Water Heater	0.03	0.11	0.78	2.18	0.03	0.55	0.00	448.42
	12	Office Furnace								
	16	Highboy Lab Furnace								
	29	Kemco Hot Water Heater								
	30	Highboy Lab Furnace								
	31	Heater (Switch House)								
	32	Olsen Boiler								
	36	Power Flame Hot Oil Asphalt								
2	17	Cleaver Brooks Heater	0.68	1.07	0.05	8.91	0.49	7.08	0.00	10,752.59
	18	DeVilbiss Paint Shop Makeup								
	19	Burnham Paint Shop Furnace								
	20	26 Radiant Furnaces								
	21	4 Ceiling Heaters								
	22	Furnace (asphalt lab roof)								
	23	Furnace (asphalt lab)								
	24	Reznor (parts)								
	25	Sterline (parts)								
	26	Reznor (parts mezzanine)								
	27	Modine (steam rack)								
	28	Alkota Cleaning Equipment								

TABLE 2
POTENTIAL EMISSIONS SUMMARY
TILCON QUARRY

GEU No.	EU No.	Description	PM 2.5 Tons	PM 10 Tons	SOx Tons	NOx Tons	VOC Tons	Co Tons	Pb Tons	GHG Tons
	29	Kemco Hot Water Heater								
	36	Power Flame Hot Oil Asphalt								
		Total	**30.99**	**46.58**	**14.71**	**66.52**	**28.95**	**90.66**	**0.00**	**28,968.55**

Noise

Changes in noise generation as a result of the Tilcon footprint expansion is expected to be insignificant to the communities surrounding the quarry. Simply, although the footprint of the quarry area would expand south of the existing boundary, processing operations at the facility will not be altered in any way by the expansion. The maximum capacities of the processing plants, hours of operation and blasting protocols will be no different moving forward. Furthermore, as the facility footprint expands south, the establishment of a proposed "no-blast zone" along the northwestern section of the facility adjacent to a residential neighborhood would reduce the impact of impulse noises and associated hauling sound levels for this large neighborhood. Figures 3 and 4 included in Attachment A shows a satellite view of this area.

Existing Operations

Drilling and blasting are common noise generating activities at the quarry. At Tilcon, the mining process commences by drilling a series of holes in the quarry rock. A subcontracted explosives specialist inserts detonators into the holes and commences the blasting process in accordance with safety and fire prevention standards. Blasting events currently occur approximately 6 times per month, in a repeating sequence of two blasts the first week, followed by one blast the second week. Tilcon typically establishes a target time of 12:00 PM for blasting events and works to minimize blasting during unfavorable weather events that may intensify impulse noises, such as thermal inversions that occur when cool air is trapped at lower altitudes below a warm layer higher in the atmosphere.

Following blasting, quarry mining commences by cutting benches in to the stone material. Operations begin at higher levels and work downward sequentially. A bulldozer is utilized to push loosened materials to a loader for stockpiling or delivery to the rock crushing plant, where stone is screened into the required material sizes. On an as needed basis, additional portable crushing and screening equipment may be brought to the site. However, this is not typical.

The vast majority of continuous noise generation occurs at the northern side of the facility adjacent to Woodford Avenue and Interstate 84. All stationary processing equipment is located in this area. The processing plant's hours of operation are 6:00am to 4:00pm and a maintenance shift from 3:00pm to 1:00am. A residential neighborhood is located to the east. Figures 3 and 4 included in Attachment A shows a satellite view of this area.

Future Operations

The annual tonnage output at Tilcon is not anticipated to change based upon the footprint expansion. Shipment trucks will continue to exit north onto Woodford Avenue. This is the haul route that is currently being used by the existing quarry operations. Therefore, the off property haul route noise is not expected to change.

Noise impacts from the activities in the expanded area will not be substantially different than they are currently. As the quarry expands south, the neighborhood to the east will be closer to process operations. Mapping estimates suggest that excavation limits will move approximately 300 feet closer to the Westwood Drive neighborhood. However, Tilcon is committed to installing a 1,000 foot vegetative barrier to reduce additional noise impacts from the facility. Vegetative barriers can reduce noise impacts by 5 to 8 decibels (dBA) per 100 feet. Furthermore, the topography of the area is such that the neighborhoods along Wooster Street, are at elevations below the highest points of the quarry limits. These residences are in the shadow zone of noise emissions behind, and at a lower elevation than the 1,000 foot vegetative barrier. Further, the quarry expansion will not alter the visual profile of the quarry in any capacity.

The State of Connecticut Regulations Section 22a-169 regulates noise impacts on the general public and the environment. Section 22a-169-1.8(h) provides an exemption specific to blasting operations. The exemption reads:

> *Noise created by blasting other than that conducted in connection with construction activities shall be exempted provided that the blasting is conducted between 8:00 a.m. and 5:00 p.m. local time at specified hours previously announced to the local public, or provided that a permit for such blasting has been obtained from local authorities.*

Additionally, General Statutes Section 22a-73 mandates that the CTDEEP reviews and approves municipal noise ordinances. The City of New Britain's noise ordinance is attached to this letter for reference. The identical exemption present in the CTDEEP regulations is present in the New Britain ordinance. No ordinances have been specifically approved for Plainville or Southington.

Summary & Conclusion

As discussed above the expansion of the Tilcon facility is not expected to increase air emissions or noise impacts. The activities described in this report, the permits listed in Table No. 1 and the Potential Emissions detailed in Table No. 2 will not substantively change as a result of the expansion. The considerations taken by Tilcon during quarry expansion will continue to reduce noise levels to the adjacent neighborhoods in the future.

Should you have any questions, please do not hesitate to contact me at 413.875.1607 or tkkucab@tighebond.com.

Very truly yours,

TIGHE & BOND, INC.

Timothy K. Kucab

Timothy K. Kucab, CHMM
Project Manager

Attachments

A – Figures
B – State and Municipal Noise Regulations

Attachment A
Figures

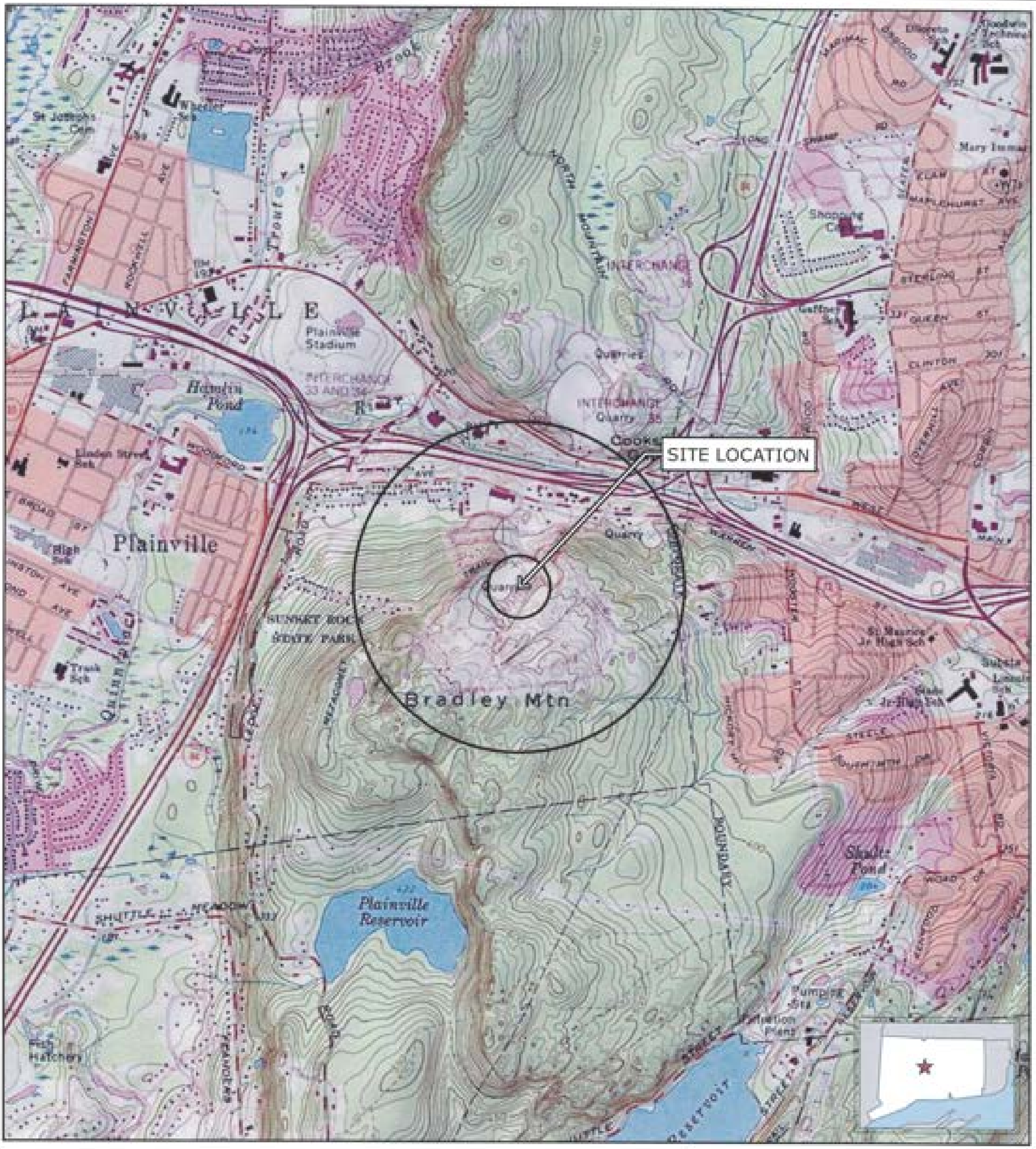


FIGURE 1
SITE LOCATION MAP

Tilcon
642 Black Rock Ave
New Britain, Connecticut

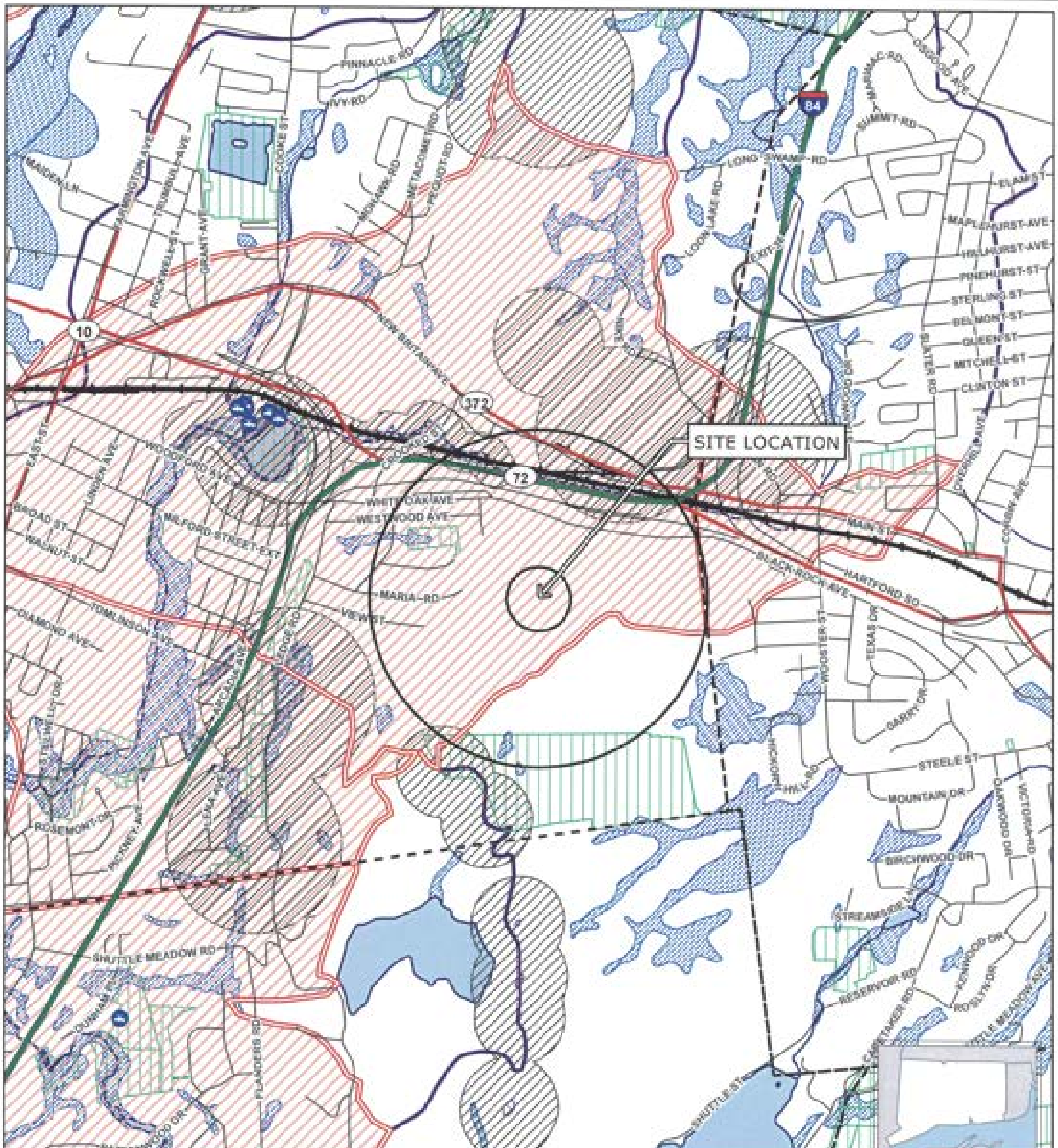
June 2017

Tighe&Bond
Engineers | Environmental Specialists

Based on USGS Topographic Map for New Britain, CT
Contour Interval Equals 10ft.
Circles indicate 500-foot and half-mile radii

1:24,000
0 1,000 2,000
Feet

N



Legend

- Community Well
- Non-Community Well
- Interstate
- US Route
- State Route
- Connector
- Minor Street or Road
- Railroad
- Watercourse
- Waterbody
- Inland Wetland Soils
- Major Drainage Basin
- Sub Drainage Basin
- Protected Open Space (City of New Britain Water Dept.)
- Critical Habitat
- Natural Diversity Database Area
- Final Adopted Aquifer Protection
- Final Aquifer Protection
- Preliminary Aquifer Protection
- CT Municipal Boundary

1:24,000

0 1,000 2,000

Feet

Tighe&Bond

Engineers | Environmental Specialists

Resource data provided by CTDEEP. Circles indicate 500-foot and half-mile radii.

FIGURE 2

PRIORITY RESOURCE MAP

Tilcon

642 Black Rock Ave

New Britain, Connecticut

December 2017

FIGURE 3
ORTHOPHOTOGRAPH
Tilcon
642 Black Rock Ave
New Britain, Connecticut

1:7,200
0 300 600
Feet

June 2017

Tighe&Bond
Engineers | Environmental Specialists

FIGURE 4
ORTHOPHOTOGRAPH

LOCUS MAP

N

0 275 550

Feet

1:6,600

NOTES

1. Based on 2016 Statewide Orthophotography, Courtesy of CTECO.

Tilcon
642 Black Rock Ave
New Britain, Connecticut

June 2017

Tighe&Bond
Engineers | Environmental Specialists

V:\Projects\N\N0916\642BlackRockAveCT_11x17_Ortho.mxd

N-0916

FIGURE 5
ORTHOPHOTOGRAPH

LEGEND

- 10 ft Contour
- CT Municipal Boundary

LOCUS MAP

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Feet
1:6,600

NOTES

1. Based on 2016 Statewide Orthophotography, Courtesy of CTECO.
2. Contours (2000) provided by CT DEP

Tilcon
642 Black Rock Ave
New Britain, Connecticut

June 2017

Tighe&Bond
Engineers | Environmental Specialists

Attachment B
State and Municipal Noise Regulations

Agency
Department of Environmental Protection

Subject
Control of Noise

Inclusive Sections
§§ 22a-69-1—22a-69-7.4

CONTENTS

Control of Noise

Sec. 22a-69-1. Definitions

Sec. 22a-69-1.1. General

(a) **adaptive reuse** means remodeling and conversion of an obsolete or unused building or other structure for alternate uses. For example, older industrial buildings, warehouses, offices, hotels, garages, etc., could be improved and converted for reuse in terms of industrial processes, commercial activities, educational purposes, residential use as apartments, or other purposes.

(b) **aircraft** means any engine-powered device that is used or intended to be used for flight in the air and capable of carrying humans. Aircraft shall include civil, military, general aviation and VTOL/STOL aircraft.

(i) **aircraft, STOL** means any aircraft designed for, and capable of, short takeoff and landing operations.

(ii) **aircraft, VTOL** means any aircraft designed for, and capable of, vertical take-off and landing operations such as, but not limited to, helicopters.

(c) **airport** means an area of land or water that is used, or intended to be used, for the landing and takeoff of aircraft and is licensed by the State of Connecticut Bureau of Aeronautics for such use. "Airport" shall include all buildings and facilities if any. "Airport" shall include any facility used, or intended for use, as a landing and take-off area for VTOL/STOL aircraft, including, but not limited to, heliports.

(d) **ANSI** means the American National Standards Institute or its successor body.

(e) **best practical noise control measures** means noise control devices, technology and procedures which are determined by the Commissioner to be the best practical, taking into consideration the age of the equipment and facilities involved, the process employed, capital expenditures, maintenance cost, technical feasibility, and the engineering aspects of the applicable noise control techniques in relation to the control achieved and the non-noise control environmental impact.

(f) **commissioner** means the Commissioner of the Department of Environmental Protection or his/her designated representative.

(g) **construction** means any, and all, physical activity at a site necessary or incidental to the erection, placement, demolition, assembling, altering, blasting, cleaning, repairing, installing, or equipping of buildings or other structures, public or private highways, roads, premises, parks, utility lines, or other property, and shall include, but not be limited to, land clearing, grading, excavating, filling and paving.

(h) **daytime** means 7:00 a.m. to 10:00 p.m. local time.

(i) **director** means the Director of the Office of Noise Control in the Department of Environmental Protection.

(j) **emergency** means any occurrence involving actual or imminent danger to persons or damage to property which demands immediate action.

(k) **intrusion alarm** means a device with an audible signal which, when activated, indicates intrusion by an unauthorized person. Such alarm may be attached to, or within, any building, structure, property or vehicle.

(*l*) **ISO** means the International Organization for Standardization, or its successor body.

(m) **lawn care and maintenance equipment** means all engine or motor-powered garden or maintenance tools intended for repetitive use in residential areas, typically capable of being used by a homeowner, and including, but not limited to, lawn mowers, riding tractors, snowblowers, and including equipment intended for infrequent service work in inhabited areas, typically requiring skilled operators, including, but not limited to, chain saws, log chippers or paving rollers.

(n) **nighttime** means 10:00 p.m. to 7:00 a.m. local time.

(o) **noise zone** means an individual unit of land or a group of contiguous parcels under the same ownership as indicated by public land records and, as relates to noise emitters, includes contiguous publicly dedicated street and highway rights-of-way, railroad rights-of-way and waters of the State.

(p) **office of noise control** means the office within the Department of Environmental Protection designated by the Commissioner to develop, administer and enforce the provisions of Chapter 442 of the Connecticut General Statutes.

(q) **OSHA** means the Occupational Safety and Health Act and any amendments thereto or successor regulations administered by the U.S. and Connecticut Departments of Labor or successor bodies.

(r) **person** means any individual, firm, partnership, association, syndicate, company, trust, corporation, municipality, agency, or political or administrative subdivision of the State or other legal entity of any kind.

(s) **public emergency sound signal** means an audible electronic or mechanical siren or signal device attached to an authorized emergency vehicle or within or attached to a building for the purpose of sounding an alarm relating to fire or civil preparedness. Such signal may also be attached to a pole or other structure.

(t) **SAE** means the Society of Automotive Engineers, Inc., or its successor body.

(u) **safety and protective devices** means devices that are designed to be used, and are actually used, for the prevention of the exposure of any person or property to imminent danger, including, but not limited to, unregulated safety relief valves, circuit breakers, protective fuses, back-up alarms required by OSHA or other state or federal safety regulations, horns, whistles or other warning devices associated with pressure buildup.

(v) **site** means the area bounded by the property line on or in which a source of noise exists.

(Effective June 15, 1978)

Sec. 22a-69-1.2. Acoustic terminology and definitions

(a) All acoustical terminology used in these Regulations shall be in conformance with the American National Standards Institute (ANSI), "Acoustical Terminology," contained in publication S1.1 as now exists and as may be hereafter modified. The definitions below shall apply if the particular term is not defined in the aforesaid ANSI publication.

(b) **audible range of frequency** means the frequency range 20 Hz to 20,000 Hz which is generally considered to be the normal range of human hearing.

(c) **background noise** means noise which exists at a point as a result of the combination of many distant sources, individually indistinguishable. In statistical terms, it is the level which is exceeded 90% of the time (L_{90}) in which the measurement is taken.

(d) **continuous noise** means ongoing noise, the intensity of which remains at a measurable level (which may vary) without interruption over an indefinite period or a specified period of time.

(e) **decibel (dB)** means a unit of measurement of the sound level.

(f) **excessive noise** means emitter Noise Zone levels from stationary noise sources exceeding the Standards set forth in Section 3 of these Regulations beyond the boundary of adjacent Noise Zones.

(g) **existing noise source** means any noise source(s) within a given Noise Zone, the construction of which commenced prior to the effective date of these Regulations.

(h) **fluctuating noise** means a continuous noise whose level varies with time by more than 5 dB.

(i) **frequency** means the number of vibrations or alterations of sound pressure per second and is expressed in Hertz.

(j) **hertz (Hz)** means a unit of measurement of frequency formerly stated as, and numerically equal to, cycles per second.

(k) **impulse noise** means noise of short duration (generally less than one second), especially of high intensity, abrupt onset and rapid decay, and often rapidly changing spectral composition.

(*l*) **infrasonic sound** means sound pressure variations having frequencies below the audible range for humans, generally below 20 Hz; subaudible.

(m) $\mathbf{L_{10}}$ means the A-weighted sound level exceeded 10% of the time period during which measurement was made.

(n) $\mathbf{L_{50}}$ means the A-weighted sound level exceeded 50% of the time period during which measurement was made.

(o) $\mathbf{L_{90}}$ means the A-weighted sound level exceeded 90% of the time period during which measurement was made.

(p) **octave band sound pressure level** means the sound pressure level for the sound contained within the specified preferred octave band, stated in dB, as described in ANSI S1.6-1967: Preferred Frequencies and Band Numbers for Acoustical Measurements.

(q) **peak sound pressure level** means the absolute maximum value of the instantaneous sound pressure level occurring in a specified period of time.

(r) **prominent discrete tone** means the presence of acoustic energy concentrated in a narrow frequency range, including, but not limited to, an audible tone, which produces a one-third octave sound pressure level greater than that of either adjacent one-third octave and which exceeds the arithmetic average of the two adjacent one-third octave band levels by an amount greater than shown below opposite the center of frequency for the one-third octave band containing the concentration of acoustical energy.

⅓ Octave Band Center Frequency (Hz)	*dB*
100	16
125	14
160	12
200	11
250	9
315	8
400	7
500	6
630	6
800	5
1000	4
1250	4
1600	4
2000	3
2500	3
3150	3
4000	3
5000	4
6300	4
8000	5
10000	6

(s) **reference pressure** is 0.00002 Newtons per square meter (N/M^2), or 20 microPascals, for the purposes of these Regulations.

(t) **sound** means a transmission of energy through solid, liquid, or gaseous media in the form of vibrations which constitute alterations in pressure or position of the particles in the medium and which, in air, evoke physiological sensations, including, but not limited to, an auditory response when impinging on the ear.

(u) **sound analyzer** means a device, generally used in conjunction with a sound level meter, for measuring the sound pressure level of a noise as a function of frequency in octave bands, one-third octave bands or other standard ranges. The sound analyzer shall conform to Type E, Class II, as specified in ANSI S1.11-1971 or latest revision.

(v) **sound level** means a frequency weighted sound pressure level, obtained by the use of metering characteristics and the weighting A, B, or C as specified in ANSI, "Specifications for Sound Level Meters," S1.4-1971 or latest revision. The unit of measurement is the decibel. The weighting employed must always be stated as dBA, dBB, or dBC.

(w) **sound level meter** means an instrument, including a microphone, an amplifier, an output meter, and frequency weighting networks for the measurement of sound levels. The sound level meter shall conform to ANSI Specifications for Sound Level Meters S1.4-1971.

(x) **sound pressure level (SPL)** means twenty times the logarithm to the base ten of the ratio of the sound pressure in question to the standard reference pressure of 0.00002 N/M^2. It is expressed in decible units.

(y) **ultrasonic sound** means sound pressure variations having frequencies above the audible sound spectrum for humans, generally higher than 20,000 Hz; super-audible.

(z) **vibration** means an ascillatory motion of solid bodies of deterministic or random nature described by displacement, velocity, or acceleration with respect to a given reference point.

(Effective June 15, 1978)

Sec. 22a-69-1.3. Coordination with other laws

(a) Nothing in these Regulations shall authorize the construction or operation of a stationary noise source in violation of the requirements of any other applicable State law or regulation.

(b) Nothing in these Regulations shall authorize the sale, use or operation of a noise source in violation of the laws and regulations of the Connecticut Department of Motor Vehicles, the Federal Aviation Administration, the U.S. Environmental Protection Agency, or any amendments thereto.

(Effective June 15, 1978)

Sec. 22a-69-1.4. Incorporation by reference

(a) The specifications, standards and codes of agencies of the U.S. Government and organizations which are not agencies of the U.S. Government, to the extent that they are legally incorporated by reference in these Regulations, have the same force and effect as other standards in these Regulations.

(b) These specifications, standards and codes may be examined at the Office of Noise Control, Department of Environmental Protection, State of Connecticut.

(c) Any changes in the specifications, standards and codes incorporated in these Regulations are available at the Office listed in (b) above. All questions as to the applicability of such changes should also be referred to this Office.

(Effective June 15, 1978)

Sec. 22a-69-1.5. Compliance with regulations no defense to nuisance claim

Nothing in any portion of these Regulations shall in any manner be construed as authorizing or legalizing the creation or maintenance of a nuisance, and compliance of a source with these Regulations is not a bar to a claim of nuisance by any person. A violation of any portion of these Regulations shall not be deemed to create a nuisance per se.

(Effective June 15, 1978)

Sec. 22a-69-1.6. Severability

If any provision of these Regulations or the application thereof to any person or circumstances is held to be invalid, such invalidity shall not affect other provisions or applications of any other part of these Regulations which can be given effect without the invalid provisions or application; and to this end, the provisions of these Regulations and the various applications thereof are declared to be severable.

(Effective June 15, 1978)

Sec. 22a-69-1.7. Exclusions

These Regulations shall not apply to:

(a) Sound generated by natural phenomena, including, but not limited to, wind, storms, insects, amphibious creatures, birds, and water flowing in its natural course.

(b) The unamplified sounding of the human voice.

(c) The unamplified sound made by any wild or domestic animal.

(d) Sound created by bells, carillons, or chimes associated with specific religious observances.

(e) Sound created by a public emergency sound signal attached to an authorized emergency vehicle in the immediate act of responding to an emergency, as authorized by subsection (d) of Section 14.80 and Section 14-la of Chapter 246 of the General Statutes and all amendments thereto, or located within or attached to a building, pole or other structure for the purpose of sounding an alarm relating to fire or civil preparedness.

(f) Sound created by safety and protective devices.

(g) Farming equipment or farming activity.

(h) Back-up alarms required by OSHA or other State or Federal safety regulations.

(i) Sound created by any mobile source of noise. Mobile sources of noise shall include, but are not limited to, such sources as aircraft, automobiles, trucks, and boats. This exclusion shall cease to apply when a mobile source of noise has maneuvered into position at the loading dock, or similar facility, has turned off its engine and ancillary equipment, and has begun the physical process of removing the contents of the vehicle.

(Effective June 15, 1978)

Sec. 22a-69-1.8. Exemptions

Exempted from these Regulations are:

(a) Conditions caused by natural phenomena, strike, riot, catastrophe, or other condition over which the apparent violator has no control.

(b) Noise generated by engine-powered or motor-driven lawn care or maintenance equipment shall be exempted between the hours of 7:00 a.m. and 9:00 p.m. provided that noise discharged from exhausts is adequately muffled to prevent loud and/or explosive noises therefrom.

(c) Noises created by snow removal equipment at any time shall be exempted provided that such equipment shall be maintained in good repair so as to minimize noise, and noise discharged from exhausts shall be adequately muffled to prevent loud and/or explosive noises therefrom.

(d) Noise that originates at airports that is directly caused by aircraft flight operations specifically preempted by the Federal Aviation Administration.

(e) Noise created by the use of property for purposes of conducting speed or endurance events involving motor vehicles shall be exempted but such exemption is effective only during the specific period(s) of time within which such use is authorized by the political subdivision or governmental entity having lawful jurisdiction to sanction such use.

(f) Noise created as a result of, or relating to, an emergency.

(g) Construction noise.

(h) Noise created by blasting other than that conducted in connection with construction activities shall be exempted provided that the blasting is conducted between 8:00 a.m. and 5:00 p.m. local time at specified hours previously announced to the local public, or provided that a permit for such blasting has been obtained from local authorities.

(i) Noise created by on-site recreational or sporting activity which is sanctioned by the state or local government provided that noise discharged from exhausts is adequately muffled to prevent loud and/or explosive noises therefrom.

(j) Patriotic or public celebrations not extending longer than one calendar day.

(k) Noise created by aircraft, or aircraft propulsion components designed for or utilized in the development of aircraft, under test conditions.

(*l*) Noise created by products undergoing test, where one of the primary purposes of the test is evaluation of product noise characteristics and where practical noise control measures have been taken.

(m) Noise generated by transmission facilities, distribution facilities and substations of public utilities providing electrical powers, telephone, cable television or other similar services and located on property which is not owned by the public utility and which may or may not be within utility easements.

(Effective June 15, 1978)

Sec. 22a-69-1.9. Burden of persuasion regarding exclusions and exemptions

In any proceeding pursuant to these Regulations, the burden of persuasion shall rest with the party attempting to enforce the Regulations. Notwithstanding the foregoing, if an exclusion or exemption stated in these Regulations would limit an obligation, limit a liability, or eliminate either an obligation or a liability, the person who would benefit from the application of the exclusion or exemption shall have the burden of persuasion that the exclusion or exemption applies and that the terms of the exclusion or exemption have been met. The Department shall cooperate with and assist persons in determining the application of the provisions of these Regulations.

(Effective June 15, 1978)

Sec. 22a-69-2. Classification of land according to use

Sec. 22a-69-2.1. Basis

Noisy Zone classifications shall be based on the actual use of any parcel or tract under single ownership as detailed by the Standard Land Use Classification Manual of Connecticut (SLUCONN).

(Effective June 15, 1978)

Sec. 22a-69-2.2. Multiple uses

Where multiple uses exist within a given Noise Zone, the least restrictive land use category for the Emitter and Receptor shall apply regarding the noise standards specified in Section 3 of these Regulations.

(Effective June 15, 1978)

Sec. 22a-69-2.3. Class A noise zone

Lands designated Class A shall generally be residential areas where human beings sleep or areas where serenity and tranquility are essential to the intended use of the land.

Class A Land Use Category. The land uses in this category shall include, but not be limited to, single and multiple family homes, hotels, prisons, hospitals, religious facilities, cultural activities, forest preserves, and land intended for residential or special uses requiring such protection.

The specific SLUCONN categories in Class A shall include:

1. Residential
11 Household Units*
12 Group Quarters
13 Mobile Home Parks and Courts
19 Other Residential
5. Trade
583 Residential Hotels
584 Hotels, Tourist Courts and Motels
585 Transient Lodgings
6. Services
651 Medical and Other Health Services; Hospitals
674 Correctional Institutions
691 Religious Activities
7. Cultural, Entertainment and Recreational
711 Cultural Activities

712 Nature Exhibitions
713 Historic and Monument Sites
*Mobile homes are included if on foundations
9. Undeveloped, Unused and Reserved Lands and Water Areas
92 Reserved Lands
941 Vacant Floor Area—Residential

(Effective June 15, 1978)

Sec. 22a-69-2.4. Class B noise zone

Lands designated Class B shall generally be commercial in nature, areas where human beings converse and such conversation is essential to the intended use of the land.

Class B Land Use Category. The land uses in this category shall include, but not be limited to, retail trade, personal, business and legal services, educational institutions, government services, amusements, agricultural activities, and lands intended for such commercial or institutional uses.

The specific SLUCONN categories in Class B shall include:
4. Transportation, Communication and Utilities
46 Automobile Parking
47 Communication
5. Trade
51 Wholesale Trade
52 Retail Trade - Building Materials
53 Retail Trade - General Merchandise
54 Retail Trade - Food
55 Retail Trade - Automotive Dealers and Gasoline Service Stations
56 Retail Trade - Apparel and Accessories
57 Retail Trade - Furniture, Home Furnishings and Equipment
58 Retail Trade - Eating, Drinking and Lodging - Except 583, 584, and 585
59 Retail Trade - N.E.C.*
6. Services
61 Finance, Insurance and Real Estate Services
62 Personal Services
63 Business Services—Except 637
64 Repair Services
65 Professional Services—Except 651
67 Government Services—Except 672, 674, and 675
68 Educational Services
69 Miscellaneous Services—Except 691
7. Cultural, Entertainment and Recreational
71 Cultural Activities and Nature Exhibitions—Except 711, 712, and 713
72 Public Assembly

73 Amusements
74 Recreational Activities
75 Resorts and Group Camps
76 Parks
79 Other, N.E.C.*
*Not Elsewhere Classified
8. Agriculture
81 Agriculture
82 Agricultural Related Activities
9. Undeveloped, Unused, and Reserved Lands and Water Area
91 Undeveloped and Unused Land Area
93 Water Areas
94 Vacant Floor Area—Except 941
99 Other Undeveloped Land and Water Areas, N.E.C.*
*Not Elsewhere Classified

(Effective June 15, 1978)

Sec. 22a-69-2.5. Class C noise zone

Lands designated Class C shall generally be industrial where protection against damage to hearing is essential, and the necessity for conversation is limited.

Class C Land Use Category. The land uses in this category shall include, but not be limited to, manufacturing activities, transportation facilities, warehousing, military bases, mining, and other lands intended for such uses.

The specific SLUCONN categories in Class C shall include:
2. Manufacturing — Secondary Raw Materials
3. Manufacturing — Primary Raw Materials
4. Transportation, Communications and Utilities — Except 46 and 47
6. Services
637 Warehousing and Storage Services 66 Contract Construction Services
672 Protective Functions and Related Activities
675 Military Bases and Reservations
8. Agriculture
83 Forestry Activities and Related Services
84 Commercial Fishing Activities and Related Services
85 Mining Activities and Related Services
89 Other Resource Production and Extraction, N.E.C.*
*Not Elsewhere Classified

(Effective June 15, 1978)

Sec. 22a-69-3. Allowable noise levels

Sec. 22a-69-3.1. General prohibition

No person shall cause or allow the emission of excessive noise beyond the boundaries of his/her Noise Zone so as to violate any provisions of these Regulations.

(Effective June 15, 1978)

Sec. 22a-69-3.2. Impulse noise

(a) No person shall cause or allow the emission of impulse noise in excess of 80 dB peak sound pressure level during the nighttime to any Class A Noise Zone.

(b) No person shall cause or allow the emission of impulse noise in excess of 100 dB peak sound pressure at any time to any Noise Zone.

(Effective June 15, 1978)

Sec. 22a-69-3.3. Prominent discrete tones

Continuous noise measured beyond the boundary of the Noise Zone of the noise emitter in any other Noise Zone which possesses one or more audible discrete tones shall be considered excessive noise when a level of 5 dBA below the levels specified in Section 3 of these Regulations is exceeded.

(Effective June 15, 1978)

Sec. 22a-69-3.4. Infrasonic and ultrasonic

No person shall emit beyond his/her property infrasonic or ultrasonic sound in excess of 100 dB at any time.

(Effective June 15, 1978)

Sec. 22a-69-3.5. Noise zone standards

(a) No person in a Class C Noise Zone shall emit noise exceeding the levels stated herein and applicable to adjacent Noise Zones:

		Receptor		
	C	*B*	*A/Day*	*A/Night*
Class C Emitter to	70 dBA	66 dBA	61 dBA	51 dBA

Levels emitted in excess of the values listed above shall be considered excessive noise.

(b) No person in a Class B Noise Zone shall emit noise exceeding the levels stated herein and applicable to adjacent Noise Zones:

Receptor

	Receptor			
	C	*B*	*A/Day*	*A/Night*
Class B Emitter to	62 dBA	62 dBA	55 dBA	45 dBA

Levels emitted in excess of the values listed above shall be considered excessive noise.

(c) No person in a Class A Noise Zone shall emit noise exceeding the levels stated herein and applicable to adjacent Noise Zones:

	Receptor			
	C	*B*	*A/Day*	*A/Night*
Class C Emitter to	62 dBA	55 dBA	55 dBA	45 dBA

Levels emitted in excess of the values listed above shall be considered excessive noise.

(Effective June 15, 1978)

Sec. 22a-69-3.6. High background noise areas

In those individual cases where the background noise levels caused by sources not subject to these Regulations exceed the standards contained herein, a source shall be considered to cause excessive noise if the noise emitted by such source exceeds the background noise level by 5 dBA, provided that no source subject to the provisions of Section 3 shall emit noise in excess of 80 dBA at any time, and provided that this Section does not decrease the permissible levels of the other Sections of this Regulation.

(Effective June 15, 1978)

Sec. 22a-69-3.7. Existing noise sources

Existing noise sources constructed between the effective date of these Regulations and January 1, 1960 shall be provided a permanent five (5) dBA maximum noise level allowance over levels otherwise herein required regardless of subsequent changes in ownership or facility utilization processes at the location of the existing noise source. Existing noise sources constructed prior to 1960 shall be provided a permanent ten (10) dBA maximum noise level allowance over levels otherwise herein required regardless of subsequent changes in ownership or facility utilization processes at the location of the existing noise source. Additionally, all existing noise sources shall be provided twenty-four (24) months in order to achieve compliance with these Regulations if a notice of violation has been, or may be, issued to the source. This time period begins with the effective date of these Regulations, not with the date of the notice of violation.

(Effective June 15, 1978)

Sec. 22a-69-3.8. Adaptive reuse of existing buildings

Buildings and other structures that exist as of the effective date of these Regulations which have been remodeled or converted for adaptive reuse or which may be remodeled or converted at a future date shall be provided a permanent five (5) dBA maximum noise level allowance above the Emitter Class of the new use of the building over levels otherwise herein required.

(Effective June 15, 1978)

Sec. 22a-69-4. Measurement procedures

Acoustic measurements to ascertain compliance with these Regulations shall be in substantial conformity with standards and Recommended Practices established by professional organizations such as ANSI and SAE.

(a) Personnel conducting sound measurements shall be trained and experienced in the current techniques and principles of sound measuring equipment and instrumentation. The Commissioner shall establish sufficiently detailed measurement procedure guidelines specifying, but not necessarily being limited to, the following: The appropriate utilization of fast or slow sound level meter dampening when making sound level measurements, the rise time specified in microseconds for measuring impulse noise, the need for a whole circuit in such measurements, and the proper weighting to be used in measuring impulse noise.

(b) Instruments shall conform to the following standards of their latest revisions:

(i) ANSI S1.4-1971, "Specifications for Sound Level Meters," Type 1 or 2.

(ii) ANSI S1.11-1966, "Specifications for Octave, One-Half Octave and One-Third Octave Band Filter Sets," Type E, Class II.

(iii) If a magnetic tape recorder or a graphic level recorder or other indicating device is used, the system shall meet the applicable requirements of SAE Recommended Practice J184, "Qualifying a Sound Data Acquisition System."

(c) Instruments shall be set up to conform to ANSI S1.13-1971, "Methods for the Measurement of Sound Pressure Levels."

(d) Instrument manufacturer's instructions for use of the instruments shall be followed, including acoustical calibration of equipment used.

(e) The determination of L_{90} to ascertain background levels requires a statistical analysis. A graphic level recording and visual interpretation of the chart recording to determine the levels is an acceptable method. Instruments designed to determine the cumulative distribution of noise levels are also acceptable used either in the field or in the laboratory to analyze a tape recording. Dynamic visual estimations from a sound level meter are not an acceptable method for determining such levels. Sound level sampling techniques are acceptable and will often be the most practical to employ. Such a technique using Connecticut Noise Survey Data Form #101 with accompanying instructions is acceptable.

(f) In measuring compliance with Noise Zone Standards, the following short-term noise level excursions over the noise level standards established by these Regulations shall be allowed, and measurements within these ranges of established standards shall constitute compliance therewith:

Allowable Levels above standards (dBA)	Time period of such levels (minutes/hour)
3	15
6	7½
8	5

(g) Measurements taken to determine compliance with Section 3 shall be taken at about one foot beyond the boundary of the Emitter Noise Zone within the receptors's Noise Zone. The Emitter's Noise Zone includes his/her individual unit of land or group of contiguous parcels under the same ownership as indicated by public land records. The Emitter's Noise Zone also includes contiguous publicly dedicated street and highway rights-of-way, railroads rights-of-way and waters of the State.

(Effective June 15, 1978)

Sec. 22a-69-5. Other provisions

Sec. 22a-69-5.1. Intrusion alarms

No person shall cause, suffer, allow or permit the operation of any intrusion alarm which, from time of activation of audible signal, emits noise for a period of time exceeding ten minutes when attached to any vehicle or thirty minutes when attached to any building or structure.

The repetition of activation of the audible signal of an intrusion alarm due to malfunction, lack of proper maintenance, or lack of reasonable care shall be considered excessive noise.

(Effective June 15, 1978)

Sec. 22a-69-6. Airport facilities

Sec. 22a-69-6.1. Extent of regulation

Airport facilities are subject to Section 3 to the extent not preempted by state or federal law or regulation.

(Effective June 15, 1978)

Sec. 22a-69-6.2. Reserved

(This subsection is reserved for possible future regulations regarding the assessment of, and long-range plans for, the reduction of airport facility noise impacts to the extent not preempted by state or federal law or regulation.)

(Effective June 15, 1978)

Sec. 22a-69-7. Variances and enforcement procedures

Sec. 22a-69-7.1. Variances

(a) Any person who owns or operates any stationary noise source may apply to the Commissioner for a variance or a partial variance from one or more of the provisions of these Regulations. Applications for a variance shall be submitted on forms furnished by the Commissioner and shall supply such information as he/she requires, including, but not limited to:

(i) Information on the nature and location of the facility or process for which such application is made.

(ii) The reason for which the variance is required, including the economic and technical justifications.

(iii) The nature and intensity of noise that will occur during the period of the variance.

(iv) A description of interim noise control measures to be taken by the applicant to minimize noise and the impacts occurring therefrom.

(v) A specific schedule of the best practical noise control measures, if any, which might be taken to bring the source into compliance with those Regulations from which a variance is sought, or a statement of the length of time during which it is estimated that it will be necessary for the variance to continue.

(vi) Any other relevant information the Commissioner may require in order to make a determination regarding the application.

(b) Failure to supply the information required by the form furnished by the Commissioner shall be cause for rejection of the application unless the applicant supplies the needed information within thirty (30) days of the written request by the Commissioner for such information.

(c) No variance shall be approved unless the applicant presents adequate proof to the Commissioner's satisfaction that:

(i) Noise levels occurring during the period of the variance will not constitute a danger to the public health; and

(ii) Compliance with the Regulations would impose an arbitrary or unreasonable hardship upon the applicant without equal or greater benefits to the public.

(d) In making a determination on granting a variance, the Commissioner shall consider:

(i) The character and degree of injury to, or interference with, the health and welfare or the reasonable use of property which is caused or threatened to be caused.

(ii) The social and economic value of the activity for which the variance is sought.

(iii) The ability of the applicant to apply best practical noise control measures, as defined in these Regulations.

(e) Following receipt and review of an application for a variance, the Commissioner shall fix a date, time and location for a hearing on such application.

(f) The Commissioner shall cause the applicant to publish at his/her own expense all notices of hearings and other notices required by law, including, but not limited to, notification of all abutters of record.

(g) Within sixty (60) days of the receipt of the record of the hearings on a variance application, the Commissioner shall issue his/her determination regarding such application. All such decisions shall briefly set forth the reasons for the decision.

(h) The Commissioner may, at his/her discretion, limit the duration of any variance granted under these Regulations. Any person holding a variance and needing an extension of time may apply for a new variance under the provisions of these Regulations. Any such application shall include a certification of compliance with any condition imposed under the previous variance.

(i) The Commissioner may attach to any variance any reasonable conditions he/she deems necessary and desirable, including, but not limited to:

(i) Requirements for the best practical noise control measures to be taken by the owner or operator of the source to minimize noise during the period of the variance.

(ii) Requirements for periodic reports submitted by the applicant relating to noise, to compliance with any other conditions under which the variance was granted or to any other information the Commissioner deems necessary.

(j) The filing of an application for a variance shall operate as a stay of prosecution, except that such stay may be terminated by the Commissioner upon application of any party if the Commissioner finds that protection of the public health so requires.

(k) In any case where a person seeking a variance contends that compliance with any provision of these Regulations is not practical or possible because of the cost involved either in installing noise control equipment or changing or curtailing the operation in any manner, he/she shall make available to the Commissioner such financial records as the Commissioner may require.

(*l*) A variance may include a compliance schedule and requirements for periodic reporting of increments of achievement of compliance.

(Effective June 15, 1978)

Sec. 22a-69-7.2. Transference

No person who owns, operates or maintains a stationary noise source shall transfer a variance from one site to another site.

(Effective June 15, 1978)

Sec. 22a-69-7.3. Responsibility to comply with applicable regulations

Approval of a variance shall not relieve any person of the responsibility to comply with any other applicable Regulations or other provisions of federal, state or local laws, ordinances or regulations.

(Effective June 15, 1978)

Sec. 22a-69-7.4. Violations and enforcement

(a) No person shall violate or cause the violation of any of these Regulations.

(b) Each day on which a violation occurs or continues after the time for correction of the violation given in the order has elapsed or after thirty (30) days from the date of service of the order, whichever is later, shall be considered a separate violation of these Regulations.

(c) Qualified personnel of the Office of Noise Control shall, with or without complaints, conduct investigations and ascertain whether these Regulations have been complied with. Whenever such personnel determines that any of these Regulations have been violated or there has been a failure to comply therewith, they shall make and serve upon the person(s) responsible for the violation a written order specifying the nature of the violation or failure and affording a reasonable time for its correction or remedy. Prior to the issuance of such order, such personnel shall make a reasonable effort in light of the circumstances to correct a violation or achieve compliance by means of conference, conciliation and persuasion as required by statute. Unless the person(s) against whom an order has been served files a written answer thereto with the Commissioner within thirty (30) days after the date of service of the order and requests a hearing thereon, such order shall become final and effective in accordance with the Connecticut Administrative Procedures Act and the rules, practices, and procedures of the Department of Environmental Protection.

(Effective June 15, 1978)

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RESOLUTION

Item # ______________ RE: ______________________________

To the Honorable Mayor, and the Common Council of the City of New Britain:

the undersigned beg leave to recommend the adoption of the following

AN ORDINANCE OF THE CITY OF NEW BRITAIN PROVIDING THAT THE CODE OF ORDINANCES, CITY OF NEW BRITAIN, BE AMENDED BY REPEALING ARTICLE V OF CHAPTER 16 IN ITS ENTIRETY AND SUBSTITUTING THIS ARTICLE V OF CHAPTER 16, CONCERNING THE EMISSION OF NOISE IN LIEU THEREOF.

BE IT ORDAINED BY THE COMMON COUNCIL OF THE CITY OF NEW BRITAIN THAT THE CODE OF ORDINANCES, CITY OF NEW BRITAIN, BE AMENDED BY REPEALING ARTICLE V OF CHAPTER 16 CONCERNING THE EMISSION OF NOISE AND SUBSTITUTING THIS ARTICLE V OF CHAPTER 16 IN LIEU THEREOF:

ARTICLE V.

Sec. 16-101. Purpose.

It is recognized that people have a right to and should be ensured an environment free from excessive sound and vibration that may jeopardize their health, safety or welfare or degrade the quality of their lives. This ordinance is enacted to protect, preserve and promote the health, safety, welfare and quality of life for the citizens of the city of New Britain through the reduction, control and prevention of noise.

Sec. 16-102. Definitions.

When used in this ordinance, the terms below shall have the following meaning:

Background Noise - Noise of a measurable intensity which exists at a point as a result of a combination of many distant sources individually indistinguishable.

Business Zone - Those areas so designated under business zone of the zoning ordinances of the city of New Britain.

Chief of Police - The chief of police of the city of New Britain or a duly authorized officer subject to his/her order.

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Form TC-002 ______________________

RESOLUTION

Item # ____________ RE: ____________________________

To the Honorable Mayor, and the Common Council of the City of New Britain:

the undersigned beg leave to recommend the adoption of the following

Construction - The assembly, erection, substantial repair, alteration, demolition or site preparation for or of public or private rights-of-way, buildings or other structures, utilities or property.

Construction Equipment - Any equipment or device operated by fuel or electric power used in construction or demolition.

Daytime Hours - The hours between 7:00 a.m. and 9:00 p.m. Monday through Saturday and the hours between 9:00 a.m. and 9:00 p.m. on Sunday.

Decibel - A unit of measurement of the sound level, the symbol for which is "db".

Demolition - Any dismantling, intentional destruction or removal of structures, utilities, public or private right-of-way surfaces or similar property.

Emergency Vehicle - Any motor vehicle authorized by any local authority to have sound warning devices, such as sirens and bells, which can lawfully be used when responding to an emergency.

Emergency Work - Work made necessary to restore property to a safe condition following an emergency or work required to protect persons or property from exposure to imminent changes.

Excessive Noise - Any sound, the intensity of which exceeds the standard set forth in section 16-105.

Impulse Noise - Sound of short duration, usually less than one (1) second, with an abrupt onset and rapid delay.

Industrial Zone - Those areas so designated under the industrial zone of the zoning ordinances of the city of New Britain.

Intrusion Alarm - A device with an audible signal and which, when activated, indicates an intrusion by an unauthorized person.

Motor Vehicle - A vehicle as defined in subdivisions (30) and (31) of section 14-1 of the Connecticut General Statutes, revision of 1958, as amended.

RESOLUTION

Item # ______________ RE: ______________________________

To the Honorable Mayor, and the Common Council of the City of New Britain:

the undersigned beg leave to recommend the adoption of the following

Nighttime Hours - The hours between 9:00 p.m. and 7:00 a.m. Sunday evening through Saturday morning and between 9:00 p.m. and 9:00 a.m. Saturday evening through Sunday morning.

Noise Level - The sound-pressure level as measured with a sound-level meter using the A-weighting network. The sound level is designated "db(A)" or "db(a)".

Person - Any individual, firm, partnership, association, syndicate, company, trust, corporation, municipality, agency or political or administration subdivision of the state or other legal entity of any kind.

Premises - Any building, structure, land or portion thereof, including all appurtenances, owedn or controlled by a person. A noise emitter's premises includes contiguous publicly dedicated street and highway right-of-ways, all road rights-of-way and waters of the state.

Property Line - That real or imaginary line along the ground surface and its vertical extension which separates real property owned or controlled by any person from contiguous real property owned and controlled by another person and which separates real property from the public right-of-way.

Public Right-of-Way - Any street, avenue, boulevard, highway, sidewalk, alley, park, waterway, railroad, or similar place which is owned or controlled by a government entity.

Residential Zone - Those areas so designated under residential zone of the zoning ordinances of the city of New Britain.

Sound - A transmission of energy through solid, liquid or gaseous media in the form of vibrations which constitute alteration in pressure or position of particle in the medium and which, in air, evoke physiological sensations, including but not limited to an auditory response when impinging on the ear.

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RESOLUTION

Item # ______________ RE: ______________________________

To the Honorable Mayor, and the Common Council of the City of New Britain:

the undersigned beg leave to recommend the adoption of the following

Sound-Level Meter - An instrument used to measure sound levels. A "sound-level meter" shall conform, at a minimum, to the American National Standards Institute operation specifications for sound level meters S1.4-1971 (Type S2A).

Sound-Pressure Level - The A-weighted sound-pressure level, expressed in decibels (dBA), measured on a sound-level meter.

Sec. 16-103. Noise measurement procedures.

For the purpose of determining noise levels as set forth in this ordinance, the following guidelines shall be applicable:

(a) A person conducting sound measurements shall have been trained in the techniques and principles of sound measuring equipment and instrumentation.

(b) Instruments used to determine sound-level measurement shall be sound-level meters as defined by this ordinance.

(c) The following steps should be taken when preparing to take sound-level measurements:

(1) The instrument manufacturer's specific instructions for the preparation and use of the instrument shall be followed.

(2) Measurements to determine compliance with section 16-105 shall be taken at a point that is located more or less one (1) foot beyond the property line of the noise emitter's premises and within the noise receptor's premises.

Sec. 16-104. Classification of noise zones.

Noise zones within the city of New Britain shall be classified as to zoning applicable for the parcel or tract of land and the surrounding parcels or tracts. Noise zones specified herein shall correspond to the following zoning descriptions in the zoning ordinances and zoning map of the city of New Britain.

RESOLUTION

Item # ______________ RE: ______________________________

To the Honorable Mayor, and the Common Council of the City of New Britain:

the undersigned beg leave to recommend the adoption of the following

Zone	Actual or Intended Use	Current Zoning**
A	Residential	S-1, S-2, S-3, T, A-1, A-2, A-3, RO
B	Commercial	OP, B-1, B-2, B-3, B-4, TP
C	Industrial	I-1, I-2, I-3

**Note: Based on the zoning ordinances and zoning map of the city of New Britain.

Sec. 16-105. Noise zone standards.

It shall be unlawful for any person to emit or cause to be emitted any noise beyond the property lines of his/her premises in excess of the following noise levels:

Emitter Noise Zone	Receptor C	Noise B	Zone Class A-Day	A-Night
Class C	70 dBA	66 dBA	61 dBA	51 dBA
Class B	62 dBA	62 dBA	55 dBA	45 dBA
Class A	62 dBA	55 dBA	55 dBA	45 dBA

Sec. 16-106. Delivery trucks.

In addition to the noise prohibitions in section 16-105, no person shall unload or cause to be unloaded delivery trucks within 200 feet of a residential district between one (1) hour after sundown and 7:00 a.m.

Sec. 16-107. Exceptions.

(a) This ordinance shall not apply to noise emitted by or related to:

(1) Natural phenomena.

(2) Any bell or chime from any building clock, school, or church.

(3) Any siren, whistle or bell lawfully used by emergency vehicles or any other alarm system in an emergency situation.

RESOLUTION

Item # ______________ RE: ______________________________

To the Honorable Mayor, and the Common Council of the City of New Britain:

the undersigned beg leave to recommend the adoption of the following

(4) A public emergency sound system.

(5) Warning devices required by the Occupational Safety and Health Administration or other state or federal safety regulations.

(6) Farming equipment or farming activity.

(7) An emergency.

(8) Snow removal equipment.

(b) The following shall be exempt from this ordinance, subject to special conditions as specified:

(1) Noise generated by any construction equipment which is operated during daytime hours, provided that the operation of construction equipment during nighttime hours shall not exceed the maximum noise levels as specified in section 16-105 of this ordinance.

(2) Noise from domestic power equipment during daytime hours.

(3) Noise from demolition work conducted during daytime hours, provided that when considered emergency work, demolition shall be exempted at all times from the noise levels set in this ordinance.

(4) Noise created by any aircraft flight operations which are specifically preempted by the Federal Aviation Administration.

(5) Noise created by any recreational activities which are permitted by law and for which a license or permit has been granted by the city, including but not limited to parades, sporting events, concerts and fireworks displays.

(6) Noise created by blasting other than that conducted in connection with construction activities shall be exempted provided that the blasting is conducted between 8:00 a.m. and 5:00 p.m. local time, at specified hours previously announced to the local public and provided that a permit for such blasting has been obtained from local authorities.

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RESOLUTION

Item # ______________ RE: ______________________________

To the Honorable Mayor, and the Common Council of the City of New Britain:

the undersigned beg leave to recommend the adoption of the following

(7) Noise created by leaf, refuse and solid waste collection, provided that the activity is conducted during daytime hours.

(8) Noise created by fire or intrusion alarm shall, from time of activation of the audible signal, emit noise for a period of time not exceeding ten (10) minutes when such alarm is attached to a vehicle or thirty (30) minutes when attached to any building or structure.

(9) Noise generated by engine-powered or motor-driven lawn care or maintenance equipment on Class A property between the hours of 8:00 a.m. and 9:00 p.m., provided that noise discharged from exhausts is adequately muffled to prevent loud noises therefrom.

(10) Public-address systems used in election campaign activities during daytime hours only.

Sec. 16-108. Vehicle noise restrictions.

The following activities are prohibited:

(a) *Motor vehicle noise*. All motor vehicles operated within the limits of the city of New Britain shall be subject to the noise standards and decibel levels set forth in the regulations authorized in section 14-80a of the Connecticut General Statutes.

(b) *Motor vehicle sound-amplifying devices*. No sound-amplifying devices on or within motor vehicles shall emit noise in excess of the noise levels as specified in section 16-105.

(c) *Unregistered recreational vehicle noise*. No person shall create or cause to be created any unreasonably loud or disturbing noise due to the operation of an unregistered recreational vehicle. A noise shall be deemed to be unreasonably loud and a violation of this ordinance when the noise so generated exceeds the noise level standards set forth in section 16-105.

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RESOLUTION

Item # ______________ RE: ______________________________

To the Honorable Mayor, and the Common Council of the City of New Britain:

the undersigned beg leave to recommend the adoption of the following

Sec. 16-109. Penalties for offenses.

Any person in violation of any of the sections of this ordinance shall be fined in an amount not to exceed fifty dollars ($50.00). Each day that such violation continues after the time for correction of the violation given in an order shall constitute a continuing violation, and the amount of the fine for each day after the first shall be ninety-nine dollars ($99.00).

Sec. 16-110. Variances.

(a) Any person living or doing business in the city of New Britain may apply to the chief of police for a variance of one (1) or more of the provisions of this ordinance which are more stringent that the Connecticut Department of Environmental Protection regulations for the control of noise, provided that the applicant supplies all of the following information to the chief of police at least twenty (20) days prior to the start of the activity for which the variance is sought:

(1) The location and nature of the activity;

(2) The time period and hours of operation of said activity; and

(3) The nature and intensity of the noise that will be generated.

(b) No variance from this ordinance shall be granted unless it has been demonstrated that:

(1) The proposed activity will not violate any provisions of the Connecticut Department of Environmental Protection regulations;

(2) The noise levels generated by the proposed activity will not constitute a danger to the public health; and

(3) Compliance with this ordinance constitutes an unreasonable hardship on the applicant.

Form TC-002

RESOLUTION

Item # ______________ RE: ______________________________

To the Honorable Mayor, and the Common Council of the City of New Britain:

the undersigned beg leave to recommend the adoption of the following

(c) The application for a variance shall be reviewed and approved or rejected at least five (5) days prior to the start of the proposed activity. Approval or rejection shall be made in writing and shall state the condition(s) of approval, if any, or the reason(s) for rejection.

(d) Failure to rule on an application within the designated time shall constitute approval of the variance.

Sec. 16-111. More stringent provisions to apply.

All provisions of the zoning ordinances of the city of New Britain which are more stringent than those set forth herein shall remain in force. If, for any reason, any word, clause, paragraph or section of this ordinance shall be held to make the same unconstitutional or be superseded by any state law or regulation, this ordinance shall not thereby be invalidated, and the remainder of this ordinance shall continue in effect.

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Alderwoman Barbara L. Yezierski

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Form TC-002

Additional Responses to Council on Environmental Quality Requests

Chapter 10 - Additional Tasks Required by the Council On Environmental Quality

Part of Lenard Engineering, Inc.'s (LEI) approved Scope of Services was to address comments from the Connecticut Council on Environmental Quality (CEQ). The CEQ reviewed LEI's Proposed Scope of Services, and requested additions to the Scope during their meetings. A copy of these meeting minutes is attached in **Appendix 10-1**. Please refer to **Appendix 1-B** for LEI's modified Scope of Services dated 2-7-2017, which includes the CEQ requests.

Each of the topics requested by the CEQ are discussed below.

A) *With regard to the cultural analysis, the study will meet the archeological requirements of the State's stormwater general permit, and will do more extensive field analysis subsequently only if the preliminary analysis indicates a need to do so.*

Response: On September 9, 2016, LEI submitted our project description, current and historic maps for the proposed project area, etc. to the State Historical Preservation Office (SHPO) for their review and comment.

The SHPO office responded on January 20, 2017, indicating that "Based on their review of the information provided to the State Historic Preservation Office, it is our opinion that the project will cause no adverse affects to the following historic properties (none identified). No further review is requested."

Copies of our September 9, 2016 submittal and the SHPO's January 20, 2017 reply letter are provided in **Appendix 10-2.**

B) *With regard to water quantity, LEI and our hydrogeologic specialist Leggette, Brashears and Graham (LBG) will provide an analysis of surface and groundwater at the site now, during construction and upon conclusion of the project (50 years out) and will include neighboring properties in all three stages.*

Response: Please refer to Chapter 6 for details. As stated in LBG's report, "there should be no potential impacts to the nearby residential water wells. The proposed quarry (expansion) should not result in any consumptive loss to the bedrock aquifers utilized by the nearby wells."

With respect to surface waters, the local drainage basins and intermittent streams within the footprint of the proposed quarry expansion and future Storage Reservoir creation will be lost. Their present discharge to the West Canal, which flows into Shuttle Meadow Reservoir, will also be lost. However, periodic pumping from the proposed Storage Reservoir intake pumping station into the West Canal will more than replace this loss of flow.

C) *LEI will define how much of New Britain's current water produced is consumed, used for purposes other than consumption and how much is lost. We will compare this value to industry standards.*

Response: Please refer to Chapter 5- Water Demand Projections for New Britain and Surrounding Communities. As shown in **Table 5-2**, historic total unaccounted-for, non-revenue water over the past five years of record averaged 19.5%, which is slightly above the typical industry standard of 15 %. Given the age of New Britain's water distribution system which exceeds 100 years old in some locations, this value of non-revenue water is considered reasonable. New Britain will continue to pursue both supply and demand conservation measures outlined in their Water Conservation Plan, with a long-term goal to reduce this un-accounted for, non-revenue water to 15 % or less.

D) *During the water quality and treatment analysis, LEI and our water treatment specialist Tighe & Bond will analyze the impacts of chemicals typically found in mining operations.*

Response: Please refer to Chapter 8- Water Quality and Treatment. In summary, Tighe & Bond identified typical compounds found in mining operations, including perchlorate, sulfur, boron, nitroaromatics and nitroamines, and others. Two rounds of water quality samples were reviewed, and these and other parameters analyzed were found to be at or below detection levels.

In summary, Tighe & Bond indicated "the water quality reviewed in this evaluation did not identify any significant differences between existing reservoirs and samples assumed to be representative of the proposed reservoir. Modifications to the Shuttle Meadow Water Treatment Plant facilities or operations are therefore not anticipated to be needed to treat water from the proposed reservoir."

E) *Applicable data used in generating conclusions to the study will be included in the study.*

Response: Applicable data used in generating conclusions to the study are attached in Appendices to each particular chapter.

F) *Impacts on the water table due to the project, including consideration of possible effects of climate change will be analyzed.*

Response: With respect to changes to the water table, Leggette, Brashears and Graham (LBG) determined in Chapter 6 "there should be no potential impacts to the nearby residential water wells. The proposed quarry (expansion) should not result in any consumptive loss to the bedrock aquifers utilized by the nearby wells".

With respect to the possible effects of climate change on both the water table and other aspects of the project, LEI reviewed the final version of the Connecticut State Water Plan, dated January 2018 which was prepared CDM Smith and Milone and MacBroom.

Section 3 of this report is entitled "Preparing for Change: Future Conditions and Opportunities". Section 3.1.4 discusses the Potential Impacts of Climate Change, and a copy of this section is attached in **Appendix 10-3**.

As stated in this report, "*the objective of this task was to synthesize and summarize the suite of climate change projections for the State of Connecticut into a practical, useful, and comprehensive data set for use in subsequent water resources analyses.*" Below, *in italics*, are excerpts from this section, which are relevant to the creation of a potential New Britain Storage Reservoir project, and the Flood Skimming utilizing the existing White Bridge Surface Water pumping station on Coppermine Brook as the primary source of supply to refill this new Storage Reservoir.

- *Results in this section correspond to year 2080, a horizon of approximately 60 years, in order to show significant possible trends.*
- *The period between 1950 and 1999 was selected as the historical climate baseline for the study.*
- *As evidenced by the annual anomaly presented above (Figure 3-10 from their report), there is general consensus in the climate models for a hotter and wetter future. Mean annual temperature changes for the 2080 planning horizon, compared to historical baseline, range from + 0.5 to + 6.5 degrees C. Mean annual precipitation changes range from approximately -5 % to + 30 %, with the vast majority of the projections predicting an increase in mean annual precipitation.*
- *All Global Climate Models (GCM) project an increase in temperature for all calendar months. Projected temperature changes appear relatively consistent across calendar months and percentile levels...In other words, both summer and winter temperatures are projected to increase by similar amounts.*
- *Precipitation projections are more variable, although consistently projecting a generally wetter future for all four scenarios (Hot - Dry ensemble, Warm – Dry Ensemble, Hot – Wet Ensemble, and Warm – Wet Ensemble). The largest precipitation increases are projected for the wetter months, including extreme wet months. It follows, then, that the seasonality plots show that winter and spring precipitation changes are projected to be larger than summer and autumn changes. Drier months are generally projected to remain about the same in terms of both frequency and rainfall level. Small decreases in extreme dry month precipitation for the hot/dry scenario.*

- *Climate changes can be translated into projected changes in water availability... Implied by the results presented here is the potential for decreased water availability due to significantly higher temperatures and evapo-transpiration losses. However, clearly this dynamic would be offset to a certain extent by increased rainfall.*

- *Typical climate forecasts tend to suggest that increased temperatures coupled with increased annual precipitation generally correspond to higher intensity storms(greater flood risk) and longer dry periods in the summer months (more frequent and/or intense droughts). Because Connecticut has so many small reservoir systems, these systems could be very sensitive to such changes.*

- *Demands could similarly be impacted, with increasing demands due to higher temperatures, but with changes tempered by increased rainfall. The timing of water availability and stream flows will also undoubtedly be impacted, with less snow pack and an earlier melt. The combination of potential rapid snowmelt and higher extreme precipitation events could translate to an increased flooding risk.*

- *The results presented above generally agree with other studies that have been done...The 2010 Climate Change Connecticut report had the following summary conclusions:*

  a) *Connecticut could see a temperature increase of 4 - 7.5 degrees F by the end of the 21st century,*

  b) *Precipitation...could increase by 5 – 10 % , and redistribute itself so that more of this increase occurs during winter months,*

  c) *Sea-level rise may increase 12-23 inches, and*

  d) *Drought frequency may increase as well as duration and intensity.*

As stated above, the impacts on climate change to existing water utilities that rely primarily on surface water will be significant; redistribution of rainfall, more extreme floods especially in the winter and spring months, followed by periods of more frequent, longer and more intense droughts.

The impact of increased precipitation in winter and spring will not greatly benefit surface water system such as New Britain, which presently does not have the capability to store large excesses in water during these seasons; these routinely flow over reservoir spillways once the reservoirs are full. The likelihood of frequent, longer and more severe droughts, especially during the summer and autumn seasons, will likely exceed the current 1: 100 year return frequency drought, which is used to calculate safe yields. Thus, overall system safe yields will likely decrease.

With the proposed 2.31 billion gallon Storage Reservoir in place, New Britain will have a location where these anticipated seasonal increases in rainfall and streamflows can be stored, in anticipation of the next drought event.

Also, flood skimming on Coppermine Brook, utilizing the existing White Bridge Surface Water pumping station, will beneficially capture these increased streamflow events, reducing downstream impacts to Bristol properties already experiencing flooding issues.

In summary, the addition of a significant water storage reservoir in New Britain's system will help counteract the potential impacts of climate change by providing additional storage for the anticipated increased winter and spring streamflows, and utilizing this water during drought periods.

G) *The possible impacts of blasting on the rock structure's ability to hold water and on Wassel Reservoir will be conducted by LEI and our geologic consultant LBG.*

Response: Please refer to Chapter 6 – Hydrogeologic Impact Assessment. As noted in Section 6.3 of their report, "the storage capacity of the proposed reservoir may be affected, to a small degree, by leakage into the underlying faults/fractures in the basalt bedrock, lithologic contacts, and more permeable strata within the Shuttle Meadow Formation. Leakage rates should decrease over time as features associated with the primary and secondary porosity of the bedrock become saturated; then continued at a significantly reduced rate controlled by the resulting hydraulic gradient and transmissivity."

Wassel Reservoir is located approximately 2 miles south of the proposed Storage Reservoir. As the watershed area for Wassel Reservoir is not located in the same drainage basin as the West Canal, the proposed Storage Reservoir should have no hydrologic impacts. In addition, since the proposed Storage Reservoir will be created in the Holyoke Basalt bedrock formation, it should have no impact on the geologic setting for Wassel Reservoir, which is shown in the Shuttle Meadow formation.

H) *The projects impact on drinking water in New Britain's West Canal and other reservoirs will be examined.*

Response: As noted throughout the report, the proposed Quarry Expansion and future Storage Reservoir creation will have only minor short term impacts, and no negative long term impacts on any of New Britain's current drinking water reservoirs.

As noted in Chapter 4 – Updated Surface Water Safe Yield Study, during the anticipated 35 - 40 years of quarrying activities, assuming none of the water captured in the quarry bottom is re-pumped for consumptive use, the overall system safe yield will drop by 0.07 MGD (70,000 gpd), from 18.23 MGD presently to 18.16 MGD during this condition. Once the new Storage Reservoir is created and on-line, system safe yield is estimated to increase to 20.20 MGD, an increase of approximately 2 MGD for the future.

As noted in Chapter 6, the temporary loss of water to the West Canal from intermittent watercourses within the footprint of the quarry expansion / Storage Reservoir can be easily offset by routine pumping from the Storage Reservoir Intake Pump Station to the West Canal.

APPENDIX 10-1
STATE OF CONNECTICUT
COUNCIL ON ENVIRONMENTAL QUALITY (CEQ)
MEETING MINUTES OF OCTOBER 19, 2016

Minutes

Minutes of the October 19, 2016 meeting of the Council on Environmental Quality, held in the Holcombe Conference Room on the fifth floor of 79 Elm Street in Hartford.

PRESENT: Susan Merrow (Chair), Janet Brooks, Alicea Charamut, Lee Dunbar, Karyl Lee Hall (by telephone), Alison Hilding, Kip Kolesinskas, Matt Reiser, Karl Wagener (Executive Director), Peter Hearn (Environmental Analyst), Cassandra Cronin (Intern).

At 9:33 AM, Chair Merrow convened the meeting, noting a quorum.

Chair Merrow asked for approval of the agenda. Charamut made a motion to approve that was seconded by Dunbar and approved unanimously. Brooks and Hilding had not yet arrived and did not vote.

Chair Merrow asked if there were any revisions to the minutes of September 21, 2016. Reiser said he had found a typo on the fifth page, a conflation of plant and plan. Chair Merrow asked for a motion to approve the minutes with that modification. Dunbar made a motion to approve the minutes with the change. It was seconded by Charamut and approved by all present. Brooks was just arriving and did not vote. Hilding had not arrived, but subsequently asked that the minutes reflect that she had read the September minutes and approved of them, with the correction.

Chair's Report

Chair Merrow said it saddened her to have to report for the second time this year on the loss of a giant among Connecticut's conservationists. Russel Brenneman was a major influence in the land preservation movement who brought civility, kindness and gentleness to the work. She said she was proud to have walked the earth at the same time he did.

Citizen Comment Period

Mr. Mike Papa of Stamford introduced himself as a practitioner of ecological landscaping for the last 10 years. He spoke of his concern that, although the free enterprise system is the driver of many innovations, it can put people on the wrong track. He used the example of landscaping practices that depend upon application of synthetic fertilizers and large amounts of irrigation. He said that with the proper soil management practices irrigation could be reduced, saving money and water, important during this period of drought. He said he gives his customers a thick book on organic lawn management. He said that part of the problem is that there is no required training or licensing for landscapers. He added that there are many other water conservation practices he would like to see put into place, like reuse of stormwater. Chair Merrow observed that the drought has brought many related issues to the fore. She thanked Mr. Papa for taking the time to come to the Council with his thoughts.

Executive Director's Report

Wagener introduced Cassandra Cronin of Trinity College, one of the Council's two interns for this semester. He said she has been working on indicators for the annual report, which would be discussed later in the meeting. He referred the Council to a picture on the smartboard of an angler with a very large carp. He informed the Council about the catch-and-release contest that had just concluded along the Connecticut River. It brings carp anglers from around the world who are interested in the large cash prizes that are put up by the sponsors, and example of tourism based on natural resources.

He said that the budget reduction option had been submitted as discussed in September. He noted that the Connecticut League of Conservation Voters' 16th Annual Environmental Summit will be on Tuesday, December 13 and that many advocates and legislators who attend this gathering will be focusing on the state budget, especially the impacts of reductions at the Department of Energy and Environmental Protection (DEEP).

He said he attended the annual invasive plants symposium and made a presentation on factors affecting Connecticut's environmental future. He said that Bill Hyatt of DEEP, former chair of the Invasive Plants Council, spoke on that council's current and future objectives. Wagener pointed out that the sole invasive plants staff position had been eliminated, and that less work would be done on invasive species by all agencies.

Wagener said that Cassandra Cronin had been researching several data sources for new ecological indicators. While freshwater mussels looked promising, the data proved otherwise. Although mussels could be a useful measure of the health of some environments, data deficiencies make trend tracking impossible at this time. He said that Cronin did have success in research into Ruffed Grouse data. He referred to chart she created that illustrated the dramatic decline in Connecticut's Ruffed Grouse population. He said the bird is a useful indicator of the decline in certain forest types. The data for one of the trend lines was from the Christmas Bird Count. He said that one must be cautious in using this count for scientific documentation of trends, but experts with whom Cronin spoke endorsed the validity of its use for grouse. The other line on the chart is from the summer count of the Connecticut Ornithological Association. Its track shows nearly the same trend. Dunbar said that the big issue concerning the decline in Grouse is habitat fragmentation. They are not migratory and they do not disperse far, so if they are driven from a habitat they may not come back. Kolesinskas said the Ruffed Grouse is a good surrogate for other species of concern like the New England Cottontail and timberdoodle. Also, hemlock trees are important for providing shelter to grouse. He also mentioned the role of invasive species. Members agreed that the grouse indicator would be a good one to pursue, especially if the report documents the other species that depend on similar habitats.

Environmental study of change of use of watershed lands in New Britain

Chair Merrow said there were people in the audience who wished to comment on this agenda item. The first to speak was Paul Zagorsky, a resident of New Britain. Mr. Zagorsky thanked the Council for its decision on July 27 to rescind its determination that the consultant to New Britain was acceptable, after reviewing the proposed scope of work. He said that decision has slowed what would have been a rushed study, allowing for an in-depth analysis. He reminded the Council that the original proposal for a study in 2007 was never done because of an opinion by the Attorney General that the Tilcon company could not be involved in it due to its inherent conflict of interest. He expressed concern that Tilcon still is deeply involved in the study process, citing a July 7, 2016 "kick-off" meeting that included the consultant and representatives of New Britain plus Tilcon's senior management, lobbyist, public relations staff and engineers. He read from e-mails that suggested the intent of the study remains to prepare the way for a quarry and cited wording in the scope of work that refers to a future quarry, with references to quarry filling and water quality. He said that after the expenditure of $180,000 to date, no ecological work has been done. He left copies of the documents to which he referred, noting that Hall had requested copies of all supporting documents at the last meeting. (Copies of all documents submitted at Council meetings are available in the Council's offices.)

The next person to comment was Ms. Lanette Macaruso, of New Britain. She said that forests play an important role in purifying water. The statute that requested the study asked for the likely impact of change in use including hydrology, forest ecology, natural land resources and wetland systems. She said there is already an example of what it will do to the environment: the existing quarry. She said Tilcon has to import water to conduct its operation, evidence that the hydrology of the site has been affected.

Mr. Bill Ostapchuk said the scope of study appears inadequate to determine ground water elevations and contours and potential impact on surrounding wells. It proposes no sampling of the current water table or finger printing of sources. He said it is missing important information on other water bodies too. He said the Shuttle Meadow Reservoir is being filled by the same source as is proposed to fill the new reservoir. He said the study's focus should be on the role of water in the cycle of life, not on calculations of safe yield.

Dr. Martin Dinep of New Britain said he has yet to see a complete map of city land and land that is to be donated as part of the plan. He said he is concerned whether the West Canal will be included in the study and expressed the belief that it should, noting the presence of breeding waterfowl and other wildlife.

Mr. James Ericson, Vice President of Lenard Engineering, spoke from the audience to say he would be happy to answer any individual's questions. Chair Merrow thanked him and invited him to participate. First, Wagener reviewed the Council's role in the scope of study, which led to discussion among the members. Reiser asked if there would be an up-or-down vote; members determined that recommendations would be offered but that such a vote was not required.

Dunbar said that the impacts described in the public act should be distinguished from the ones that might be included by the "including but not limited to" clause. Wagener said there is no statutory authority to approve or reject the scope of work for the study, but since the Council is charged with a final review of the study, it is logical that the Council provide guidance as to what it will look for in the final product.

There was discussion of flood-skimming. Charamut noted that Hilding and others had, at the September meeting, noted the need to define flood-skimming. Charamut described her understanding of it and asked Mr. Ericson questions about it. Mr. Ericson said that Charamut's description was correct and that the description would be in the study. Charamut asked Mr. Ericson how the threshold for "flood skimming" would be established and about studying its potential effect on downstream wells, and asked if the pumping to the reservoir would include only flood-skimming or would also include volumes allowed by the water department's diversion registration. Mr. Ericson said that both would be looked at, with the goal of developing optimal scenarios. In response to another question from Charamut, he said the study would extend to minimum releases at Copper Mine Brook and to raw-water and treated-water interconnections with the Metropolitan District Commission's (MDC) water supply. The minimum-flow analysis would focus on White Bridge Pond Station and Copper Mine Brook. Hilding asked if climate change and its effects on evaporative losses will be considered. Mr. Ericson answered yes; DEEP's minimum stream flows for the Connecticut River Basin are being used to which anticipated climate change impacts will be added. Charamut pointed out that there is no stream gauge on the Copper Mine Brook and asked from where the stream flow data is derived. Mr. Ericson said that Burlington Brook data has been used to model Copper Mine, such as in 2002, plus there are historical records.

START

Chair Merrow suggested that the best approach to the next phase of discussion would be to discuss each point from Wagener's October 5, 2016 memo that summarized the Council members' comments and as well as comments received from the public at the September 21, 2016 Council meeting and subsequently in writing. The Council asked Mr. Ericson to respond to each point. Regarding the need for specialized expertise, Mr. Ericson said that Tighe & Bond will be performing the water quality components of the study, and that they have added air and noise to the scope. He said that Environmental Planning Services will provide the landscape-scale analysis and will use GIS analysis to do so.

With regard to cultural analysis, Mr. Ericson said that the study will meet the archaeological survey requirements of the state's stormwater general permit, and will do more extensive field analysis subsequently only if the preliminary analysis indicates a need to do so. Dunbar agreed with this approach.

Brooks and Wagener discussed whether or not an archaeological analysis is beyond the scope of an environmental study.

With regard to water quantity, Mr. Ericson said that Leggette Brashears & Graham will provide an analysis of surface and ground water at the site now, during construction and upon conclusion of the project (50 years out) and will include neighboring properties in all three stages. Dunbar said there is dispute among experts over the proper methodology for such an analysis, so the method selected should be made clear.

Kolesinskas said that New Britain has much old housing stock and consequently likely to have leakages and inefficient plumbing fixtures. Mr. Ericson and Mr. Bligh said that New Britain is efficient by industry standards, with less than 15% of non-revenue water, which encompasses leaks and non-metered uses. The study will define how much is consumed, used for purposes other than consumption and how much is lost. Charamut said she would like to see a comparison of the cost of improved conservation and education to the cost of a new reservoir with its interconnections to other water supplies. Hilding supported the idea of improved education about water conservation and added that the analysis should include any losses that might occur due to the geology of the new quarry.

Mr. Ericson addressed concerns about water quality by saying Tighe & Bond will project water quality including after flood-skimming. Hilding elaborated on the potential for chemicals that might be used in, or be a byproduct of, mining to remain in the fractures and fissures in the rocks and, in the future, be released into the water in the reservoir. Mr. Ericson said the study will anticipate the potential effect of any chemicals used in mining.

All data used in the report will be included, not just the conclusions of the study.

Mr. Ericson said that an analysis of invertebrates will not be in the study, which will focus on reptiles, amphibians and birds. There will be a breeding-bird survey. There was discussion of the potential need to study bat habitat, pursuant to new regulatory requirements. Mr. Ericson said the consultants will also be able to address the suggestions submitted by Mr. William Moorhead, including those pertaining uncommon plant species, dry subacidic forest, and mapping of critical habitats and communities of high biodiversity significance.

With regard to effects on the water table, Mr. Ericson said that Tighe and Bond will be studying it, including consideration of the possible effects of climate change in its analysis.

Hilding reiterated the need to study the integrity of the rock after blasting and mining with regard to its ability to hold water efficiently. Mr. Ericson said that the possible impacts of blasting on the rock structure's ability to hold water and on Wassel Reservoir will be done by Tighe & Bond.

Hilding said that if work is performed at night the possible effects of light and heat on wildlife should be examined. Mr. Ericson said that to his knowledge, there is no night work at a quarry. Hilding also said that the effects of noise on nearby wildlife should be included.

The Council members discussed whether an analysis of potential alternative sources of stone elsewhere is appropriately within the scope of study as a "no build alternative." Most thought not. The Council agreed that the suggestion for the Council to select and vet the water quality parameters was beyond the Council's expertise. The Council did not see the need for a literature search for environmental analyses of quarry operations elsewhere, accepting that Tighe & Bond had ample local expertise in this regard. Mr. Ericson noted that New Britain had already submitted the qualifications of the consultants to the Council and they were found acceptable. The Council did not see a need for interim meetings to insure the scope of work is being followed, since the final product will answer that question.

Reiser asked if the expanded scope of work leaves sufficient funds to perform the study. Mr. Ericson answered that some of the work has shifted to the ecological aspects of the work and away from the engineering aspects. He said that it might be necessary for more funds for some analyses to be completed. He said it would be up to New Britain to determine if it wishes to fund a second public meeting about the project.

Chair Merrow also said there were some questions asked by the public today that need to be answered. She asked Mr. Ericson if the West Canal and other reservoirs will be included in the environmental study. Mr. Ericson said the entire system will be examined, including the project's impact on drinking water. He said that now water is transferred to the Shuttle Meadow Reservoir and that only surplus water would be used to fill a new reservoir; currently, the reservoir overflows during periods of ample rain. Mr. Gil Bligh of the New Britain Water Department, speaking from the audience, concurred.

Hilding said that at the last Council meeting Mr. Vidich had stated his belief that more than one public meeting should be held about the project. Brooks said that because this is a geographically-localized project, not a statewide program, multiple public meetings would be exceptional. Chair Merrow said that Mr. Ericson might not be able to respond to the number of meetings that will be held.

END

Chair Merrow asked for a motion to summarize the Council's deliberations and actions. Charamut made a motion to state that

> the minutes of the meeting, including the on-the-record commitments made by Mr. Ericson, shall be sent to the Water Planning Council and any other interested parties, that the Council will follow the process, and that the next action by the Council will be to review the final report upon its completion.

Dunbar seconded the motion which was approved unanimously.

Some members of the audience asked for the opportunity to add to the discussion.

Justine Beach of New Britain said she was happy to see the improved scope of work that has resulted from

APPENDIX 10-2
STATE OF CONNECTICUT
HISTORIC PRESERVATION OFFICER (SHPO)
CORRESPONDENCES

LENARD ENGINEERING, INC.
2210 MAIN STREET
PO BOX 1088
GLASTONBURY, CT 06033
PHONE: (860) 429-5400

LETTER OF TRANSMITTAL

DATE: September 9, 2016
JOB NUMBER: 16-370

ATTN: Todd Levine
RE: SHPO Project Review Form

TO: Todd Levine
State Historic Preservation Office
One Constitution Plaza
Hartford, CT 06103

We are sending you: ☒ Attached ☐ Under separate cover ☐ Prints ☐ Plans ☐ Specifications
☐ Other ____________________

Copies	Date	No.	Description
1	September 2016		Project Review Form

For your review and comment.

REMARKS:

Mr. Levine,

Enclosed is a project review form for the City of New Britain.

Copies to:

SIGNED: *Sara Nichols*
Sara Nichols

DATE: September 9, 2016

State Historic Preservation Office
One Constitution Plaza · Hartford, CT 06103 · 860 256 2800 · cultureandtourism.org

PROJECT REVIEW COVER FORM

1. This information relates to a previously submitted project. ☐

You do not need to complete the rest of the form if you have been previously issued a SHPO Project Number. Please attach information to this form and submit.

SHPO Project Number ____________
(Not all previously submitted projects will have project numbers)

Project Address O Biddle Pass Plainville CT
(Street Address and City or Town)

2. This is a new Project. ☐ If you have checked this box, it is necessary to complete ALL entries on this form.

Project Name Future Drinking Water Storage Reservoir

Project Location O Biddle Pass
Include street number, street name, and or Route Number. If no street address exists give closest intersection.

City or Town Plainville
In addition to the village or hamlet name (if appropriate), the municipality must be included here.

County Hartford
If the undertaking includes multiple addresses, please attach a list to this form.

Date of Construction (for existing structures) N/A

PROJECT DESCRIPTION SUMMARY (include full description in attachment):

New Britain is to lease 131.4 acres (the O Biddle Pass in Plainville) for stone and mineral extraction which will create a future water storage reservoir for the City of New Britain and interconnected water companies in the region surrounding the areas supplied by New Britain's water reservoir system.

TYPE OF REVIEW REQUESTED

a. Does this undertaking involve funding or permit approval from a State or Federal Agency?

[X] Yes ☐ No

Agency Name/Contact	Type of Permit/Approval	State	Federal
Department of Public Health	Water Company Lands	X	
Department of Energy and Environmental Protection	CEPA	X	

	Yes	No
b. Have you consulted the SHPO and UCONN Dodd Center files to determine the presence or absence of previously identified cultural resources within or adjacent to the project area?		X
If yes: Was the project site wholly or partially located within an identified archeologically sensitive area?		
Does the project site involve or is it substantially contiguous to a property listed or recommended for listing in the CT State or National Registers of Historic Places?		X
Does the project involve the rehabilitation, renovation, relocation, demolition or addition to any building or structure that is 50 years old or older?		X

Connecticut

State Historic Preservation Office

One Constitution Plaza | Hartford, CT 06103 | 860 256 2800 | Cultureandtourism.org

PROJECT REVIEW COVER FORM

The Historic Preservation Review Process in Connecticut Cultural Resource Review under the National Historic Preservation Act – Section 106 http://www.achp.gov/106summary.html involves providing technical guidance and professional advice on the potential impact of publicly funded, assisted, licensed or permitted projects on the state's historic, architectural and archaeological resources. This responsibility of the State Historic Preservation Office (SHPO) is discharged in two steps: (1) identification of significant historic, architectural and archaeological resources; and (2) advisory assistance to promote compatibility between new development and preservation of the state's cultural heritage.

Project review is conducted in two stages. First, the SHPO assesses affected properties to determine whether or not they are listed or eligible for listing in the Connecticut State or National Registers of Historic Places. If so, it is deemed "historic" and worthy of protection and the second stage of review is undertaken. The project is reviewed to evaluate its impact on the properties significant materials and character. Where adverse effects are identified, alternatives are explored to avoid, or reduce project impacts; where this is unsuccessful, mitigation measures are developed and formal agreement documents are prepared stipulating these measures. For more information and guidance, please see our website at: http://www.cultureandtourism.org/cct/cwp/view.asp?a=3933&q=293820

ALL PROJECTS SUBMITTED FOR REVIEW MUST INCLUDE THE FOLLOWING MATERIALS*:

[x] **PROJECT DESCRIPTION** Please attach a full description of the work that will be undertaken as a result of this project. Portions of environmental statements or project applications may be included. The project boundary of the project should be clearly defined**

[x] **PROJECT MAP** This should include the precise location of the project – preferably a clear color image showing the nearest streets or roadways as well as all portions of the project. Tax maps, Sanborn maps and USGS quadrangle maps are all acceptable, but Bing and Google Earth are also accepted if the information provided is clear and well labeled. The project boundary should be clearly defined on the map and affected legal parcels should be identified.

[x] **PHOTOGRAPHS** Clear, current images of the property should be submitted. Black and white photocopies will not be accepted. Include images of the areas where the proposed work will take place. May require: exterior elevations, detailed photos of elements to be repaired/replaced (windows, doors, porches, etc.) All photos should be clearly labeled.

For Existing Structures	Yes	N/A	Comments
Property Card	[ ]	[x]	
For New Construction	Yes	N/A	Comments
Project plans or limits of construction (if available)	[ ]	[x]	
If project is located in a Historic District include renderings or elevation drawings of the proposed structure	[ ]	[x]	
Soils Maps http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm	[ ]	[x]	
Historic Maps http://magic.lib.uconn.edu/	[ ]	[x]	
For non-building-related projects (dams, culverts, bridge repair, etc)	Yes	N/S	Comments
Property Card	[x]	[ ]	
Soils Map (see above)	[x]	[ ]	
Historic Maps (see above)	[x]	[ ]	

PROJECT CONTACT

Name James Ericson, PE Title Vice President

Firm/Agency Lenard Engineering Inc.

Address 2210 Main Street

City Glastonbury State CT Zip 06033

Phone 860-659-3100 Cell ____ Fax 860-659-3193

Email Ericson@lenard-eng.com

*Note that he SHPO's ability to complete a timely project review depends largely on the quality of the materials submitted.

** Please be sure to include the project name and location on *each page* of your submission.

Town of Plainville
Property Listing Report

Parcel ID 46-A-01

Account R07054

Property Information

Owner	NEW BRITAIN CITY OF
Address	0 BIDDLE PASS
Mailing Address	1000 SHUTTLE MEADOW AVE NEW BRITAIN , CT 06050
Land Use	.
Land Class	C

Census Tract	4207
Neighborhood	505
Zoning	R-40
Acreage	124
Utilities	
Lot Setting/ Desc	/

PARCEL VALUATIONS (Assessed value = 70% of Appraised Value)

	Appraised	Assessed
Buildings	0	
Outbuildings		
Improvements		
Extras		
Land	930000	
Total	930000	651000
Previous		

Construction Details

Year Built	
Stories	0
Building Style	0
Building Use	0
Building Condition	
Total Rooms	0
Bedrooms	
Full Bathrooms	
Half Bathrooms	
Bath Style	
Kitchen Style	
Roof Style	
Roof Cover	

EXTERIOR WALLS:

Primary	
Secondary	

INTERIOR WALLS:

Primary	
Secondary	

FLOORS:

Primary	
Secondary	

HEATING/AC:

Heating Type	
Heating Fuel	
AC Type	

BUILDING AREA:

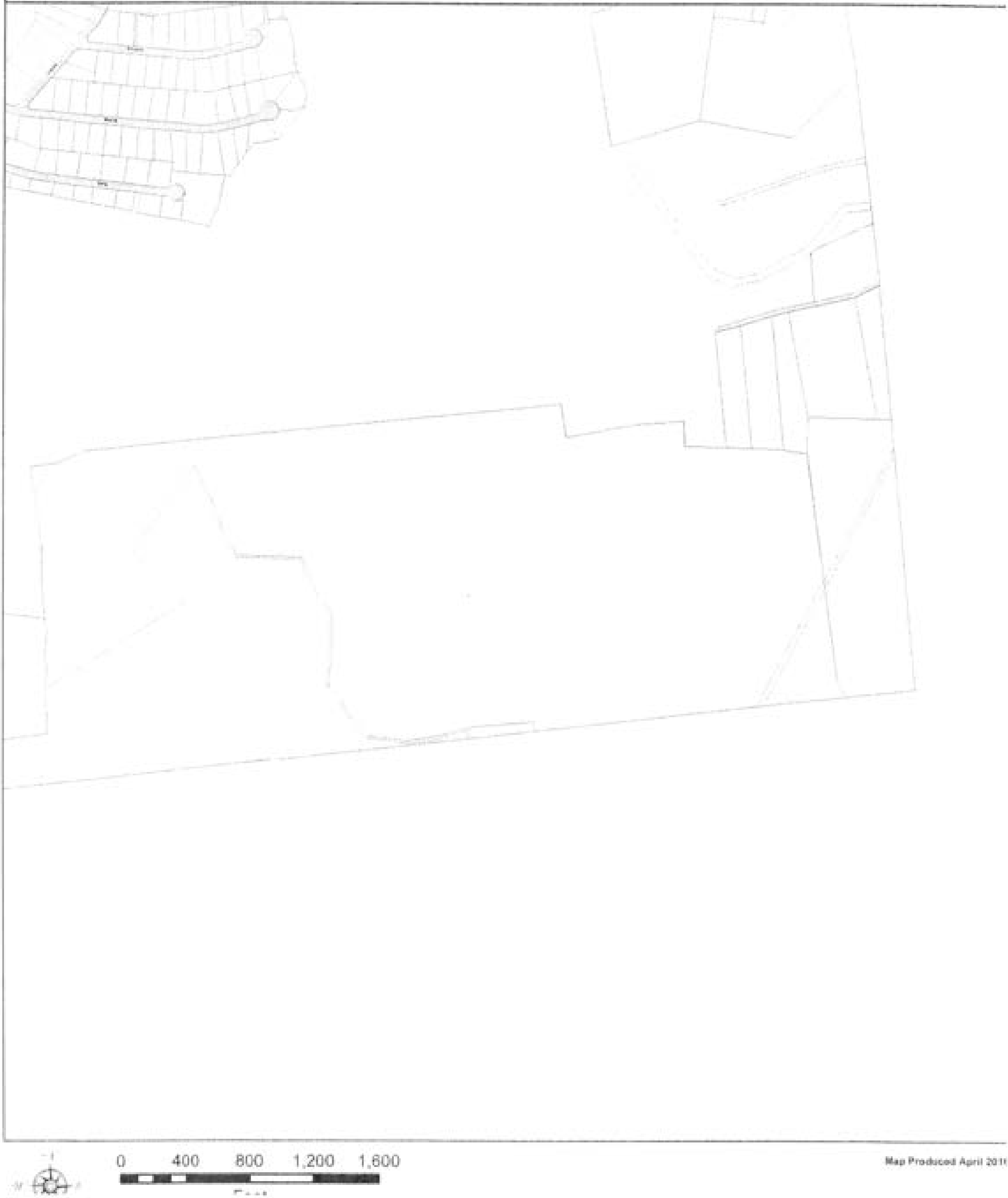
Effective Building Area	
Gross Building Area	
Total Living Area	

SALES HISTORY:

Sale Date	0
Sale Price	0
Book/ Deed	039 398

Town of Plainville, Connecticut - Assessment Parcel Map

Parcel: 46-A-01 **Address:** 0 BIDDLE PASS



Map Produced April 201

Descriptor/Area

Notice

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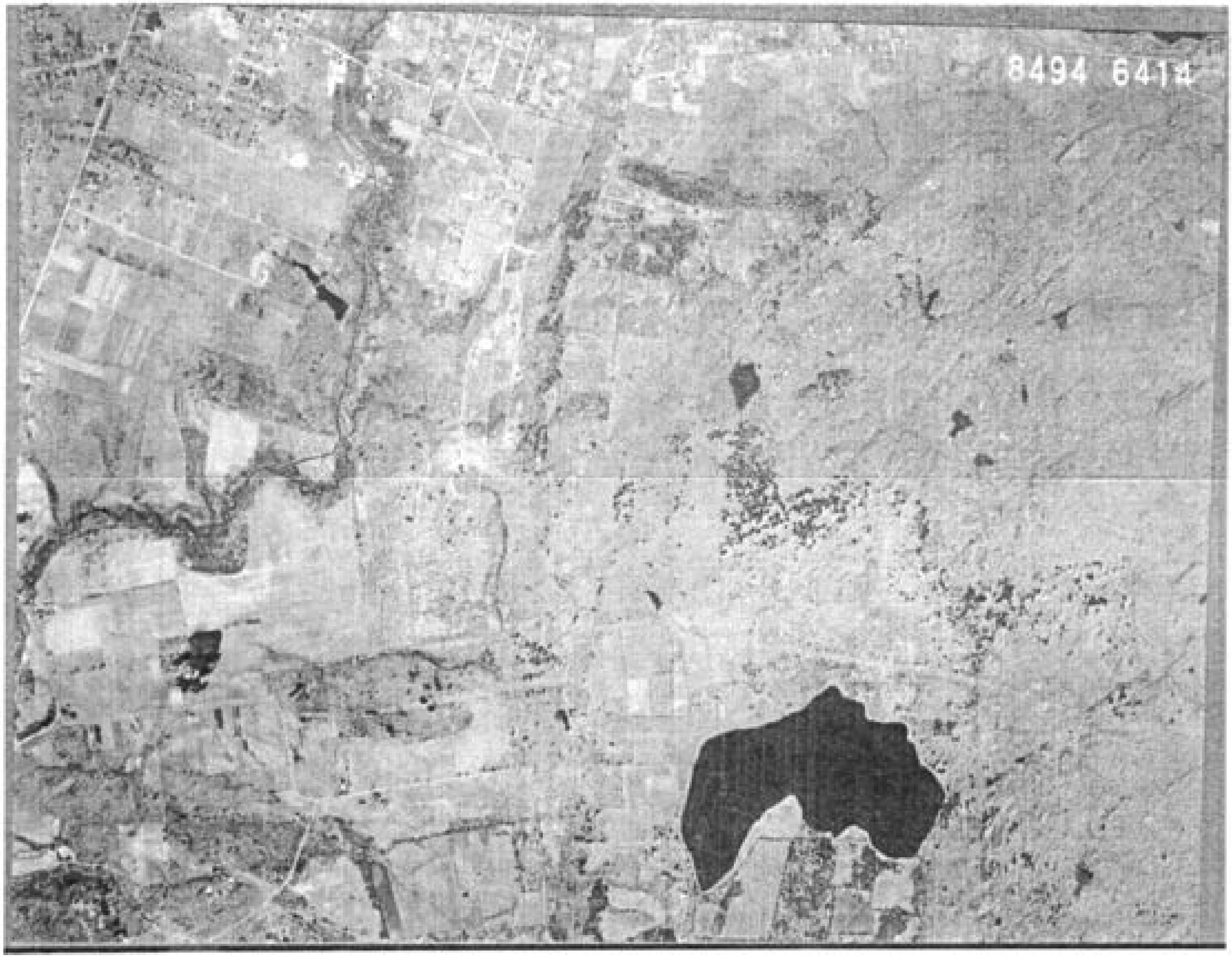
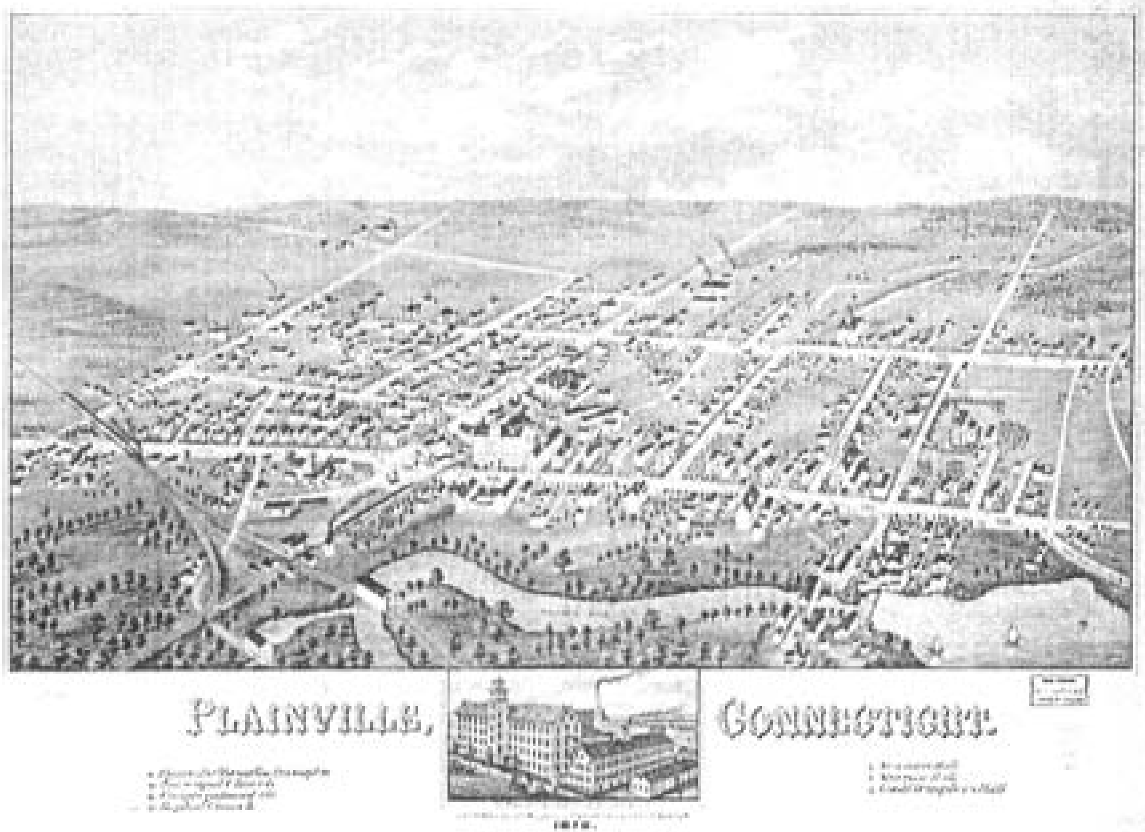
The providers of this database: CLT, Big Room Studios, and Plainville, CT assume no liability for any error or omission in the information provided here.

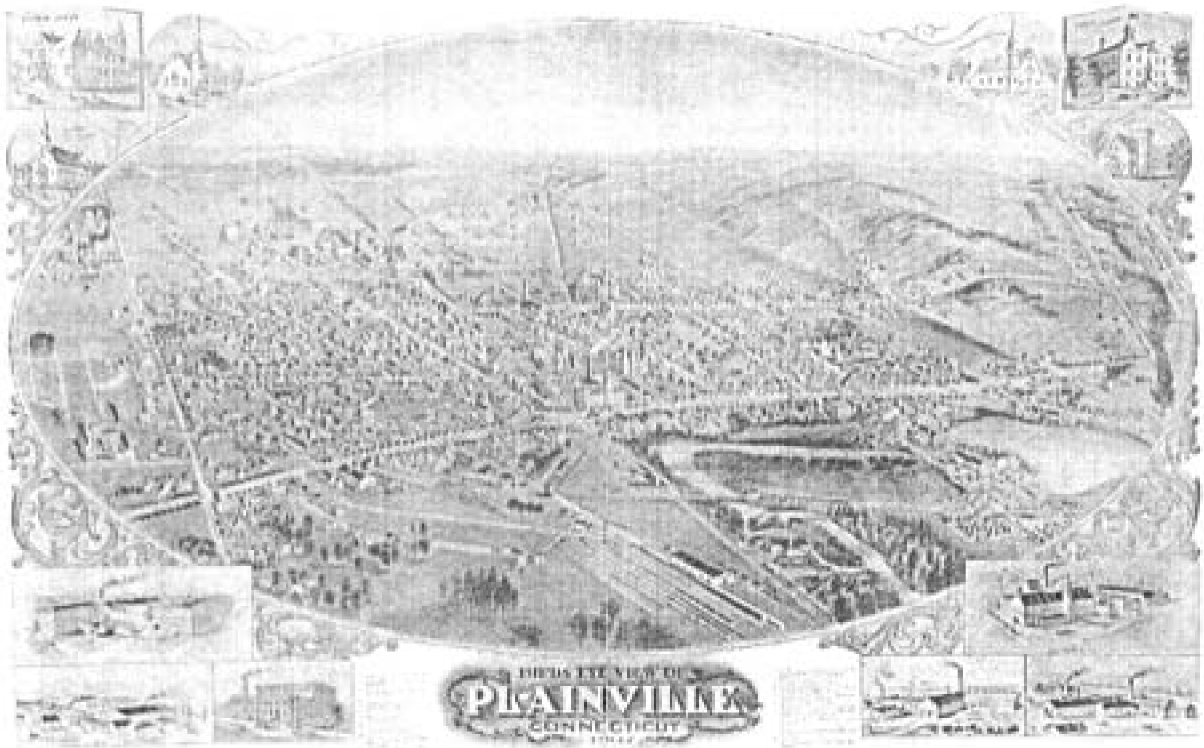
Currently All Values Have Not Been Finalized and Are Subject To Change.

Comments regarding this service should be directed to: jbuden@plainville-ct.gov

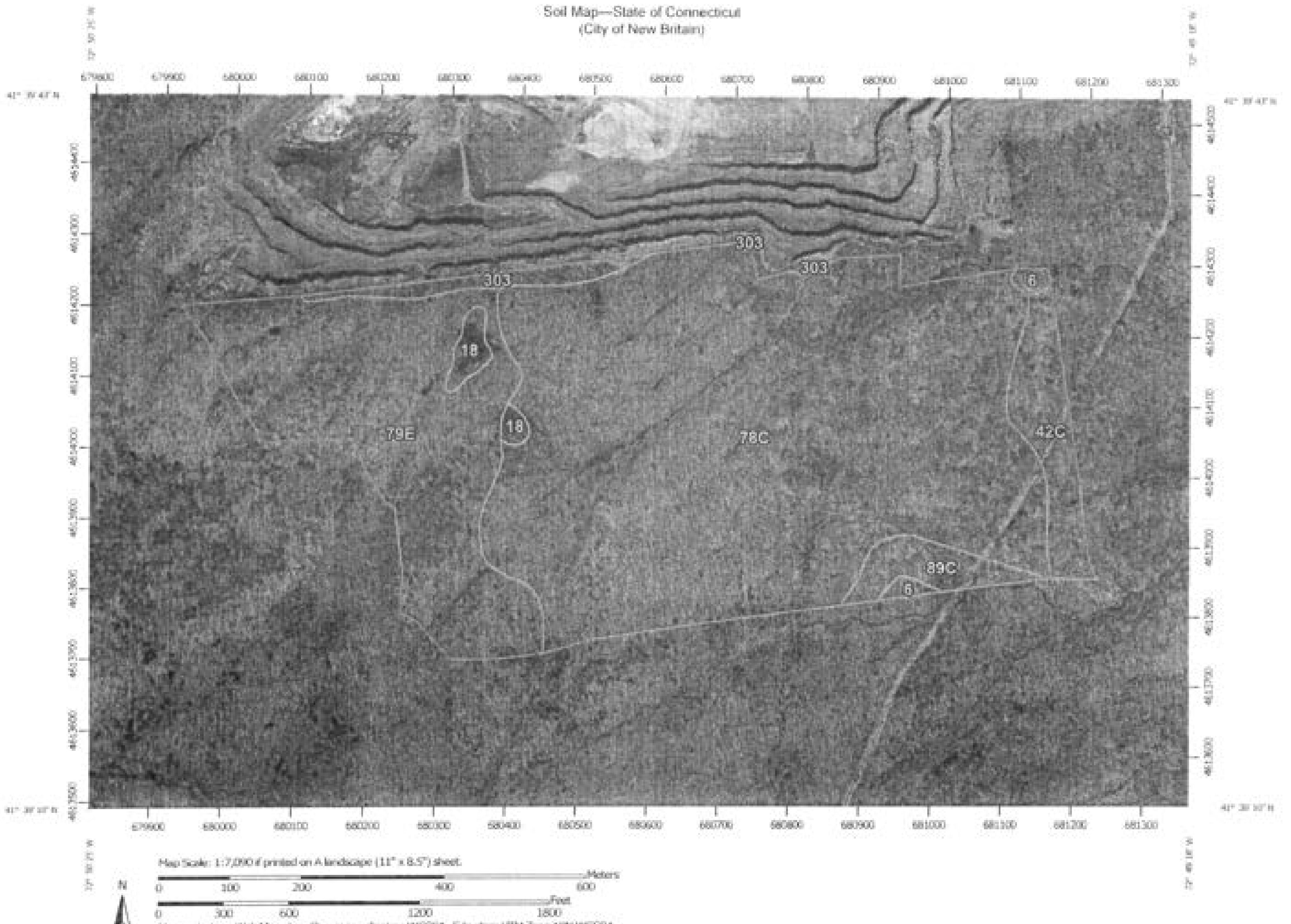


Aerial Survey of Connecticut 1934


PLAINVILLE, CONNECTICUT.


BIRD'S EYE VIEW OF
PLAINVILLE
CONNECTICUT

Soil Map—State of Connecticut
(City of New Britain)



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: State of Connecticut
Survey Area Data: Version 14, Sep 22, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 28, 2011—Apr 18, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

State of Connecticut (CT600)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
6	Wilbraham and Menlo soils, extremely stony	0.8	0.6%
18	Catden and Freetown soils, 0 to 2 percent slopes	1.5	1.1%
42C	Ludlow silt loam, 2 to 15 percent slopes, extremely stony	6.0	4.6%
78C	Holyoke-Rock outcrop complex, 3 to 15 percent slopes	86.2	65.7%
79E	Rock outcrop-Holyoke complex, 3 to 45 percent slopes	31.1	23.7%
89C	Wethersfield loam, 3 to 15 percent slopes, extremely stony	3.2	2.5%
303	Pits, quarries	2.4	1.8%
Totals for Area of Interest		**131.2**	**100.0%**

GRAPHIC SCALE

SOURCES:
PROPERTY LINES COMPILED FROM
RESPECTIVE TOWN ASSESSORS RECORDS.

Lenard Engineering, Inc.

PROJECT LOCATION MAP

PROPOSED STORAGE RESERVOIR
CITY OF NEW BRITAIN

Aug. 31, 2016

1"=300'

Drawing #
1

Department of Economic and Community Development

Connecticut still revolutionary

State Historic Preservation Office

One Constitution Plaza | Hartford, CT 06103 | 860.256.2800 | Cultureandtourism.org

PROJECT REVIEW COVER FORM

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(Street Address and City or Town)

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☒ Yes ☐ No

Agency Name/Contact	Type of Permit/Approval	State	Federal
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Department of Energy and Environmental Protection	CEPA	☒	☐
		☐	☐

	Yes	No
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If yes: Was the project site wholly or partially located within an identified archeologically sensitive area?	☐	☐
Does the project site involve or is it substantially contiguous to a property listed or recommended for listing in the CT State or National Registers of Historic Places?	☐	☒
Does the project involve the rehabilitation, renovation, relocation, demolition or addition to any building or structure that is 50 years old or older?	☐	☒

State Historic Preservation Office

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Project plans or limits of construction (if available)	[ ]	[X]	
If project is located in a Historic District include renderings or elevation drawings of the proposed structure	[ ]	[X]	
Soils Maps http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm	[ ]	[X]	
Historic Maps http://magic.lib.uconn.edu/	[ ]	[X]	
For non-building-related projects (dams, culverts, bridge repair, etc)	Yes	N/S	Comments
Property Card	[X]	[ ]	
Soils Map (see above)	[X]	[ ]	
Historic Maps (see above)	[X]	[ ]	

PROJECT CONTACT

Name James Ericson, PE Title Vice President
Firm/Agency Lenard Engineering Inc.
Address 2210 Main Street
City Glastonbury State CT Zip 06033
Phone 860-659-3100 Cell Fax 860-659-3103
Email Ericson@lenard-eng.com

*Note that he SHPO's ability to complete a timely project review depends largely on the quality of the materials submitted.
** Please be sure to include the project name and location on *each page* of your submission.

Department of Economic and Community Development

Connecticut
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State Historic Preservation Office

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PROJECT REVIEW COVER FORM

SHPO USE ONLY

Based on our review of the information provided to the State Historic Preservation Office, it is our opinion that:

- [x] No historic properties will be affected by this project. No further review is requested.

- [ ] This project will cause no adverse effects to the following historic properties. No further review is requested:

- [ ] This project will cause no adverse effects to the following historic properties, <u>conditional</u> upon the stipulations included in the attached letter:

- [ ] Additional information is required to complete our review of this project. Please see the attached letter with our requests and recommendations.

- [ ] This project will adversely affect historic properties as it is currently designed or proposed. Please see the attached letter for further details and guidance.

[signature] 1/20/17

Catherine Labadia
Deputy State Historic Preservation Officer

Date

Biddle Pass Drinking Water Storage Plainville

APPENDIX 10-3

SECTION 3.1.4
DISCUSSION ON POTENTIAL IMPACTS OF CLIMATE CHANGE
FINAL STATE WATER PLAN

JUNE 2018

Lenard Engineering, Inc.

The percent reductions for SWW/GWW and EDW were applied to the water demand estimates for these categories estimated for each basin, and the total reduction in water demand was calculated for each of the three scenarios. Note that the percent reductions do not apply to agricultural or industrial water use. The 2040 estimated water demands (in MGD) with no conservation, and under conservation Scenarios I, II and III are shown graphically in **Figure 3-8** for each regional basin. As might be expected, the largest potential reductions are in the regional basins with the highest withdrawals. The Farmington Basin, for example, might expect reductions of over 7.0, 15.5, and 18.6 MGD under Scenarios I, II and III respectively. In the Norwalk regional basin, smaller but still meaningful reductions of 1.5, 3.1 and 3.8 MGD might be expected under the three scenarios. There, the estimated future average annual needs for both instream and out-of-stream uses are 93% of streamflow. With the Scenario 3 reductions, this lowers the in- and out-of-stream water needs to 88% of streamflow – providing a bit more of an already small buffer to help meet water needs. In a drought situation, when the needs would exceed streamflow, these savings are much more important.

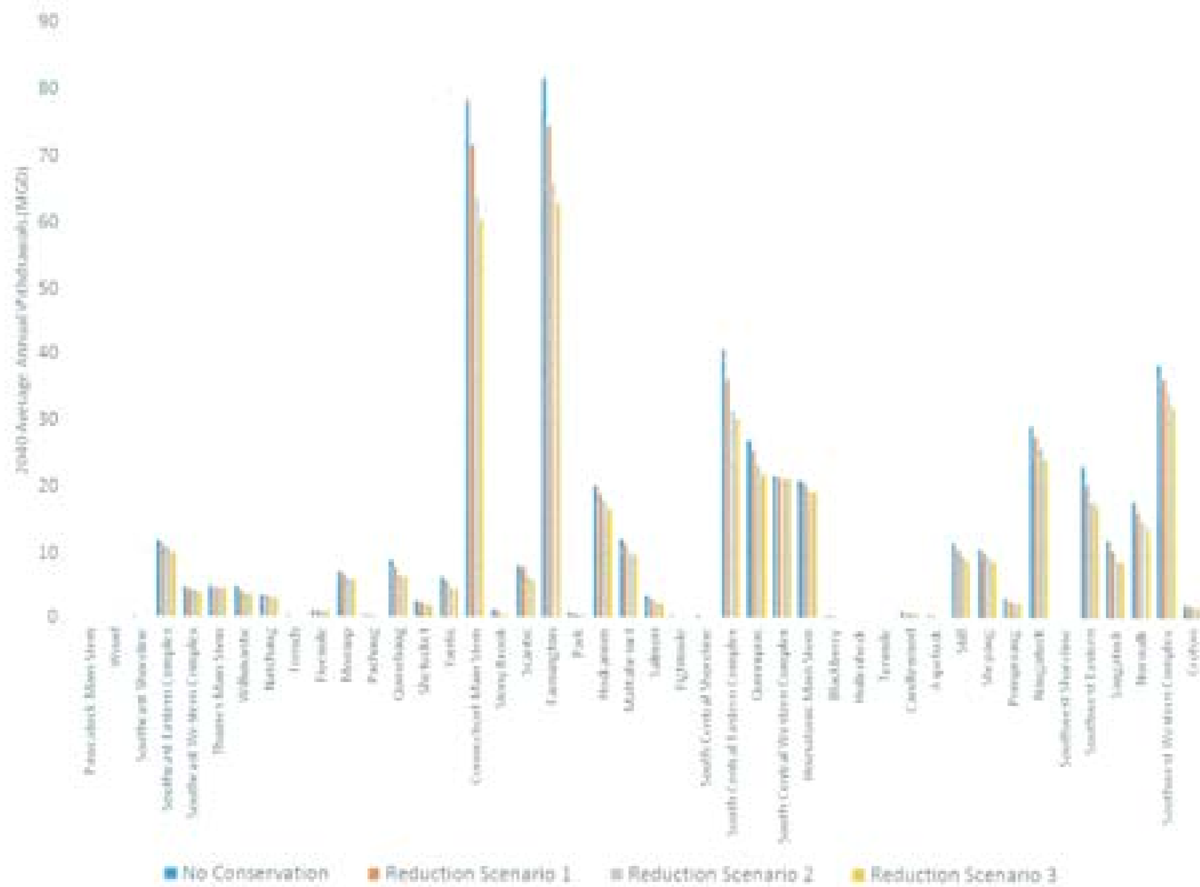


Figure 3-8. 2040 Average Annual Withdrawals Under No Conservation and Scenarios I, II and II

3.1.4 Potential Impacts of Climate Change

3.1.4.1 Objectives

The objective of this task was to synthesize and summarize the suite of available climate change projections for the State of Connecticut into a practical, useful, and comprehensive data set for use in subsequent water resources analyses. It is hoped that the summary data set will have utility on its own for providing insight into the range of possible climate outcomes for the state, and also serve as an experimental data set to test future conditions in specific basins as necessary. Note that the goal of this analysis is not to predict the future climate for the state, but to define a range of conditions that are deemed scientifically possible based on state-of-the-art climate modeling.

Climate forecasts typically extend for 50 – 100 years, which exceeds the 25-year planning horizon for the Plan. However, the data set can be easily scaled or adjusted to provide bounded possible climate scenarios for any future decade within the 100-year horizon. Results in this section correspond to year 2080, a horizon of approximately 60 years, in order to show significant possible trends. Following the presentation of the analysis, a summary of other literature on Connecticut climate trends is presented for comparison (see end of **Section 3.1.4.3**).

3.1.4.2 Methods

Future climate scenarios for the state were developed utilizing a combination of state-of-the-art climate models and historically available climate observations. All scenarios are intended to represent discrete plausible climate futures centered on a 2080 planning horizon. No attempt is made to assess the likelihood that these potential climate futures will occur, but rather they are presented as a range of projected conditions based on the best available science and engineering.

Future climate projections for the state have been summarized under this task using the full suite of available global climate model (GCM) projection data sets. These projections include monthly mean air temperature and monthly total precipitation, downscaled to a 1/8th-degree latitude/longitude grid. These published data were obtained from public data portal maintained by the U.S. Bureau of Reclamation (http://gdodcp.ucllnl.org/downscaled_cmip_projections/dcpInterface.html).

A total of 110 different climate model projections were downloaded for the period 2000 to 2100. A modeling overlap period of projections and a historical observed dataset (gridded to same 1/8th-degree grid) were also obtained for the years 1950 to 1999. All projections represent the latest in scientific research and were developed under the World Climate Research Programme Coupled Model Intercomparison Project, Phase 5 (CMIP5). The CMIP5 data set includes 35 different climate models developed at top research institutions around the world and applied across a range of model input assumptions. No attempt was made to assess the likelihood of these models being correct or not. Rather, they were used to test plausible future climate scenarios for this study.

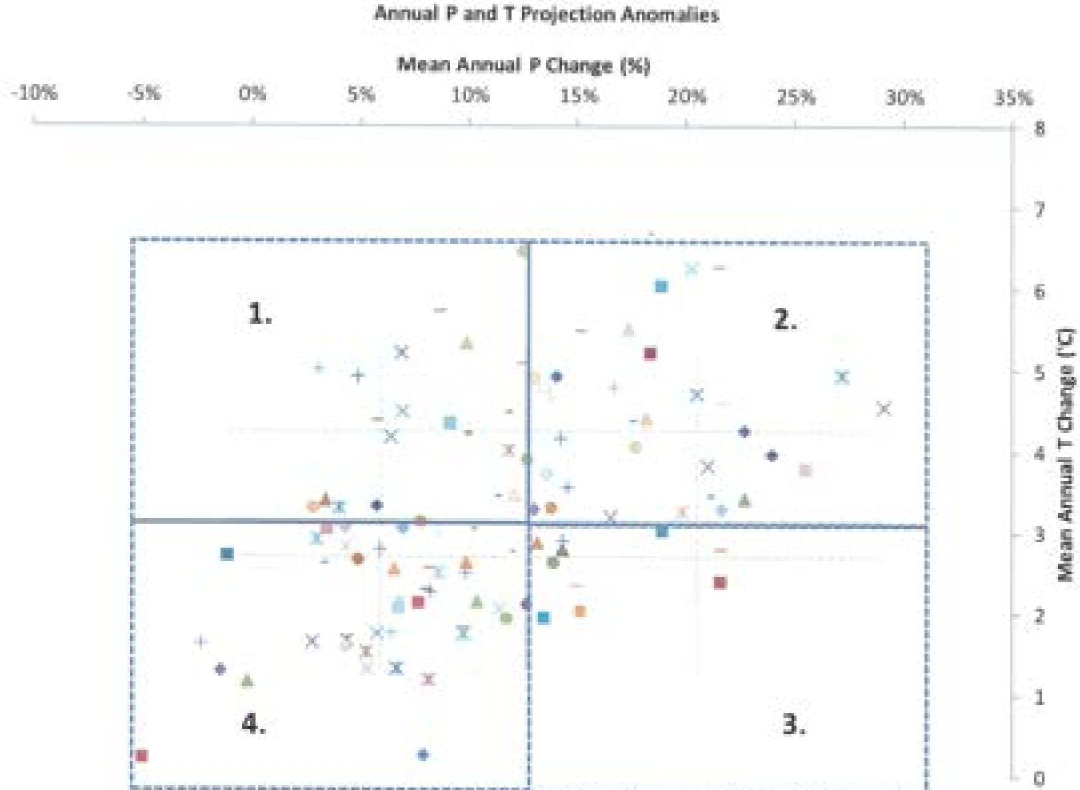
Climate model projections were obtained for a single, centrally located 1/8th-degree grid cell for this analysis (**Figure 3-9**). The selected cell is considered representative of the central region of the state, with respect to climate variability, and at a suitable distance from urban centers to avoid any potential urban heating influences.

Figure 3-9. Representative Climate Model Projection Grid Cell (yellow highlight)

A sampling band of ± 10 years, centered on 2080, was used to capture natural year to year variability in the climate data, while still being representative of late 21st century climate trend projections

Climate model data were pooled into four different ensembles (groups), each of which is used to develop different future climate scenarios which a.) illuminate the range of projected variability and uncertainty b.) provide insight into the ramifications of different greenhouse gas emissions pathways, and c.) can each be easily used in subsequent water resources analyses and modeling. The scenarios are intended to be viewed as equally plausible – that is, no predicted outcome is assumed to have any higher or lower probability of occurring than any other (**Figure 3-10**). All 110 GCM projections, downscaled to the selected grid cell noted above, are represented on this plot as discrete points. Four different climate data ensembles were constructed using this plot representing the four boxed quantile ranges shown in the figure.

1. Hot/Dry: 50th to 100th percentile Temp, 0 to 50th percentile Precip
2. Hot/Wet: 50th to 100th percentiles Temp and Precip
3. Warm/Wet: 0 to 50th percentile Temp, 50th to 100th percentile Precip
4. Warm/Dry: 0 to 50th percentile Temp and Precip.



Climate Scenarios: (1) hot/dry, (2) hot/wet, (3) warm/wet, (4) warm/dry

Figure 3-10. Annual Anomalies (2080 vs. historical) of GCM Temperature and Precipitation Projections, with Designated Scenario Ensembles (each symbol represents a different climate model projection set)

Data from all model projections residing within a given quantile box were pooled to create the four ensembles. In this way, all available climate projections were used and no projection was used in more than one ensemble. Advantages of this approach, as advocated by Reclamation (Reclamation 2010) are that it allows for easy visualization of the range and uncertainty in climate projections and does not require subjective selection of model projections, while at the same time still providing a practical number of pooled scenarios for use in subsequent analyses.

For each climate model ensemble, a method referred to as the "hybrid delta ensemble" (HDe) method (Reclamation, 2010) was applied to adjust historical climate records to reflect the four future climate projection data sets (See Appendix F for details on this approach). In this method, statistical adjustments are made to the historical observed data set (1950 - 1999) based on relative changes predicted by the pooled GCM projections. In this way, this method preserves the month-to-month pattern of variability and many of the core statistics of the observed historical record in its forecast of future conditions. The method has been used extensively by the U.S. Bureau of Reclamation and others as a means of incorporating climate model projections into water resources planning studies.

The "delta" in the HDe name refers to the difference between GCM forecasts of the future vs. GCM hindcasts of the past. The "hybrid" term refers to the fact that the method uses a range of delta values to adjust the historical record based on relative climate conditions. For example, during wet observed periods calculated deltas associated with wet modeled periods are used. Similarly, during observed dry periods, dry modeled period deltas are used to adjust the record. The same principle is applied in adjusting the temperature record. The advantages of this approach are that it is often more palatable to stakeholders because it is so strongly tied to actual observed climate data (rather than using model projections by themselves) and it eliminates any overriding bias in the GCMs by using delta values (modeled vs. modeled) rather than the projection data themselves. See Appendix F for further details on the HDe methodology.

Note that the 1950 to 1999 period was selected as the historical climate baseline period for this study for a number of reasons. First, we desired to follow, as closely as possible, well established and published methods for developing climate scenarios for water resources planning. The 1950 to 1999 period is standard in Reclamation's HDe approach. There are seemingly multiple reasons for this. Firstly, historical climate observations projected onto the same 1/8th-degree spatial grid as the climate model projections, and critical to the approach, are only available for this limited historical period (Maurer et al. 2002). Secondly, all of the climate models used in this study have been trained (calibrated) to the 1950 to 1999 period as part of the model downscaling task. Model output beyond 1999 are pure projection and are not directly linked to observed data. There are therefore numerical advantages and increased defensibility in using this period as a baseline for calculating climate delta values (modeled future minus modeled baseline). Lastly, the past ten years globally have been among the hottest on record. Including this decade in the historical baseline, intended to represent a stationary past, would therefore be somewhat inappropriate and potentially make the approach less defensible. This was undoubtedly a consideration in Reclamation's original methodology development.

The result of the HDe method is a set of four different 50-year climate data sets that are reflective of 2080 conditions, as projected by climate model, but maintain the same pattern of variability observed in the recent historical record (1950 – 1999). Results are presented below.

3.1.4.3 Results and Discussion

As evidenced by the annual anomaly plot presented above (Figure 3-10), there is general consensus in the climate models for a hotter and wetter future. Mean annual temperature changes for the 2080 planning horizon, compared to historical baseline, range from approximately +0.5 °C to + 6.5 °C. Mean annual precipitation changes range from approximately -5% to +30%, with the vast majority of the projections predicting an increase in mean annual precipitation.

Results of the hybrid delta ensemble (HDe) analysis are presented in **Figures 3-11** through **3-18**. Each figure shows a comparison of historical observed data to the same data set adjusted to reflect 2080 climate model projections. Summary output includes a.) monthly time series plots of average temperature and total precipitation, b.) mean monthly temperature and precipitation bar charts, and c.) monthly temperature and precipitation percentile plots. The first summarizes the raw output and illustrates month to month variability, the second provides insight into the seasonality of the projected changes, and the third shows the full range of projected changes, including extreme months. Differences across sets of ensemble plots highlight the variability and uncertainty associated with the climate model projections and potential differences associated with greenhouse gas emissions pathways. For example, the "hot/dry" ensemble projects a mean monthly temperature change of 4.5 °C and a mean monthly precipitation change of 10 mm/month, while the "warm/wet" ensemble projects a temperature change of 2.6 °C and a precipitation change of 17 mm/month.

As noted above, all GCM ensembles project an increase in temperature for all calendar months. Projected temperature changes appear relatively consistent across calendar months and percentile levels, for each of the ensemble scenarios. In other words, both summer and winter temperatures are projected to increase by similar amounts; and a similar shift is observed for both extreme cold and extreme hot months. Precipitation projections are more variable, although consistently projecting a generally wetter future for all four scenarios. The largest precipitation increases are projected for the wetter months (higher percentiles), including extreme wet months. It follows, then, that the seasonality plots show that winter and spring precipitation changes are projected to be larger than summer and autumn changes. Drier months are generally projected to remain about the same in terms of both frequency and rainfall level. Small decreases in extreme dry month precipitation are projected for the "hot/dry" scenario.

Climate projections can be translated into projected changes in water availability. This work will provide insight into the potential ramifications of the changing climate on water resources. Implied by the results presented here is the potential for decreased water availability due to significantly higher temperatures and evapo-transpiration losses. However, clearly this dynamic would be offset to a certain extent by increased rainfall. The analysis does not explicitly project changes in the distribution of rainfall on an event basis (this is a monthly analysis), which could affect flooding potential and also the frequency and intensity of summer droughts. However, typical climate forecasts tend to suggest that increased temperatures coupled with increased

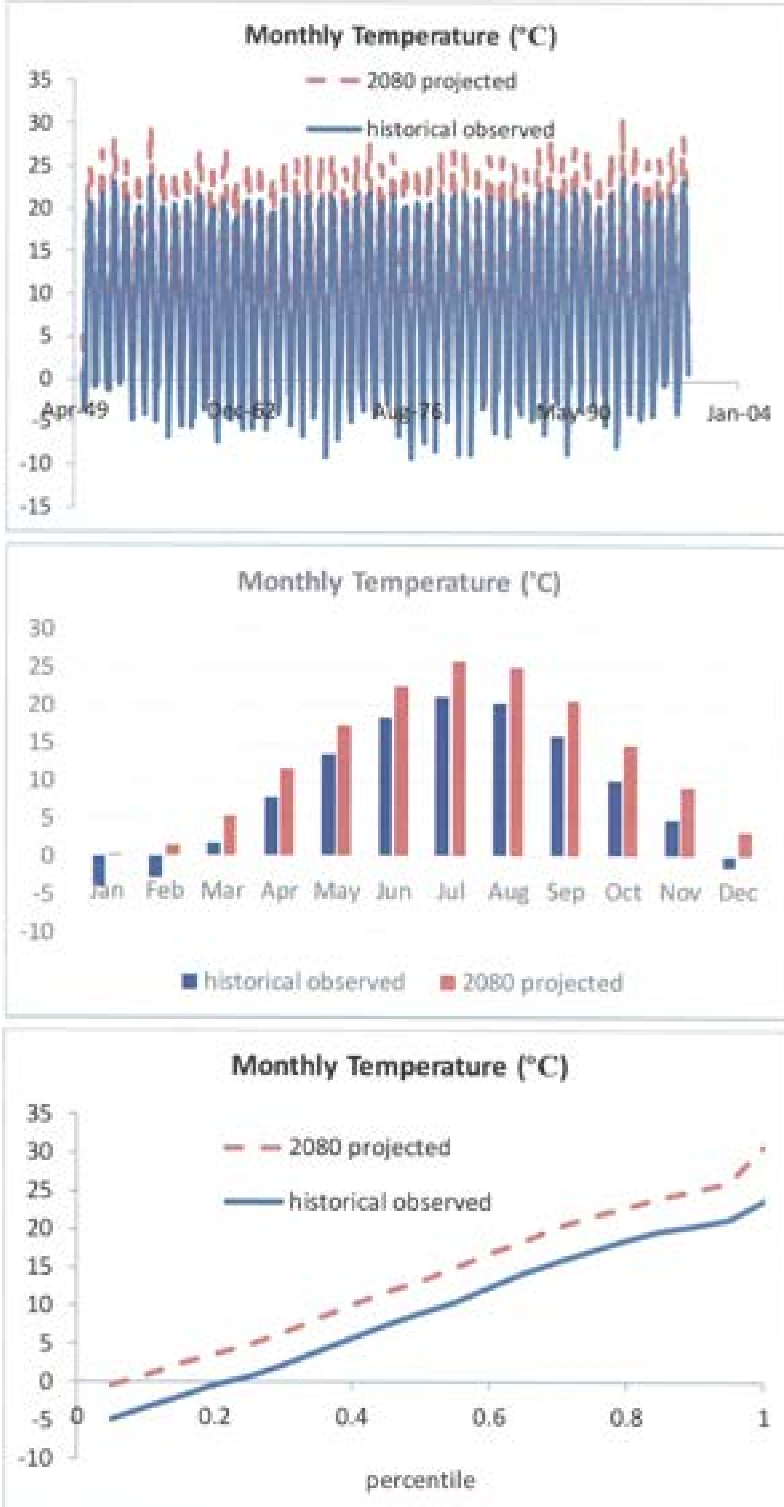


Figure 3-11. Monthly Temperature Projections: 2080 Planning Horizon, Hot Dry Ensemble

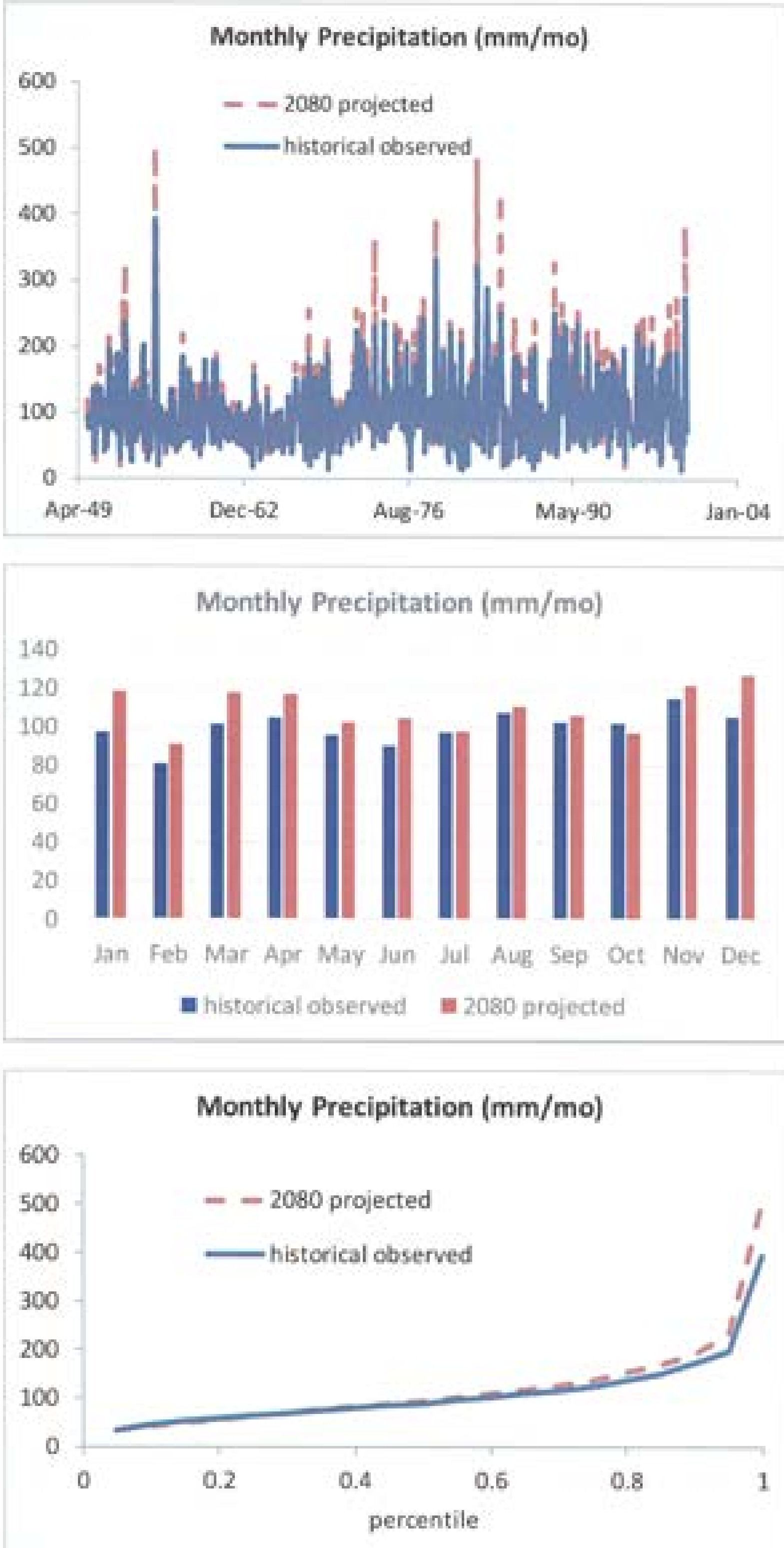


Figure 3-12. Monthly Precipitation Projections: 2080 Planning Horizon, Hot Dry Ensemble

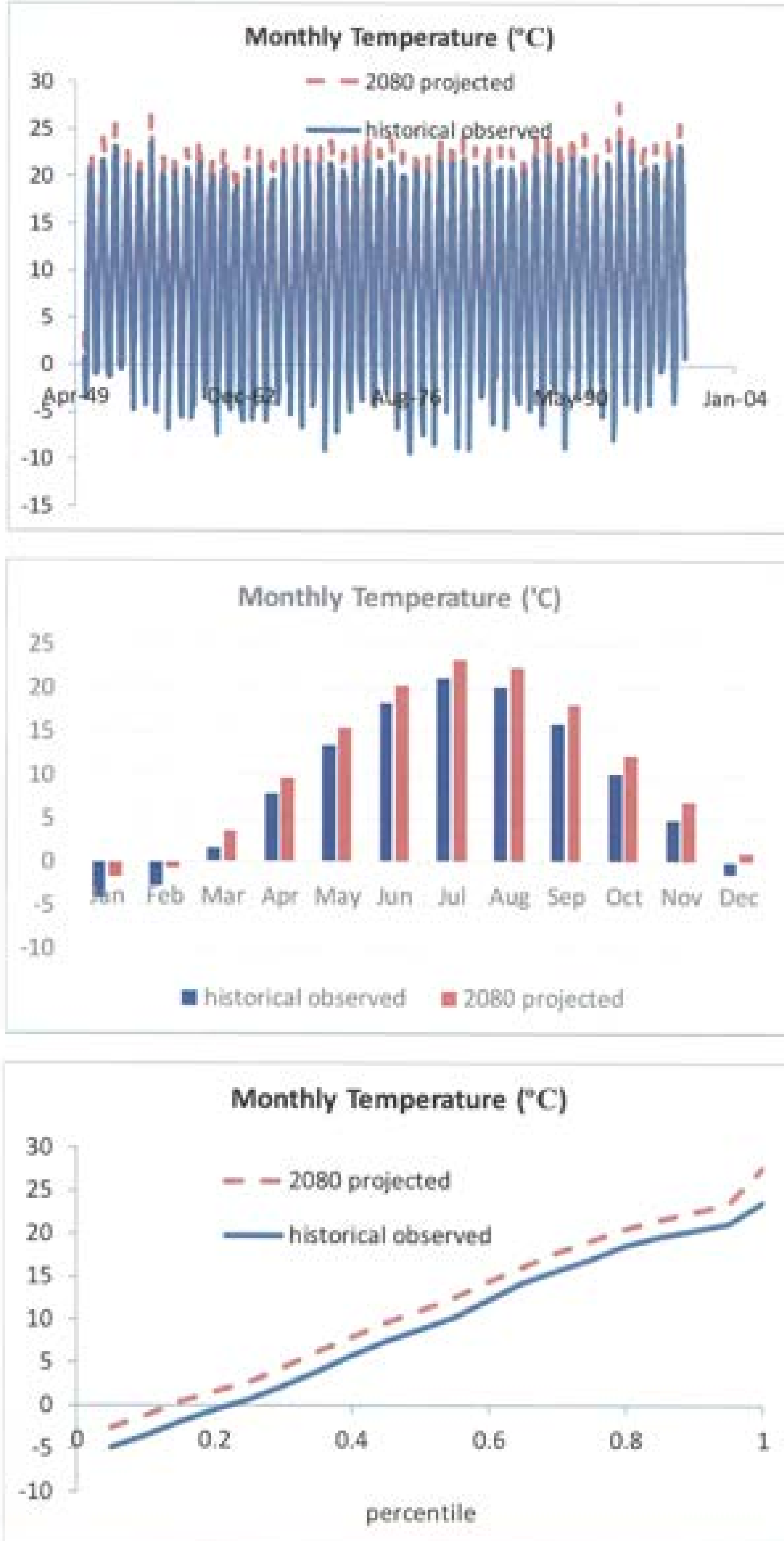


Figure 3-13. Monthly Temperature Projections: 2080 Planning Horizon, Warm Dry Ensemble

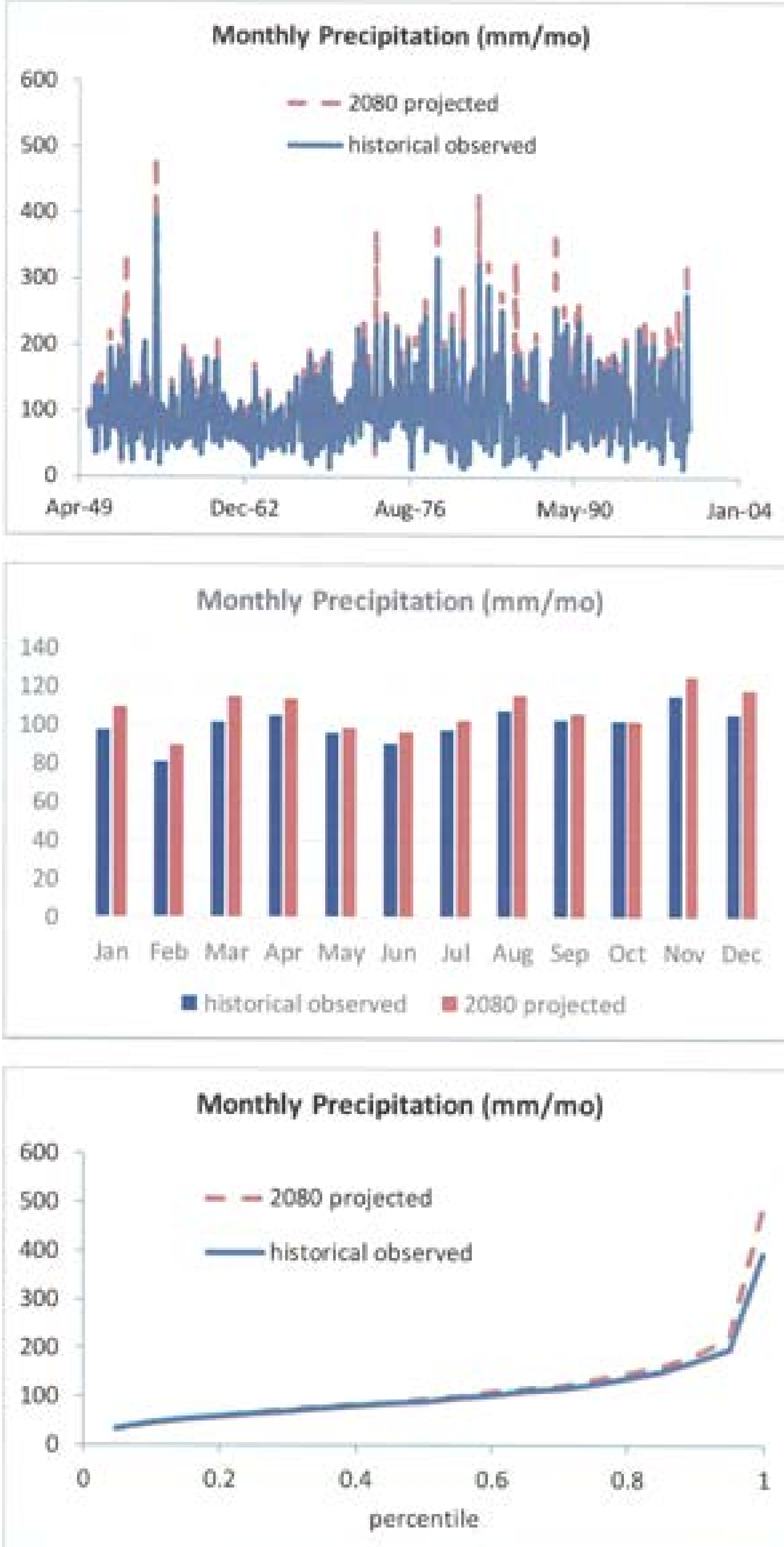


Figure 3-14. Monthly Precipitation Projections: 2080 Planning Horizon, Warm Dry Ensemble

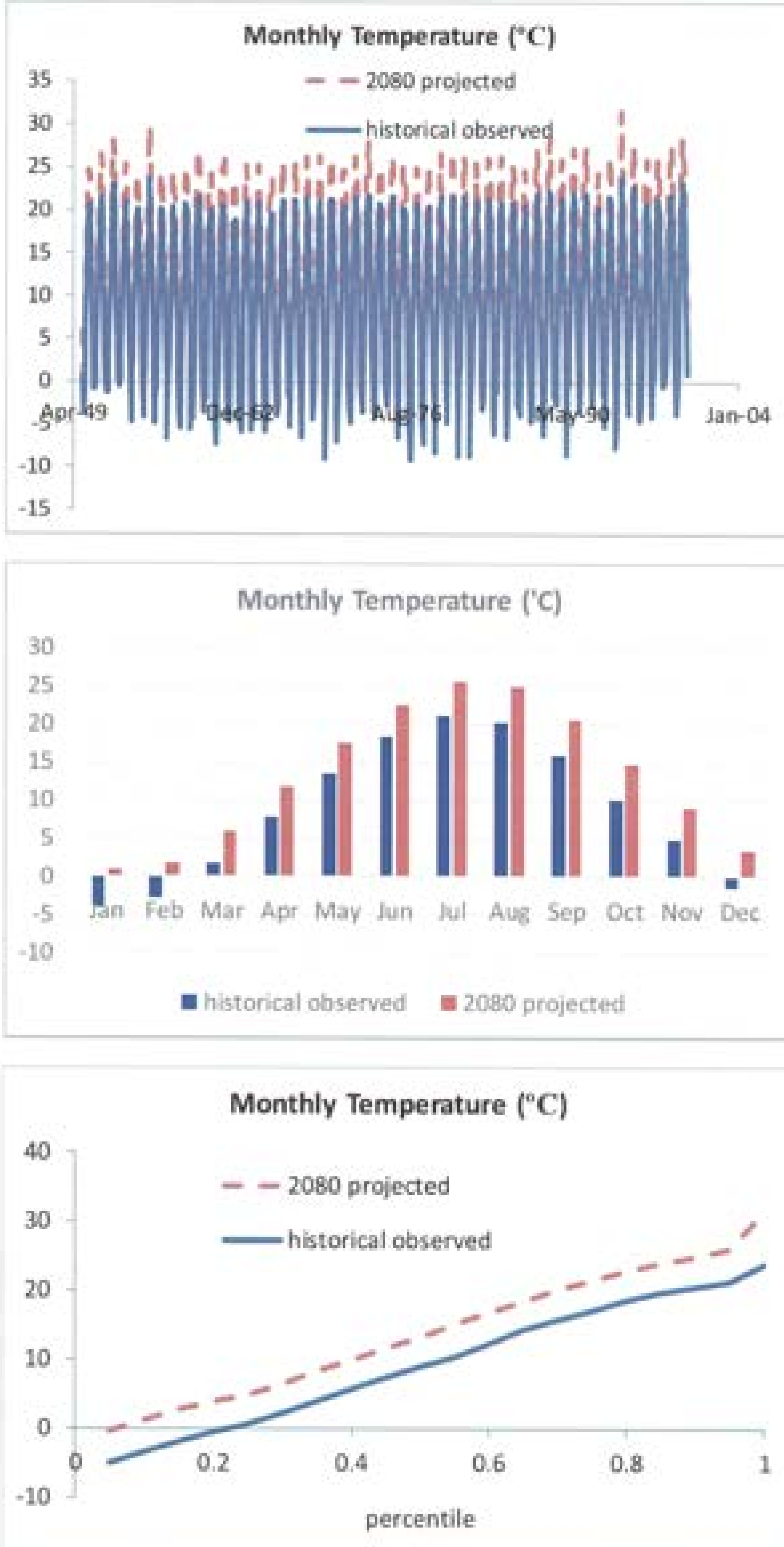


Figure 3-15. Monthly Temperature Projections: 2080 Planning Horizon, Hot Wet Ensemble

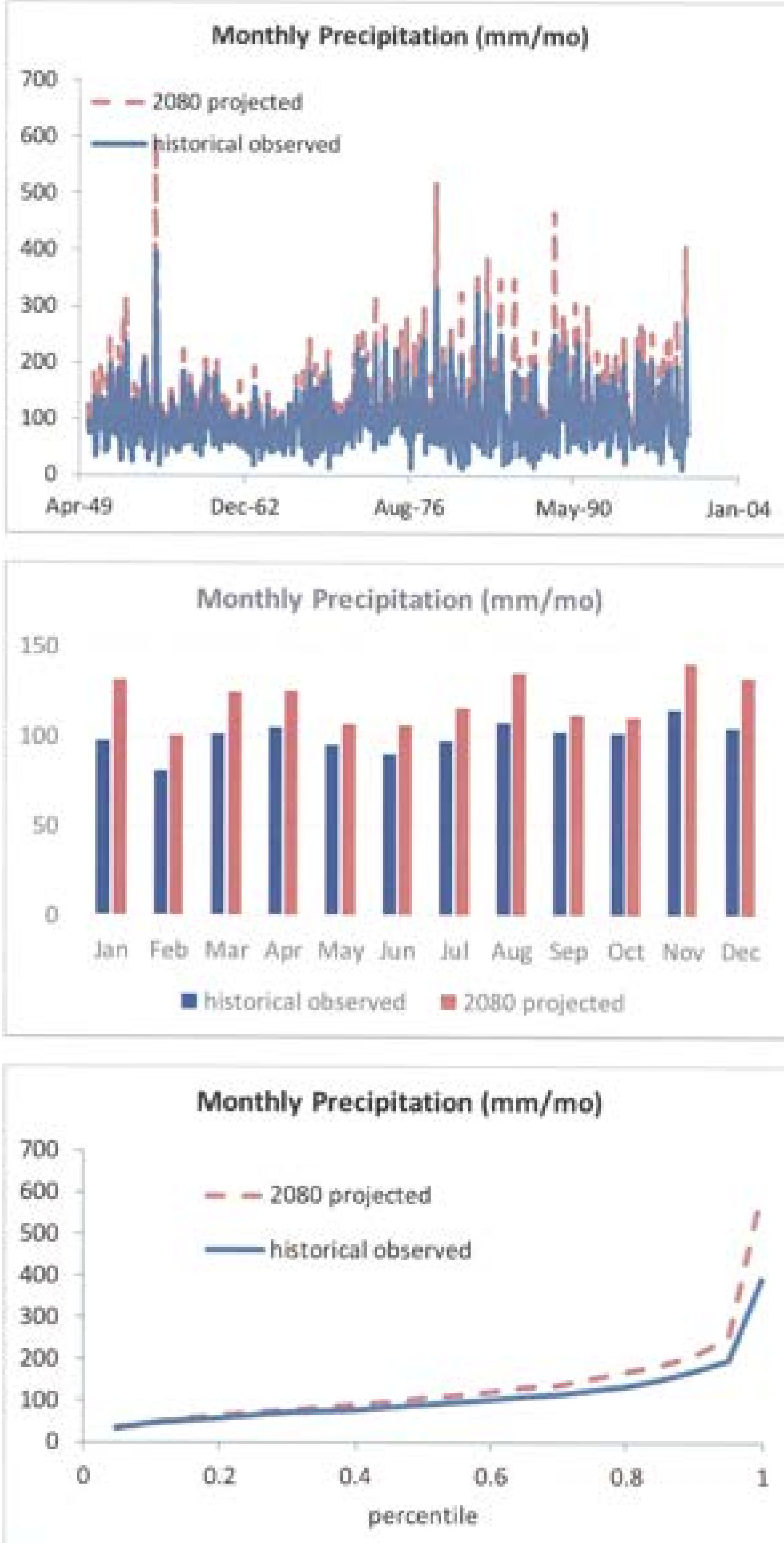


Figure 3-16. Monthly Precipitation Projections: 2080 Planning Horizon, Hot Wet Ensemble

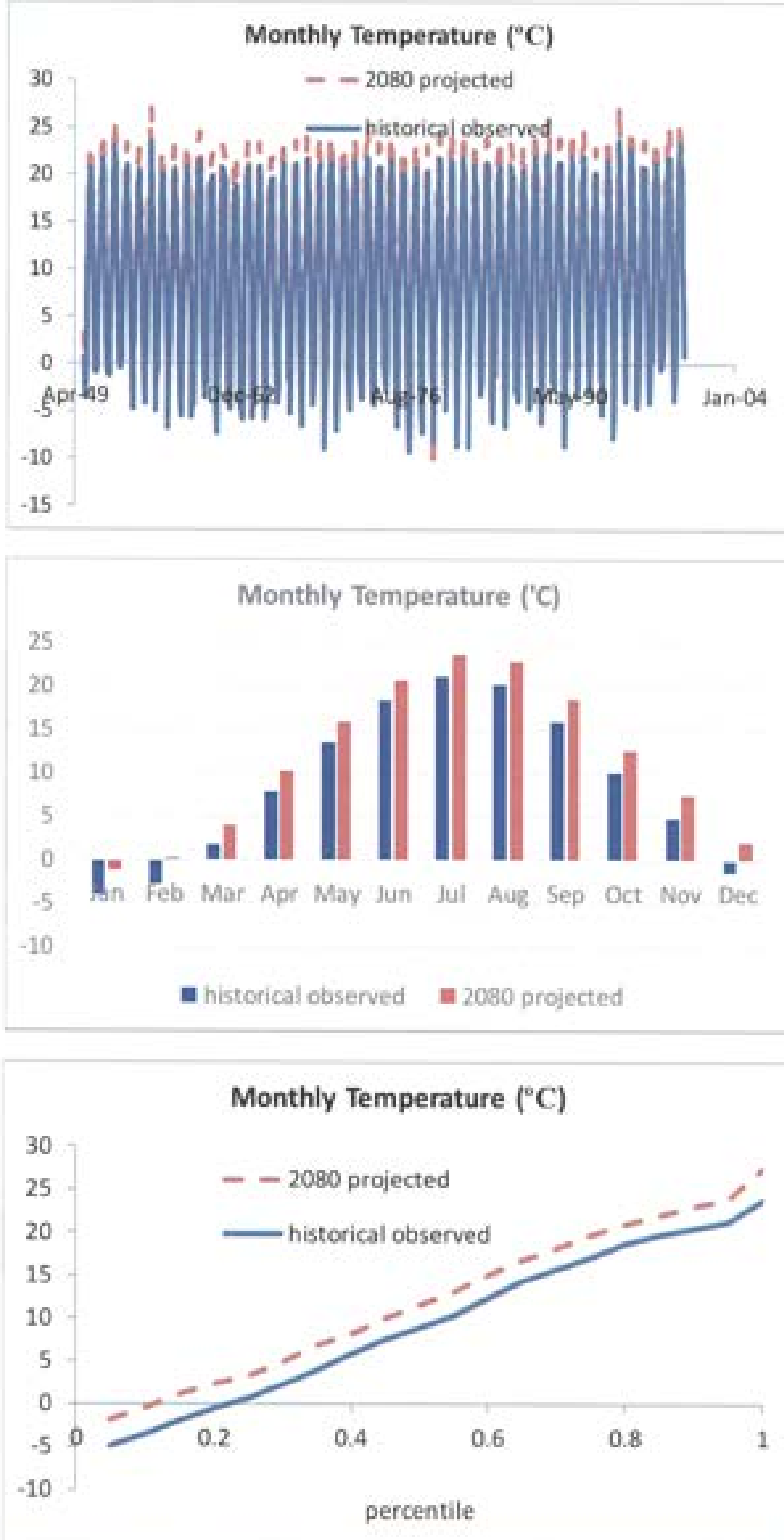


Figure 3-17. Monthly Temperature Projections: 2080 Planning Horizon, Warm Wet Ensemble

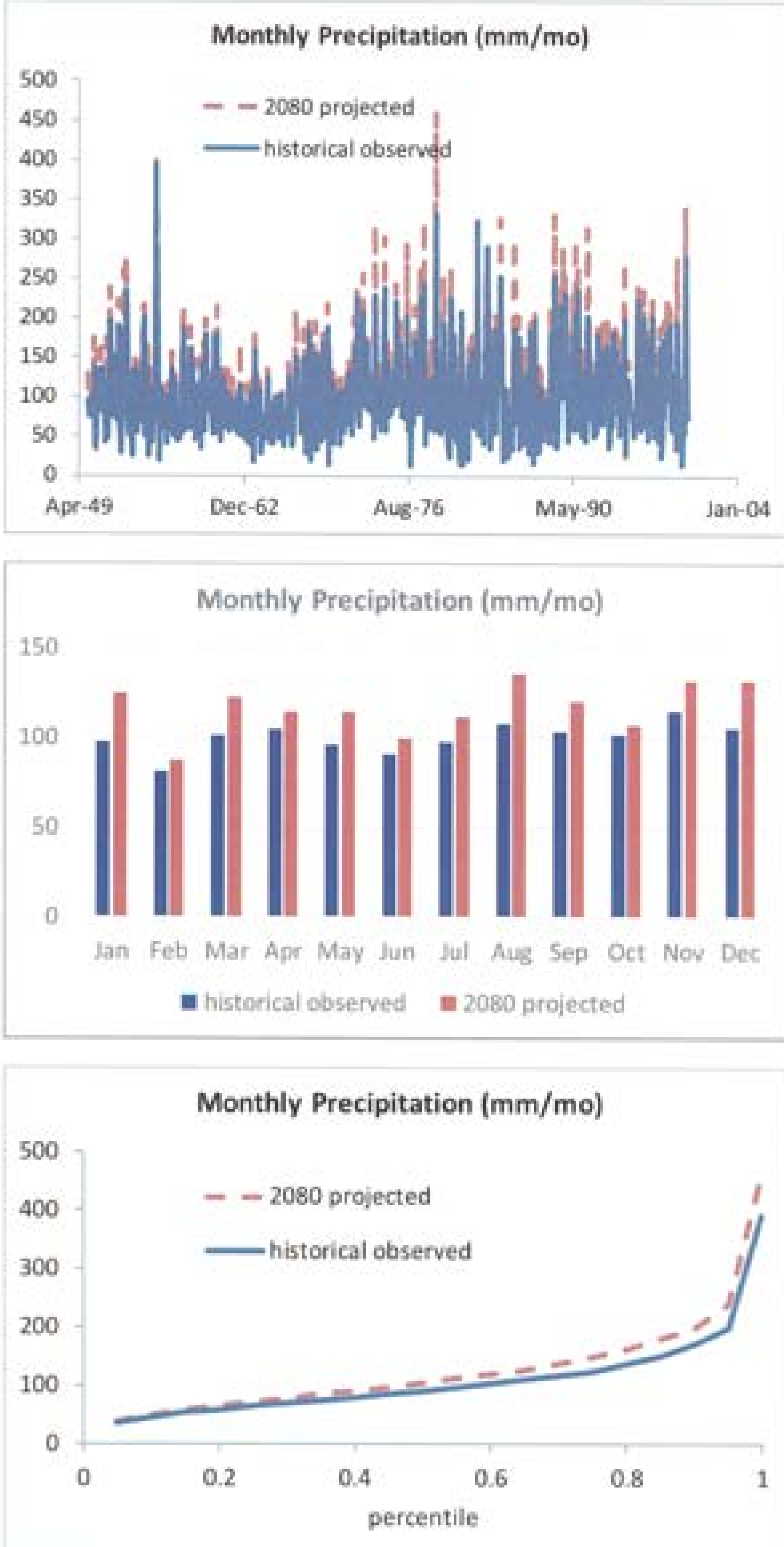


Figure 3-18. Monthly Precipitation Projections: 2080 Planning Horizon, Warm Wet Ensemble

annual precipitation generally correspond to higher intensity storms (greater flood risk) and longer dry periods in the summer months (more frequent and/or intense droughts). Because Connecticut has so many small reservoir systems, these systems could be very sensitive to such changes, and case study examples may be advisable in the next phase of work.

Demands could similarly be impacted, with increasing demands due to higher temperatures, but with changes tempered by increased rainfall. The timing of water availability and stream flows will also undoubtedly be impacted, with less snow pack and earlier melt. The combination of potential rapid snow melt and higher extreme precipitation events could translate to an increased flooding risk. Lastly, river water quality could be negatively impacted by the higher temperatures; higher water temperatures can lead to increased growth rates of both algae and bacteria, and lower dissolved oxygen saturation levels.

The results presented above generally agree with other studies that have been done on potential future climate trends in Connecticut. In 2010, a report was issued by Climate Change Connecticut[9] that suggested the following summary conclusions:

a) Connecticut could see a temperature increase of 4 – 7.5°F by end of the 21st century.
b) Precipitation in Connecticut could increase by 5-10% by end of the century, and redistribute itself so that more of this increase occurs during winter months.
c) Sea-level rise may increase 12-23 inches by the end of the century.
d) Drought frequency may increase as well as duration and intensity.

Findings (a) and (b) generally agree with the range of potential conditions presented in the analysis above. Finding (c), regarding sea level rise, is an important consideration for Connecticut's coastal areas that is not addressed by the methodology used in this report. Finding (d), on drought frequency and intensity, while seemingly contradictory to the prediction of more overall rain, supports the notion that the distribution of rainfall may change significantly (more rain in winter, less rain in summer), causing more frequent dry periods during the warmer months, where the impacts of drought can be exacerbated by increasing temperatures and resulting evaporative losses from water bodies and soil moisture.

As summarized in Section 3.1.4.1, climate forecasts typically extend 50-100 years, which exceed the 25-year planning horizon for the Plan. Climate will have impacts in the years and decades beyond the Plan's planning horizon, and future analyses should include such considerations.

3.1.4.4 Climate Change Impacts on Streamflow

Objectives

The objective of this task was to translate the climate change projections described above into projections of streamflow for the 44 regional planning basins across the state. These hydrologic

[9] Climate Change Connecticut. 2010. "The Impacts of Climate change on Connecticut Agriculture, Infrastructure, Natural Resources and Public Health" A Report by the Adaptation Subcommittee to the Governor's Steering Committee on Climate Change. http://www.ct.gov/deep/lib/deep/climatechange/impactsofclimatechange.pdf

projections are desired to provide insight on the range of potential changes in surface water availability, and in timing of delivery, across the state. The projections were specifically constructed to provide for easy input into subsequent analyses, modeling, and graphical comparisons.

Methods

The same hybrid delta ensemble (HDe) method used to project climate variables, as described above, was also applied here to generate hydrologic projections. In this method, existing recent historical flow records were modified to reflect climate change projections associated with a specific planning horizon. For this exercise, a 2040 planning horizon (± 10 years) was selected, to align with previously developed water demand projections. Instead of precipitation and temperature projections, the approach applied here used published "gridded runoff" projections from essentially the same set of GCMs as above. Note that because this analysis only focused on projections through year 2040, and not 2080 as described in the previous section, relatively smaller changes are expected. The source of these runoff projections is also the same as above (http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/dcpInterface.html). Gridded runoff projections were developed by this consortium by routing 2040 precipitation and temperature projections through a macroscale rainfall-runoff model – the Variable Infiltration Capacity (VIC) model. These runoff projections can be viewed as a surrogate for projected changes in surface water availability and flow rates. More information on the gridded runoff projections and the VIC modeling can be found at: http://gdo-dcp.ucllnl.org/downscaled_cmip_projections/techmemo/BCSD5HydrologyMemo.pdf.

As recommended in the above cited report, the gridded runoff projections were used within a "delta" method, whereby only projected *changes* in surface water flow rates (as monthly depths) were used to modify streamflow records. By using runoff change factors (modeled future vs. modeled past), within the HDe method, the impacts of any residual bias in the projections are minimized. Also, as described above, historical observed patterns of flow variability are retained in future projections. Additionally, within this method, the magnitudes of the applied change factors vary across a full distribution of percentiles, resulting in a more accurate reflection of the patterns of variability in the GCM projections. The selected change factor for each month in the adjusted record is based on the relative percentile value of the given month's observed streamflow record. High flow months are adjusted using change factors associated with projected high flow conditions and low flow months adjusted with change factors associated with projected low flow conditions. Note that the model hind cast period used for the calculation of change factors again corresponds to the 1950 – 1999 period. This is the model "overlap" period used by the USBR consortium to guide model downscaling and bias correction. For further details on the HDe method, the reader is again referred to Appendix F.

The same centrally located GCM grid cell shown in Figure 3-9, and used in the climate parameter projection exercise described above, was used for this analysis. Climate model projections for this grid cell were used to modify streamflow records for the 44 regional planning basins. Underlying this approach is the assumption that climate change projections for this central location are relevant to, and representative of, locations anywhere in the state. To verify this assumption, climate projections for four corner grid cells (**Figure 3-19**) were compared, on an annual average basis, to the central grid cell. Results of this verification exercise are provided below (**Figure 3-20**). Based on this analysis, the grid cells were deemed to be adequately correlated.

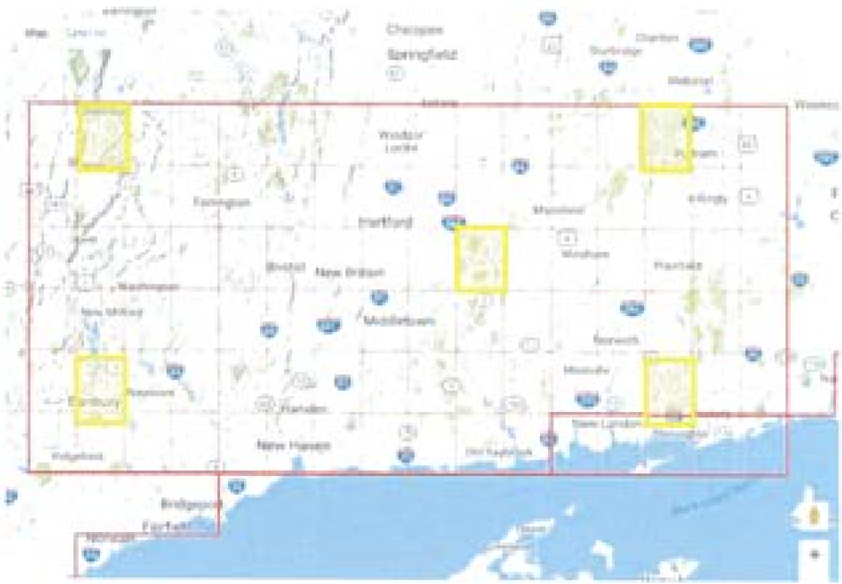


Figure 3-19. GCM Grid Cells Used in Spatial Comparison

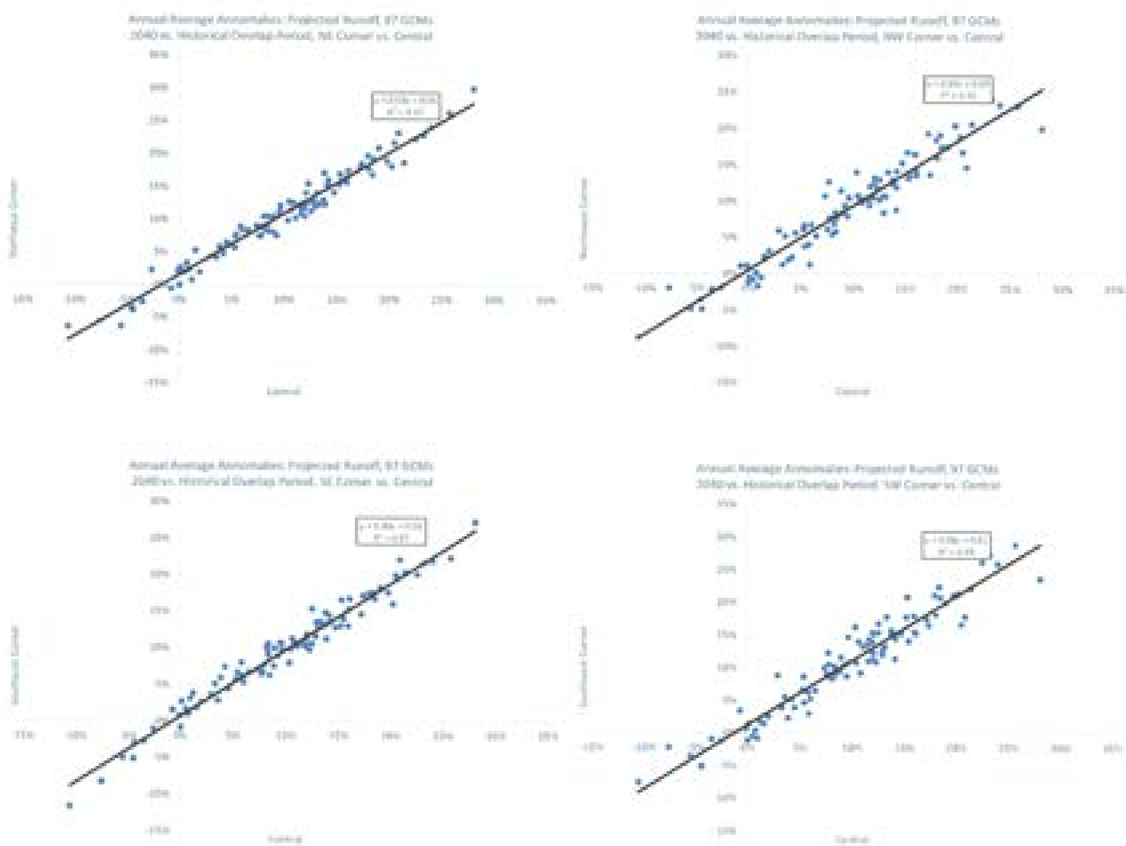
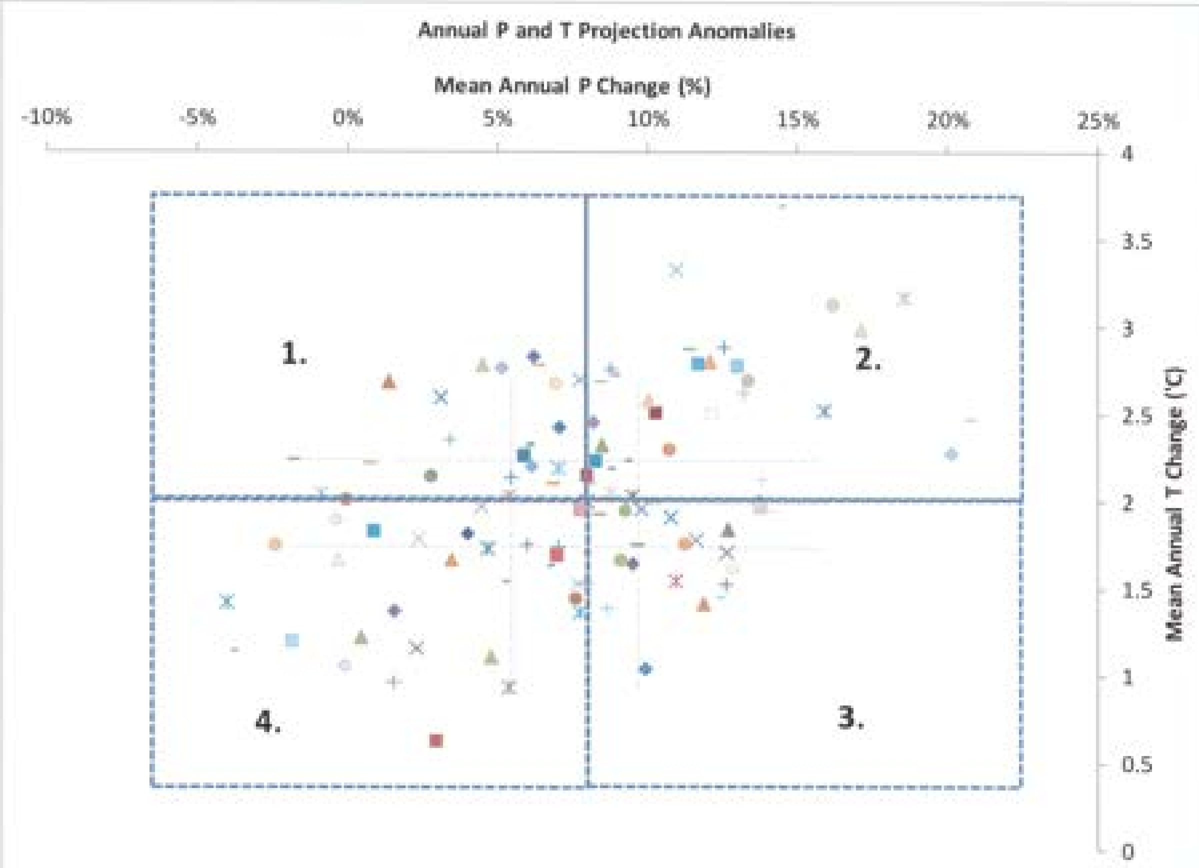


Figure 3-20. Grid Cell Comparisons: Assessment of Spatial Variability in Connecticut Gridded Runoff Projections



Climate Scenarios: (1) hot/dry, (2) hot/wet, (3) warm/wet, (4) warm/dry

Figure 3-21. Annual Anomalies (2040 vs. historical) of GCM Temperature and Precipitation Projections, with Designated Scenario Ensembles (each symbol represents a different climate model projection set)

Results

Results of this analysis, including all 176 projected monthly flow traces, are provided in Appendix F. For each of the basins and each of the four climate scenarios, projected average monthly flows are higher compared to the historical observed record. This is not surprising given the results shown in Figure 3-21, where the vast majority of 2040 climate projections indicate an overall increase in annual precipitation compared to the model hind cast period. While it is safe to assume that evapotranspiration (ET) rates will increase in the future due to higher temperatures (and are modeled as such), it appears that these increases will be largely offset by increases in precipitation.

Consistently, across all basins, the hot/dry ensemble projects the lowest average streamflow while the hot/wet ensemble projects the highest. The largest increases in streamflow are generally projected for the winter months (Dec - Feb), for all four climate ensembles. This is likely attributable to a combination of both greater winter precipitation and reduced snow accumulation. With respect to the latter, this same dynamic may be implied in the spring time results (Mar – May), where flows are generally projected to increase only slightly or to decrease fairly significantly. Warmer winter temperatures will equate to reduced snow fall and accumulation and consequently less spring melt.

For the hot/dry scenario, flows are generally projected to decrease for nearly all non-winter months, for all basins. These reduced spring, summer, and fall flows, however, are more than offset, in terms of their impact on annual totals, by large increases in winter precipitation and runoff. Percentile analysis indicates that the largest flow months will increase by the greatest amount; while many projections indicate that lower flow months will experience a significantly smaller increase, if at all. Extreme low flows are projected to be even lower for our planning horizon, compared to baseline, for many of the ensemble / basin combinations, particularly for the hot/dry and warm/dry scenarios.

These results in general appear to have greater ramification with respect to the seasonal *timing* of flows rather than annual magnitudes. The projections in changes in extreme events, both low and high flows, may also warrant further consideration. High flow events would best be analyzed using daily projections, which were beyond the scope of this study.

3.1.5 Additional Indicators of Potential Basin Risks

3.1.5.1 Land Use

An exploratory correlation analysis was performed to identify and evaluate correlations between land use and risk of water stress (where stress is defined in this Plan as the risk of not satisfying all instream and out-of-stream needs). The intention of this analysis is to determine whether observed correlations, such as those between land use and water quantity[10], are evident regionally in Connecticut and to screen factors that warrant additional study. A strong correlation between variables can indicate the expected direction of change of one variable associated with another but cannot be used to identify the cause of the relationship, for which additional research and analysis is needed.

Data Collection, Processing and Statistical Methods

Land use data was obtained from the Multi-Resolution Land Characteristics Consortium (MRLC) National Land Cover Database[11] (NLCD 2011). This is a widely-used dataset that characterizes land cover by 20 categories across the United States. The land use data shown in **Figure 3-22** was processed in ArcGIS using the Spatial Analyst Toolset prior to the correlation analysis. The 20 land use categories were combined into 7 classifications of land use based on category similarities. The simplified categories are Water, Developed, Barren, Forested, Shrubs and Grasses, Agricultural, and Wetlands. Impervious surface percentage was also included in this analysis.

For the correlation analysis, the instream and out-of-stream water needs as a percent of streamflow was used as an indicator of risk of water stress, for both current and future average

[10] Bjerklie, D.M., Starn, J.J., and Tamayo, Claudia. 2010. "Estimation of the effects of land use and groundwater withdrawals on streamflow for the Pomperaug River, Connecticut" U.S. Geological Survey Scientific Investigations Report 2010–5114. http://pubs.usgs.gov/sir/2010/5114.

[11] Homer, C. C. Huang, L. Yang, B. Wylie and M. Coan. 2004. Development of a 2001 National Landcover Database for the United States. Photogrammetric Engineering and Remote Sensing", Vol. 70, No. 7, July 2004, pp. 829-840. https://www.mrlc.gov/nlcd11_data.php.

- Anticipated Permitting Requirements

Chapter 11 - Anticipated Permitting Requirements

A) INTRODUCTION

If the State Legislature, after review of comments and recommendations from the Water Planning Council, the Council on Environmental Quality, municipalities and State agencies, and the public, decides this project is beneficial and that a change in Water Company Use should be allowed, then a significant permitting effort will follow.

The following lists the anticipated local, State and Federal permits that will likely be required.

B) LOCAL PERMITTING

The current Tilcon Quarry operates under a Town of Plainville zoning permit, which is updated annually, based upon Tilcon's proposed expansion plans for that year. It is anticipated this local permit will continue to be renewed as part of the proposed Quarry expansion portion of the project.

A local Inland Wetlands and Watercourses permit will be required, for work within regulated areas, which are defined as wetlands, watercourses and all lands within 100 feet of wetlands and watercourses. Please refer to Chapter 7 – Wetland and Biological Inventory and Assessment, prepared by Davison Environmental, for more details.

C) STATE PERMITTING

Department of Public Health (DPH) Drinking Water Section permits will obviously be required for this project as well. These would include:

1) Water Company Land Permit - The temporary loss of 13.6 acres of Class I Water Company land during quarrying activities to create the future Storage Reservoir will require a DPH – Change of Land Use permit. Note that all this land in the future will revert back to being both Class I land, once the Storage Reservoir is created.

2) DPH Source Permitting - The DPH will likely want to review and approve plans for the proposed Storage Reservoir, its Intake Pump Station, and any related infrastructure improvements.

3) Water Supply Plan Update - If the project is approved, New Britain will be required to update their Water Supply Plan to account for both the temporary reduction of 0.07 MGD in safe yield, followed by the 2 MGD increase in system safe yield once the Storage Reservoir is on line.

4) Central Connecticut WUCC Approvals - The addition of a new significant source of supply, which will benefit both New Britain and all surrounding communities, will need to be presented to the Central Connecticut WUCC for review and comment. The Central Connecticut WUCC plan would have to be revised, to include this new source as well as its positive impacts on water supply in the region.

The Department of Energy and Environmental Protection (DEEP) will likely require several permits, as follows:

5) Water Diversion Permit - A Water Diversion Permit is required for new withdrawals of water which exceed 50,000 gpd over any 24 hour period, or modifying watersheds over 100 acres, both of which would apply to this project. Due to the size and potential environmental impacts identified in this report, an Individual Water Diversion Permit will be required.

6) DEEP Section 401 Water Quality Certificate – In conjunction with an anticipated Army Corp of Engineers permit, a DEEP Section 401 Water Quality Certificate is required for any applicant seeking a federal license or permit who conducts activities that discharge into any navigable waters, including all wetland, watercourses and natural and man-made ponds. This State permit is typically issued concurrently with an Army Corp of Engineers Section 404 permit, and the required consultations are the same for each.

7) DEEP General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities (Stormwater General Permit) - The project will result in the disturbance of_greater than one acre of land due to clearing, grading and/or excavation activities, which triggers this permit.

D) FEDERAL PERMITTING

8) Army Corp of Engineers (ACOE) Individual Permit – Work within wetlands and waters of the United States is subject to jurisdiction under Section 404 of the Clean Water Act, which is administered by the ACOE. Due to the total square footage of wetland and watercourse disturbances, this project will require an ACOE Individual Permit.

E) PERMIT COORINATION MEETINGS

If this project advances to the permitting phase, conducting one or more permit coordination meetings involving all local, state and federal agencies involved is encouraged, to review exact permit requirements from each agency, and to obtain input early in the process.

Impact of New Storage Reservoir on New Britain's Available Supply and Margin of Safety

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Chapter 12 - Impact Of New Storage Reservoir On New Britain's Available Supply and Margin of Safety

A) Introduction- The State of Connecticut Department of Public Health Drinking Water Section established Connecticut General Statute section 25-32, Water Supply Plan Regulations. A major component of these regulations is determining Available Supply and Margin of Safeties for Public Water Systems.

"Available Supply" is defined as the maximum amount of water a company can dependably supply, taking into account both safe yield and potential technical or contractual restrictions.

"Margin of Safety" is defined as a unitless ratio of available supply to demand.

This chapter discusses the impacts of the proposed Storage Reservoir on both available supply and margin of safety, as well as environmental, regulatory and contractual factors that may impact these values in the future.

B) Existing New Britain Available Supply and Source Safe Yield – As provided in the New Britain's 2014 Water Supply Plan, New Britain's available supply is limited by their source of supply safe yield, which is 17.64 MGD.

As noted in Chapter 4, by utilizing pumped storage and the MDC interconnection earlier in a drought than in previous models, the Safe Yield will increase from 17.64 MGD to **18.23 MGD**. LEI will utilize this updated safe yield value of **18.23 MGD** as New Britain's existing system available supply.

LEI next evaluated changes in available supply, projected water demands and the resultant margins of safety, both with and without the proposed Storage Reservoir in place.

C) Available Supply and Margins of Safety Without Storage Reservoir- Assuming No Regulation Or Contractual Changes- As noted in Section B above, New Britain's current available supply is **18.23 MGD**. The recently adopted DEEP minimum streamflow regulations require all dam operators in the Connecticut River Basin to provide downstream releases to meet DEEP Minimum Streamflow regulations beginning in 2027. For New Britain, this will require periodic downstream releases from Shuttle Meadow, Wassel, Wolcott and Whigville Reservoirs, and North and South Harts Ponds.

As part of the 2018 Water Supply Plan update, LEI will evaluate the impact of these releases on system safe yield. Our preliminary estimate is for approximate safe yield reductions of 2 MGD +/-, which will be finalized in the next Water Supply Plan. Based on this estimate, New Britain's available supply will drop to **16.23 MGD** in 2027. Assuming there are no more reductions in available supply, the **16.23 MGD** available supply would be utilized throughout the 50 year planning period, through 2060.

Table 12-1 below provides a comparison of available supply vs. projected water demands through 2060, and calculates the margin of safety. These values assume no changes to DPH Water Supply Plan and Safe Yield regulations, DEEP Water Diversion regulations, potential impacts of climate change or changes to New Britain's agreement with the MDC. As shown below, New Britain's Margins of Safety stay above the DPH required 1.15 value of available supply divided by water demand.

TABLE 12-1
MARGIN OF SAFETY CALCULATIONS
WITHOUT 2.31 BILLION GALLON STORAGE RESERVOIR
NEW BRITAIN WATER DEPARTMENT

Year	2015	2020	2030	2060
Available Supply without Storage Reservoir (MGD)	18.23	18.23	16.23	16.23
Existing and Projected Water Demands (MGD)	9.39	9.90	10.31	10.94
Margin of Safety (Available Supply / Demand)	1.94	1.84	1.57	1.48

D) Available Supply and Margins of Safety Without Storage Reservoir - Assuming Potential Environmental, Regulatory or Contractual Changes

1) Impacts of Climate Change - As discussed in Chapter 10, the recently completed State Water Plan presented likely impacts of climate change on water resources in Connecticut. One of the conclusions was that other weather will become wetter (especially in the winter months), and warmer. The frequency and intensity of both floods and drought will likely be more severe.

   Current DPH regulations base surface water safe yield on a 1:100 year return frequency drought event. For New Britain, this event was the three year, 1964 – 1967 drought. In the event of droughts that are equal or more severe than this 1:100 year drought, safe yields will be reduced to some degree. Although it is difficult to predict how severe what climate change impacts will have, for discussion purposes, we will evaluate a safe yield reduction of 10 % (1.82 MGD) on New Britain's future available supply and margin of safety.

2) Revisions to Connecticut DEEP Diversion Policies – The 1982 DEEP Water Diversion regulations established guidelines for both registered and permitted diversions. Registered diversions were existing diversions in place as of 1982, and these usages were grandfathered as part of the law. As all of New Britain's sources pre-date 1982, they all are classified as registered diversions.

   Public comments received on the State Water Plan have included requests for the State to modify how registered diversions are treated, and in some cases have these registered diversion holders re-apply under the Diversion permit process.

   Over the next 50 years, through the 2060 planning period, it is possible that a) environmental regulations will continue to become stricter, and b) that some modifications to the current diversion regulations will occur. These will likely become more restrictive in water withdrawals, especially in low flow or drought conditions.

   Similar to the potential impacts of climate change, we have evaluated the impact of a 10 % reduction (1.82 MGD) to New Britain's available supply.

3) Possible Modifications to MDC Raw Water Purchase Agreement – The 1931 and 1958 agreements between MDC and New Britain allows for New Britain to purchase an average daily demand of up to 5.0 mgd on a yearly basis, and up to 10.0 mgd over a six month period. During the most recent two year drought in 2016 -2017, New Britain activated this interconnection for a portion of three months, which was critical to allow their reservoirs to recover.

   All large surface water supplied public water systems will likely experience the same pressure to reduce available supply identified above from a) DEEP minimum streamflow releases, b) potential climate change impacts, and c) Possible DEEP Diversion Permit regulation changes. The MDC will likely face the same challenges at New Britain on this item.

   In the event environmental or regulation changes impact the MDC's available supply, they may look to modify their agreement with New Britain, especially during drought conditions. It is impossible to predict whether this would happen, or what impact on the contractual volumes this would have. For discussion purposes, we have evaluated a potential 1 MGD reduction in available water from the MDC on both available supply and margin of safety.

4) Increases in Future Demands - Chapter 5 predicted fairly minimal increases in average daily demands, from 9.39 MGD to 10.94 MGD, between 2015 and 2060. These were based on small increases in commercial and industrial demands, as well as limited growth by the four sale-for-resale customers.

   Large sale-for-resale customers may experience the similar safe yield reductions as New Britain, due to DEEP minimum streamflow releases, climate change, and more stringent regulatory conditions. Potential adverse water quality or contamination issues may also contribute to sale-for-resale customers seeking additional supplies of purchased water from New Britain.

Lastly, the addition of one or more new major commercial or industrial water users could quickly exceed the projected increases in these categories. For the basis of discussion, we will evaluate the impact of an additional 1 MGD water demand on 2060 margins of safety, beyond those projected in Chapter 5.

5) Revised Available Supply and Margin of Safety Calculations - **Table 12-2** below calculates system margin of safety, assuming the potential reductions in available supply and increases in demands, including:

- a 2 MGD reduction due to DEEP minimum streamflow releases, starting in 2027
- an additional 1.82 MGD (10 %) reduction loss in safe yield due to climate change
- an additional 1.82 MGD (10 %) reduction due to potential water diversion permit restrictions
- a 1 MGD reduction in available supply from the MDC interconnection, and
- a new 1 MGD demand from existing or future users.

TABLE 12-2
AVAIALBLE SUPPLY AND MARGIN OF SAFETY CALCULATIONS
WITHOUT STORAGE RESERVOIR,
ASSUMING POTENTIAL AVAILABLE SUPPLY REDUCTIONS
NEW BRITAIN WATER DEPARTMENT

Year	2015	2020	2030	2060
Available Supply **without** Storage Res.	18.23	18.23	18.23	18.23
Potential Reductions in Available Supply	0	0	2.0 *	6.64 **
Available Supply with Source Reductions (MGD)	18.23	18.23	16.23	11.59
Average Daily Demand, (MGD)	9.39	9.90	10.31	11.94***
MOS – **without** Storage Res., without new major user	1.94	1.84	1.57	0.97

*Estimated minimum streamflow reductions of 2 MGD
**Estimated min. streamflow and additional Available Supply reductions of 2 MGD + 4.64 MGD (safe yield, Diversion, and MDC contract reductions)
*** Additional 1 MGD demand included

E) Available Supply and Margins of Safety **With Storage Reservoir** - Assuming Potential Environmental, Regulatory or Contractual Changes

Assuming this Environmental Study receives approval for New Britain to proceed with permitting, and this permitting takes two years to complete, and that permits are granted for construction, the earliest start date for construction is 2020. Therefore, the timelines listed below assume a 2020 start date for construction.

As noted in Chapter 4, New Britain's Available Supply and Source Safe Yield will be reduced by 0.07 MGD, from 18.28 MGD to 18.21 MGD, due to a temporary loss of watershed area to Shuttle Meadow Reservoir, during the Quarry expansion. Therefore, the available supply for **2020**, with the Storage Reservoir under construction, would be **18.21 MGD**.

As mentioned in Section C of this chapter, LEI estimates a 2 MGD +/- reduction in system safe yield as an impact of the DEEP Minimum Streamflow regulations, which would take effect in **2027**. This would reduce the year 2030 available supply from 18.21 MGD to **16.21 MGD**.

Finally, as discussed in Chapter 4, the addition of the proposed 2.31 billion gallon Storage Reservoir combined with flood skimming on Coppermine Brook would increase New Britain's system safe yield from 18.23 MGD, to 20.20 MGD, or an additional 1.97 MGD. This increase in safe yield would only occur once the Storage Reservoir is constructed and on-line, projected in

2060. Taking into account the two previous reductions, the system available supply in 2060 is calculated as follows:

$$\text{Available Supply (2060)} = 18.23 \text{ MGD} + 1.97 \text{ MGD} - 0.07 \text{ MGD} - 2.0 \text{ MGD} = \mathbf{18.13\ MGD}$$

Table 12-3 below re-calculates New Britain's margin of safety, with the Storage Reservoir in place, taking into account the same potential environmental, regulatory and contractual factors given in Section D above.

As shown in **Table 12-3**, the addition of the proposed 2.31 billion gallon Storage Reservoir would allow New Britain to provide acceptable Margins of Safety greater than 1.1, even with potential reductions in available supply.

TABLE 12-3
AVAIALBLE SUPPLY AND MARGIN OF SAFETY CALCULATIONS
WITH STORAGE RESERVOIR,
ASSUMING POTENTIAL AVAILABLE SUPPLY REDUCTIONS
NEW BRITAIN WATER DEPARTMENT
(MGD)

Year	2015	2020	2030	2060
Available Supply **with** Storage Res.	18.23	18.16	18.16	18.13
Potential Reductions in Available Supply	0	0	2.0 *	4.64 **
Available Supply with Source Reductions (MGD)	18.23	18.16	16.16	13.49
Average Daily Demand, without new major user(s) (MGD)	9.39	9.90	10.31	11.94***
MOS – **without** Storage Res., without new major user	1.94	1.87	1.60	1.13

*Estimated minimum streamflow reductions of 2 MGD
**Estimated additional Available Supply reductions of 4.64 MGD
*** Additional 1 MGD demand included

F) <u>Conclusions</u> – Although it is impossible to predict the impacts of future events on safe yield and available supply, it is fairly certain that a) climate change will negatively impact safe yield and available supplies, especially for reservoir systems, and b) regulations will be more stringent, not less stringent in the future.

As shown above in **Table 12-2**, potential reductions in available supply from a combination of factors, coupled with even a 1 MGD increase in water demands over current projections, could result in reduced margins of safety close to or below 1.0 for New Britain and the neighboring communities that rely on New Britain for water supply.

As shown in **Table 12-3**, the construction of this Storage Reservoir increases New Britain's Margin of Safety to above 1.1, even with potential environmental, regulatory or contractual reductions in available supply.

Project Benefits and Environmental Impacts

Chapter 13 - Project Benefits and Environmental Impacts

A) INTRODUCTION

In any major project, the overall project benefits need to be compared and contrasted with the likely environmental impacts, so that an informed decision can be made on moving forward. This chapter highlights contents from the previous twelve chapters, and provides a comparison of these two items.

B) PROJECT BENEFITS

The proposed Storage Reservoir project will have the following benefits:

1) It will provide New Britain with an additional 2.31 billion gallons of usable water storage, an increase of 45 % above the current 2.85 billion gallons stored in Shuttle Meadow, Wassel, Whigville, Wolcott, Lower Harts and Upper Harts Ponds combined.

2) It will increase New Britain's system safe yield from 18.23 MGD to 20.20 MGD, an approximate 2 MGD increase.

3) Only a 0. 07 MGD, or 70,000 gpd loss in safe yield is estimated during the time the existing Tilcon Quarry is expanded to its proposed final limits, and adequate safe yields and available supplies will be maintained during quarry expansion and reservoir creation. Therefore, temporary pumping of stormwater runoff during quarry expansion will not be necessary.

4) Approximately 44 acres of woodlands on the western portion of the site will be left undisturbed, to preserve the NDDB identified sub-acidic rocky summit outcrop community, the two largest vernal pools on the parcel, Bradley Mountain and the majority of the hiking trails, as well as other ecological receptors.

5) An additional 17 acres adjacent to the Tennessee Gas Transmission main easement on the southeastern portion will remain undisturbed, which will minimize impacts to environmental receptors, as well as provide additional buffers to both the gas transmission main and the residential neighborhoods in New Britain.

6) If approved, Tilcon Inc. would donate approximately 291 acres, of which 132 acres is presently within New Britain's watershed area, to the Towns of Plainville and Southington, and to the City of New Britain, as protected open space, enhancing source protection and water quality in the future.

7) The primary means of filling the proposed 2.31 billion gallon Storage Reservoir is flood skimming from Coppermine Brook, utilizing New Britain's existing White Bridge Surface Water pumping station. Upon completion of this Storage Reservoir, New Britain would only withdraw water from Coppermine Brook during periods which meet DEEP Minimum Streamflow requirements, and turn off their pumps during periods of lower flows. This by itself will significantly increase streamflows in Coppermine Brook, especially during low flow periods.

8) The increase in New Britain's Safe Yield will benefit not only New Britain, but the entire Central Connecticut region, especially those utilities presently interconnected (Berlin, Kensington, Plainville and Bristol), as well as potentially other communities.

9) Although future water demand projections are expected to only slightly increase between the present and 2060, from 9.39 MGD in 2015 to 10.94 MGD in 2060, future events may significantly impact New Britain's available supply. These include:

   - Surface water releases from New Britain's existing reservoirs to meet DEEP Minimum Streamflow regulations by 2027,
   - The impacts of climate change and potential reductions in safe yield,
   - potential changes in Water Diversion policies in Connecticut, which could restrict existing withdrawals and reduce safe yields,
   - potential changes and long-term reductions with the MDC raw water purchase contract,
   - increased water demands from a yet to be identified future Town or large user,
   - catastrophic loss of a major source of supply due to flooding, dam breach, contamination, sabotage or other acts,
   - or others.

10) In summary, the major benefit in providing a new Storage Reservoir is to ensure that adequate supplies of drinking water will be available to both New Britain and the surrounding communities. In an uncertain future, the addition of a future source of supply will help counteract the results of loss of supply, regulatory changes, or an unforeseen increase in demand.

C) ENVIRONMENTAL IMPACTS

The proposed quarry expansion and future Storage Reservoir creation will have the following associated environmental impacts:

- Approximately 72 acres of woodland would be cleared.
- Approximately 4.7 acres of wetlands would be lost, including several vernal pools, within the footprint of the proposed Storage Reservoir.
- Approximately 13.6 acres of Class I watershed land will be temporarily lost, during quarry expansion, and prior to utilizing the excavation as a Storage Reservoir. Upon completion and activation of the Storage Reservoir, this Class I watershed land will be significantly increased to include the 109 acre surface area of the Storage Reservoir itself, as well as an additional 59 acres within 250 feet of the high water mark, creating a total of 168 acres of Class I land.
- The headwaters of two intermittent streams which begin on the property and help supply the West Canal and Shuttle Meadow Reservoir, fall within the footprint of the proposed Storage Reservoir. This amounts to a temporary loss of watershed area of 0.17 square miles, resulting in a reduction of 0.07 MGD safe yield, to Shuttle Meadow Reservoir, until the Storage Reservoir is created.
- Although no federally listed endangered species were detected during the study, several state listed species of concern were found to be present, and potentially impacted by the project: the Jefferson Salamander, the Spotted Turtle, the Eastern Box Turtle and Fir Clubmoss.