PROPOSAL TO COMPLETE A

HYDROLOGIC STUDY OF
MARANACOOK LAKE WATERSHED

Prepared for:
MARANACOOK LAKE OUTLET
DAM COMMITTEE
 Towns of Readfield and Winthrop, Maine

Prepared by:
GZA GeoEnvironmental, Inc.
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Portland, Maine 04101

Contact:
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Senior Consultant
207-358-5101
james.hillier@gza.com

September 26, 2014
GZA File No. 09.P000077.15

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September 26, 2014
File No. 09.P000077.15

Mr. Jeffrey Woolston
Town Manager
Winthrop Town Office
17 Highland Avenue
Winthrop, Maine 04364

Re: Proposal for Maranacook Lake Watershed Hydrologic Study
97 Bowdoin Street
Winthrop, Maine

Dear Mr. Woolston:

In response to your request for proposals, GZA GeoEnvironmental, Inc. (GZA) is pleased to provide this proposal to the Maranacook Lake Outlet Dam Committee (Committee), of the Towns of Winthrop and Readfield, to complete a hydrologic study of the Maranacook Lake watershed. GZA’s scope of services, schedule, budget estimate, and conditions of engagement are provided in the following sections.

BACKGROUND

GZA is especially committed to working with you to understand the hydrology of Maranacook Lake, and to the effective management of its water levels. In addition to the customized hydrologic model described in this proposal, we are prepared to share with the Towns of Winthrop and Readfield unique information on the depth, shape and volume of the Maranacook lake basin that is essential to understanding the form and function of Maranacook Lake.

In 2003, a state-of-the-art bathymetric map of Maranacook Lake was created by a geoscience firm called Hillier and Associates, Inc. (HAI) using matching funds from the Maine Technology Institute. This was the first of eight bathymetric maps created by HAI in central Maine using an innovative method combining sonar and GPS data acquisition with GIS analysis technology. The 50,000-plus location / elevation (x,y,z) points acquired in this Maranacook bathymetric survey replaced the previous Inland Fisheries and Wildlife survey that contained only a dozen or so depth measurements.

This innovative work was performed by two life-long Readfield residents: engineer – Robert Mohlar, P.E. (now employed by Maine DEP), and hydrogeologist – Jim Hillier, C.G. (now employed by GZA), together with professional guidance from Colby College Professor Whitney King, PhD. Other environmental science work performed at Maranacook Lake by HAI won recognition from EPA’s Region 1 and the New England Water Works Association which awarded the local company the “New England Water Supplier Business Honor in 2002”. Please refer to the attached honors certificate.

The bathymetric source data and GIS files containing this information are private intellectual property with an estimated replacement value of $10,000. If GZA is selected as the consultant to perform the “Maranacook Lake Watershed Hydrologic Study,” we will use this bathymetric data...
to prepare our analytical model and, with the final hydrologic model project report, the bathymetric data set and GIS file of Maranacook Lake will be donated to the Cobbossee Watershed District at no additional charge.

GZA understands that the Committee is seeking technical assistance with the evaluation of the Maranacook Lake watershed to guide decisions regarding the modification of the dam for the potential to increase outflow in order to achieve water level goals. In recent years the increased precipitation and shallow gate of the dam have resulted in a number of issues the Committee would like to evaluate. These include:

- Erosion issues along the lake due to higher full pond elevations;
- Increased difficulty in lowering lake levels following precipitation events;
- Difficulty in accomplishing a fall-season draw down.

The Maranacook Lake Dam is State-regulated and is classified as a Low Hazard Dam. In accordance with Maine regulations, the Spillway Design Flood (SDF) for the dam is the 100 year flood.

The Committee has requested a customized hydrologic model to determine water inflow to the lake and show the resultant lake levels and duration of levels above target levels, given the current configuration of the Maranacook Lake Outlet Dam. Calibration of the model will utilize existing precipitation and lake levels data from the selected events. The goal of the project is to model a number of flow scenarios to aid in subsequent analysis for potential dam structure modifications necessary for achieving specific water level goals.

SCOPE OF SERVICES

Our proposed tasks for technical evaluation to meet the Committee’s goals include the following:

TASK 1 – REVIEW OF AVAILABLE DATA

GZA will review reports and data for the Maranacook Lake watershed and dam, if available; these include:

- Federal Emergency Management Agency (FEMA), Kennebec County, Maine Flood Insurance Study (FIS) No. 23011CV001A effective June 16, 2011;
- Available inspection reports from Maine Emergency Management Agency Dam Safety Department for the Torsey Lake Dam, Maranacook Lake Dam and Annabessacook Dam;
- Cobbossee Watershed District field-measured and recorded data at the wire-weight gage at dam1;
- Local rain gage data from National Climatic Data Center;

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1 GZA proposes to review the collected meteorological and water level data for calibration with the models. We will evaluate the feasibility of using this data with and without data from additional sources.
Surrounding public available watershed studies; and
Design drawings of the downstream mill, if available.

**TASK 2 – SITE VISIT AND LIMITED FIELD SURVEY**

GZA proposes to visit the Torsey, Maranacook and Annabessacook dams to conduct a GPS based survey of the structure for input into the proposed models. We understand that no field survey has been completed for the dam. The survey will be on an assumed datum. GZA will collect relative measurements of the upstream Torsey Lake Dam, upstream bridge on Route 41, Maranacook Lake dam structure, downstream mill, and Annabessacook Dam for modeling purposes only. A formal survey should be performed in support of any final design in subsequent work. A coordination meeting with the Committee Chair will be scheduled to occur during this visit to discuss the file review and data collection. The site visit and meeting will assist in the development of the model inputs for the proposed analysis.

**TASK 3 – HYDROLOGIC AND HYDRAULIC ANALYSIS**

The 2011 FEMA FIS for Kennebec County includes analysis of Maranacook Lake. The FIS states that the investigation of the dam “led to the conclusion that a sophisticated study of high-water elevations in the lakes such as routing flows through the lake would be misleading.” Additionally, it is noted that the FIS does not provide peak flows associated with the lake, but rather with still-water elevations.

It is clear that peak flows in the Maranacook Lake system are controlled by the watershed and basin hydrography, hydraulics, and by dam structures. Based upon our interpretation of the FIS study and observations made during the site visit, GZA understands that the best path to describing conditions that affect proper dam geometry and operation is to develop both a hydraulic model and hydrologic model of the dam. The goal of the analysis is to evaluate the existing conditions, perform an alternatives analysis and provide the Committee with a tool for assessing the operation and water level control for water quality and flood management purposes.

**Spillway and Bridge Hydraulic Model**

GZA proposes to develop a series of water surface profiles extending from just upstream of the Main Street Bridge to the discharge point within Annabessacook Lake. GZA will develop the profiles using the Army Corps of Engineers HEC-RAS program (Version 4.1.0). We intend to utilize the dynamic, unsteady flow options within the 1-dimensional HEC-RAS flow model.

The water profile analysis will estimate hydraulic losses through the Main Street Bridge, over the spillway and through the downstream reach and Mill. GZA’s hydraulic model will represent existing conditions. The water surface profile will be used to develop an understanding of the hydraulic control points for Maranacook Lake. We will develop a rating curve for flow out of Maranacook Lake which will become an input to the subsequent watershed/hydrologic model (discussed below).

GZA will provide a basis for future evaluation of the dam which will identify a limited number of options for spillway modifications as part of Task 4. The HEC-RAS model will become a tool that the Committee can use to evaluate the dam under additional scenarios.
Watershed Model

GZA proposes to build a rainfall/runoff simulation model using the United States Army Corps of Engineers HEC-HMS program (Version 3.5) for the approximately 14-square-mile watershed contributing to the dam. Our hydrology analyses will include the 1, 2, 5, 10, 25, 50, and 100 year (i.e. SDF) precipitation events based on data available from the Northeast Regional Climate Center data. Specifically, we anticipate that this effort will include the following tasks:

- Evaluate and determine the contributing watershed areas and division of sub-areas; develop input assumptions and utilize existing data for the dam located upstream of the lake that may affect the attenuation and translation of flood hydrographs to the Maranacook Lake and Dam;
- Calibrate and verify a unit hydrograph input data (initial and constant loss functions, time of concentration, etc.) for the runoff model;
- Input the rating curve from the HEC-RAS model to define outflow from the dam; and
- Use the verified hydrologic model to route various flood scenarios ranging from the 1-year flood up to the SDF through the Maranacook Lake and over the existing spillway;

GZA notes that lake elevations are recorded on a weekly basis. It is possible that records do not capture the peak elevations associated with specific storm events. We will calibrate our model accordingly using this data.

GZA will also utilize our HEC-HMS model to perform a drawdown analysis of Maranacook Lake (under existing conditions). Lake bathymetry will be based upon state-of-the-art bathymetric source data and GIS files that will subsequently be transferred to the Cobbossee Watershed District.

TASK 4 – ALTERNATIVE ANALYSIS

The overarching design criteria of the dam is to safely pass the SDF with sufficient minimum freeboard to account for wind set up and wave run up and avoid overtopping. As part of the alternatives analysis, we will evaluate the shape and size of the fixed spillway.

Using our calibrated HEC-HMS model and our HEC-RAS model, GZA will develop up to three spillway configuration alternatives. GZA’s evaluation will focus on developing spillway options that addresses the Committee’s objectives for dam operation. The evaluation will be performed by modifying the dam geometry in HEC-RAS and then inputting the resultant rating curve from the upstream end of the model at the outlet rating curve into the HEC-HMS model to calculate the peak water surface elevation in Maranacook Lake. Some possible alternatives to modeling may include:

A) Modify geometry of primary or auxiliary spillway weir length and or elevation;
B) Raise top of dam elevation to provide additional hydraulic head;
C) Provide overtopping protection/hardening over a portion of the currently non-overflow portion of the dam.

As part of the alternatives analysis we will also perform a draw down analysis to generate draw-down curves for evaluation of the events the Committee would like to address (e.g., baseflow conditions, gate open, gate raised, etc.) We have assumed that up to three drawdown
analyses will be performed. The customized model will be provided in a no-fee program language and in a format that is usable by the Cobbossee Watershed District on conventional desktop computer equipment.

TASK 5 – SUMMARY REPORT

GZA will provide the committee with all digital model files once the project has been completed. GZA will prepare a written report describing the summaries of the data gathering, model(s) development process and methods, the model(s) results, and alternative analysis performed. GZA will provide recommendations for the Committee to evaluate future modifications to the dam structure and guidance for the Committee’s future use of the models.

RESPONSIBILITIES OF MARANACOOK LAKE OUTLET DAM COMMITTEE

To complete the scope of services described above, we request that Maranacook Lake Outlet Dam Committee provide the following to GZA:

1. Access to the dam and assistance in conducting site reconnaissance activities;
2. Historical data collected by the Committee;
3. Historical records and/or studies, if available; and
4. Seasonal target lake levels.

GZA QUALIFICATIONS

GZA is a professional services consulting firm focused on geotechnical, environmental, water, ecological, and construction management services. With a staff of interrelated professionals dedicated to providing high-level expertise on complex projects above, below and at ground-level, GZA’s experts provide seamless integration across practice areas, client type, and location. GZA employs more than 530 engineers, scientists, and technical support staff in 25 offices throughout the United States that cater to clients in the architecture and engineering, contracting, governmental, industrial, infrastructure, institutional, legal, oil and gas, power, and real estate industries. The firm is consistently ranked among the top 100 firms on Engineering News Record’s annual list of the top 200 environmental firms. Excelling as a multi-disciplinary, multi-office firm of proactive, bright, and dedicated people, we provide value to our clients and our profession. Please refer to the attached resumes and relevant project descriptions.

Hydrology and Hydraulic Engineering

GZA’s engineers and hydrologists have performed numerous hydrologic studies of lakes, reservoirs and impoundments using current computer simulation software and digital mapping technology to produce defined, practical, results that describe flow conditions and dam breach scenarios. Their ability to handle flood flows is a critical component of dam safety. Common deficiencies include inadequate spillway and outlet capacities, Advances in hydraulic assessment techniques enable our engineers to estimate watershed response to meteorological events and to evaluate the hydraulic efficiencies of existing dams. Through our computer modeling, our staff can determine the hydraulic capacity of a dam’s outlet structures, assess the potential for overtopping, and simulate dam breaches to estimate flood wave routing.
Civil and Geotechnical Engineering

GZA’s engineers and hydrologists provide an impressive mix of capabilities applicable to a range of water resource projects. We offer necessary civil, geotechnical and structural experience to design, construct and repair water supply systems and infrastructure. Our environmental engineers and scientists contribute to these projects by assessing the potential impacts of meteorological events, construction techniques, and impending supply and storage demands. Clients benefit from our combined expertise that provides a scope of service related to permitting, safety, and system-wide improvements.

Environmental Consulting and Permitting

On behalf of our clients, GZA’s engineers and scientists routinely work with local, State and federal regulators to obtain permits associated with the preservation of wetlands and other water resources. These processes range from permitting assignments to complex submittals, such as those required for dam removal or dredging.

Construction Services

Our staff use civil engineering knowledge and construction management skills to complete dam construction, repair, and rehabilitation and removal projects. GZA’s staff can oversee the entire project, including all contractor obligations and contract administration, or we can simply oversee project work to ensure compliance with design plans and specifications. In any scenario, GZA offers the full-service capabilities to handle each aspect of dam safety, retrofit, repair and construction projects.

PROJECT TEAM

Mr. James E. Hillier, C.G., C.P.G., a GZA Senior Consultant in our Augusta and Portland, Maine offices, will serve as Project Manager. Mr. Hillier is a Senior Consultant with over 35 years of experience in hydrology, engineering, and geologic studies. Mr. Hillier’s abilities to organize project teams and to complete challenging programs make him particularly effective for our clients. Mr. Hillier manages GZA environmental services to the State of Maine and municipalities involving major improvements to highways, bridges, or utilities; he manages the General Consulting Agreements and performs much of the hydrogeologic work and quality control associated with these projects. He is a hydrologist with extensive experience and personal commitment to the Readfield - Winthrop area, its people, and its unique natural resources.

Mr. Christopher L. Snow, P.E., a GZA Principal in our Portland, Maine office, will be the GZA principal-in-charge. Mr. Snow is responsible for management and technical performance of projects in the geotechnical area. He has served as principal-in-charge, project manager, geotechnical engineer, or consultant reviewer for a large variety of constructed facilities including industrial, commercial and municipal buildings; dams; landfills; natural and engineered earth and rock slopes; tanks; pipelines; highways, railroads and bridges; waterfront structures; temporary and permanent retaining structures, and marine outfalls.

Mr. Chad W. Cox, P.E., a GZA Principal in our Norwood, Massachusetts office, will be the consultant reviewer and provide technical assistance to the team. Mr. Cox has extensive experience in many aspects of civil engineering including dam safety and design, water supply, transportation, and geotechnical construction. In addition, he is also well-versed in the permitting process which accompanies large civil works, having prepared permit applications required by the U.S. Army Corps of Engineers, EPA, NEPA, MEPA, and others. Mr. Cox has worked on
numerous dams performing such tasks as inspection, deficiency evaluation, planning, hydraulic, structural, and geotechnical design, contract writing, contractor submittal review, and construction observation.

Ms. Jennifer Pisani, a GZA Assistant Project Manager in our Portland, Maine office with a water resource engineering background, will provide the technical skills to develop the proposed statistical analysis and modeling.

Ms. Aimee Mountain, a GZA Assistant Project Manager in our Portland office, is extensively experienced in GIS and data management techniques, specifically for public applications involving asset management and environmental tracking.

Mr. Bradley Tirone, a GZA Assistant Project Manager in our Augusta, Maine office with environmental science degrees and extensive local field experience, will provide any needed field assistance.

Resumes for the project team are included in this proposal.

**SCHEDULE**

GZA estimates that the Scope of Services presented above can be completed by December 31, 2014 as requested after receipt of written authorization to proceed (i.e., receipt of a signed contract) and all requested information.

**BASIS OF BILLINGS**

Billings for GZA professional services will be on a fixed fee basis and will be invoiced according to the tasks list shown below. GZA’s estimated cost for the Scope of Services outlined above is $14,540, according to the following cost breakdown:

<table>
<thead>
<tr>
<th>TASK</th>
<th>BUDGET ESTIMATE</th>
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<tbody>
<tr>
<td>Task 1 – Review of Available Data</td>
<td>$1,000</td>
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<tr>
<td>Task 2 – Site Visit and Limited Field Survey and Meeting</td>
<td>$2,540</td>
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<tr>
<td>Task 3 – Hydrologic and Hydraulic Analysis</td>
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<td>Task 4 – Alternative Analysis</td>
<td>$3,500</td>
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<td>Task 4 – Summary Report</td>
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<td><strong>TOTAL</strong>:</td>
<td><strong>$14,540</strong></td>
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Actual charges may be greater or less depending on the level of effort required. You will be notified of conditions requiring an increase in the budget estimate as soon as they become evident. All services will be charged as incurred, on a monthly basis.

*Invoices for our services will be mailed to the address presented above. Should your billing address be different, please notify the undersigned so that appropriate changes can be made.*
CONSULTANT STATEMENT

GZA GeoEnvironmental, Inc., represented herein by Mr. James E. Hillier, Mr. Chad W. Cox and Mr. Christopher L. Snow, makes this proposal without any connection to any other Proposer making any proposal for the same services; no person acting for or employed by either Town is directly or indirectly interested in the Proposal or any agreement which may be entered into, to which the Proposal relates or in any portion of the profits therefrom.

We appreciate this opportunity to submit this proposal to Maranacook Lake Outlet Dam Committee and look forward to working with you.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

[Signatures]

James E. Hillier, C.G., C.P.G.  Christopher L. Snow, P.E.
Senior Consultant             Principal-in-Charge

Attachment: Project Team Resumes
Project Descriptions and Qualifications
EPA New England Honor Certificate
Summary of Experience
Mr. Hillier is a Senior Consultant with over 35 years of experience in hydrology, engineering, and geologic studies. Mr. Hillier’s abilities to organize project teams and to complete challenging programs make him particularly effective for our clients. His years of technical experience in Maine, Colorado, and Alaska give him a realistic and productive approach to engineering, and geologic studies.

Relevant Project Experience
Senior Consultant and Hydrogeologist, Mr. Hillier manages GZA environmental services to the State of Maine involving major improvements to highways, bridges or utilities in the State of Maine right of way. He manages the General Consulting Agreements with the State and performs much of the hydrogeologic work and quality control associated with these projects. Services range from environmental assessments of single sites or long transportation corridors. He has managed environmental GCAs with MaineDOT since 1999, and provided consulting services valued at more than 2.7 million dollars at more than fifty DOT properties, bridges, and highway corridors throughout Maine.

Hydrogeologist, Mr. Hillier owned and operated a geosciences and environmental engineering firm, Hillier & Associates, Inc. (HAI) in Augusta, Maine between 1996 and 2011. During that time HAI was continuously prequalified to perform work for the Maine DEP and assisted the Maine DEP to investigate and remediate more than 20 sites.

Hydrogeologist, Maranacook Lake Project, Town of Readfield, Maine. Together with the Town’s Planning Board, Code Enforcement Officer, and technical staff from the Cobbosseecontee Watershed District, and Kennebec Soil and Water Conservation District, received a competitive grant from the Environmental Protection Agency to fund studies, then design and construct road improvements within the north basin watershed. The watershed survey was completed in the summer of 2000. As the local Boy Scout Master, Mr. Hillier also provided training for assistance from several Eagle Scout candidates, and with the Code Enforcement Officer and local high school science department, organized Readfield’s first Youth Conservation Corps. Designed road improvements and managed the construction of several erosion control features on one of Readfield’s worst roads, a significant source of nutrient and residual petroleum export to Maranacook Lake. The project won from EPA Region 1 - Water Supplier Business Honors of the Year - 2005.

Geologist, Watershed Assessment/Bathymetric Mapping, Newport Water District, Newport, Maine. Conducted a detailed resource and watershed assessment of Nokomis Pond. Bathymetric mapping determined elevation-based capacity of the resource. Properties located within the pond’s watershed were digitized. Bathymetry and digitized tax maps were integrated into a GIS model to be used as resource management-planning too.
**Hydrogeologist**, Mr. Hillier was hired by the City of Augusta, Maine to guide the City and 22 applicants (gravel pit and quarry operators) through implementation of a new Mining Ordinance. Mr. Hillier worked closely with City Managers and Planning Board to assist – review - permit numerous projects. He assessed engineering and environmental conditions of each property, presented findings to the public and Planning Board, and assisted in preparing the City’s decision on each application.

**Certified Geologist, Consultation - Maine DOT Surface Water Quality Protection Program.** Between 1998 and 2005, Mr. Hillier provided design detail and construction oversight for numerous stormwater related transportation projects in Maine. Projects include natural stream channel redesign, pavement perimeter infiltration systems, ditch filtration and bio-retention systems, and standard erosion control. HAL worked exclusively on these projects and was an author of the Stormwater Best Management Practices Manual prepared in 2004.

**Geologist, River Crossings-Algonquin Gas Transmission Co, Maine.** Mapped geologic conditions and potential hazards at a planned river crossing for high-pressure gas transmission main planned to cross the Piscataquis River between Maine and New Hampshire. Managed on-shore and offshore seismic refraction surveys and made recommendations regarding alignment and mode of pipeline construction.

**Geologist, Northeast & Maritimes Gas Pipeline Pre- and Post Construction Testing, Duke Energy.** Provided Duke Energy with geologic consulting services related to alignment selection, construction monitoring, and post-construction evaluations of the Northeast & Maritimes Gas Pipeline in 1998 through 2000. Directed and logged exploratory drilling at six planned river crossing locations, working from floating barges. Following field work, we documented the surficial and bedrock geology of each area in reports to the gas pipeline client. We also performed geochemical surveys of river water to evaluate its potential for use in filling and flushing pipes. During pre-construction and post construction stages, performed surveys on more than 100 wells and structures located within 600-feet of the pipeline alignment to evaluate the potential damage and effect of blasting rock and soil during pipeline construction.

**Mack Point Marine Terminal, MaineDOT, Sears Island, Maine.** Investigated this site to evaluate, characterize, and describe hydrogeologic conditions regarding the presence of uncontrolled oil and hazardous materials. Investigation focused on the presence and concentrations of petroleum, and heavy metals in ground water, surface water, and soils at the site. Hydrogeologic field assessment detected weathered gasoline in ground water at specific monitoring wells at the site, while laboratory analysis of this ground water detected petroleum concentrations and Methyl-Tertiary-Butyl-Ether (MTBE). Prepared recommendations to remediate problem area on the site.

**Fairfield-Benton Bridge, MaineDOT Environmental Office, Fairfield, Maine.** Contracted with the Maine DOT Environmental Office to direct construction site remediation for the Fairfield-Benton Bridge Replacement Project in Fairfield, Maine. Scope of work included the inspection, identification, and classification of soils potentially contaminated with petroleum products associated with a former service station adjacent to the alignment of the new bridge “footing” and the Kennebec River. Responsible for determining Group classifications in order to direct the handling, reuse, temporary stockpiling, and transportation or disposal of contaminated soils and groundwater.

**Geologist, Alyeska Pipeline Service Co., Subsurface Investigations of Permafrost Related to Settlement of Trans Alaska Pipeline, Alaska.** Performed extensive geologic and engineering studies of the foundation characteristics of the 800-mile long Trans-Alaska Pipeline Systems (TAPS) between 1980 and 1986 with Quadra Engineering of Anchorage, Alaska. A 1980 pipeline rupture caused by melting permafrost resulted in the release of some 40,000 barrels of crude oil into the subsurface and head waters of the Atigan River in the remote Arctic Brooks Mountain Range. The oil spill was detected near Pump Station #4 during spring melt and oil was found to have flowed 146 miles to the Arctic Ocean. Mr. Hillier was the lead geologist among a team of pipeline design engineers employed by Alyeska Pipeline Service Company to evaluate the cause of the rupture, and to repair and secure the stressed section of the pipeline. In 1980 Mr. Hillier directed a field program involving more than one hundred sixty bore holes, trenches and inspection borings, then prepared
preliminary and final reports detailing the relationship of melting permafrost to the loss of foundation and ultimate failure of the pipeline at this location. The compromised pipe was patched and continued operation while a series of 20 below-ground thermo-piles where installed to support the pipe.

Over the course of the following six years, Mr. Hillier continued to work closely with engineers at Alyeska, and employed various methods of geologic mapping, research, refrigerated core sampling and remote geophysical techniques to evaluate potential problem areas in the 800-mile pipeline route. Mr. Hillier managed exploratory core-drilling crews, geologists and technicians in programs that operated around-the-clock to gather needed information on pipeline stability.

From this work another leak was detected and repaired at a location near Mile Post 633. At another arctic location, 44 miles south of Atigan Pass, a 1.3-mile section of buried pipeline was removed and re-routed out of the Dietrich River basin. Mr. Hillier inspected the reroute construction during winter months of 1985 when the river waters were frozen and less vulnerable to environmental impairment by construction activity.

Seismologist, Petroleum Exploration in Western United States, Denver, Colorado. Mr. Hillier worked with field exploration crews on mapping projects throughout the western United States at sedimentary basins in Texas, Oklahoma, Utah and Colorado. Field work performed in the over-thrust belt in Utah and Colorado was in mountainous terrain and employed helicopters to transport crews and seismic explosive charges into the exploration areas, while field work in Oklahoma and Texas employed truck mounted vibrator equipment to supply the necessary seismic impulses.

Publications


Presentations

Guest Lecture to University of Maine at Farmington, Geologic Stratigraphy Class, 1990 "The Engineering Properties of Soils and Glacial Geomorphology," Geology Department, U of Maine at Farmington.


Professional Activities

University of Southern Maine, Instructor in Environmental Regulation, 2003-2006
American Institute of Professional Geologists, Member, 1984-present
Maine Geological Survey Mapping Review Committee, Member, 1998-present
Geological Society of Maine, Vice President, 1992-1994
ASFE – Fundamentals of Professional Practice, 1994

Professional Development

40-hour OSHA Site Safety Training, Site Supervisor Training, 8 hr Refresher
RESUME

Christopher L. Snow, P.E.
Associate Principal

Summary of Experience
Mr. Snow is responsible for management and technical performance of projects in the geotechnical area. He has served as principal-in-charge, project manager, geotechnical engineer, or consultant reviewer for a large variety of constructed facilities including industrial, commercial and municipal buildings; dams; landfills; natural and engineered earth and rock slopes; tanks; pipelines; highways, railroads and bridges; waterfront structures; temporary and permanent retaining structures, and marine outfalls. Relevant project experience includes:

Relevant Project Experience

DAMS

Project Engineer, Design and Reconstruction of Zoned Earth Embankment, Dundee Dam. Performed finite element seepage analyses for design of, and assisted in monitoring the reconstruction of a 50-foot-high zoned earth dam with a concrete core wall. Performed slope stability analyses for an embankment where a new cast-in-place concrete wall was used to raise the embankment level to prevent overtopping.

Project Engineer, Construction Phase Seepage and Stability Analyses, West Grand Lake Dam. Evaluated stability and seepage conditions for construction of a cast-in-place concrete cutoff wall in an existing earth-filled, timber crib dam structure using flow nets, infinite slope analysis, and computer slope stability analyses.

Project Engineer, FERC Embankment Stability Evaluation, Stewart’s Bridge Dam. Evaluated slope stability of a 110-foot-high earth dam to determine if safety factors met the 1991 FERC guidelines. Computer-assisted stability analyses used the Modified Bishop’s Method to determine safety factors. Five principal conditions were evaluated: downstream slope under normal operating pond level, probable maximum flood water level, and earthquake (pseudo-static), and upstream slope for rapid drawdown and earthquake.

Project Engineer, Spillway and Gate Structure Evaluation, Messalonskee Lake Dam. Developed exploration program and performed rock anchor design to increase sliding resistance of masonry block and cast-in-place concrete dam founded on weathered bedrock.

Project Engineer, Evaluation of Piping Failure, Ashuelot Paper Co. Dam. Evaluated cause of piping failure of concrete-filled timber crib dam built on pervious foundation soils. Seepage and piping evaluations were based on flow net analyses and review of design calculations, construction documentation, and post-failure engineering reports.

HIGHWAYS AND HIGHWAY BRIDGES

Principal-In-Charge, Route 125 Bridge Replacement Durham-Lisbon, Maine. Responsible for subsurface investigations, geotechnical design, report preparation and bid phase support for replacement of an 800-foot long bridge over the Androscoggin River and relocation of the approach roadway. Geotechnical challenges included bridge foundations bearing on bedrock at the edges of a gorge below the Warubmo Dam, and one pier to be constructed within the waterway.

GZA GeoEnvironmental, Inc.
The approach roadway sits on a steep side slope with active slope failures downhill from the road. Stabilization alternatives including various retaining structures were evaluated with relocation of the roadway into the hill being the preferred alternative. Constructability challenges include difficult access and challenging, exposed bedrock conditions for support of a temporary access trestle, as well as bedrock excavation in and directly adjacent to a sensitive migratory fish water body. Aquatic impacts of blasting and hoe-ramming were evaluated in support of the project permitting process, and control measures will be incorporated in the project specifications to minimize adverse impacts to salmon.

**WATERFRONT AND RETAINING STRUCTURES**

**Project Engineer, Old Orchard Beach Outfall, Old Orchard, Maine.** Responsible for subsurface investigation, including marine geophysical survey and preparation of foundation design and construction report for pump station, 4,200-foot-long force main and 5,000-foot-long ocean outfall and diffuser.

**Project Manager, Mountain View Yacht Club, Gilford, New Hampshire.** Responsible for construction of new sedimentation basin for fresh water marina. Facility improvements include 1,000 linear feet of anchored steel sheet pile bulkhead and dredging and disposal of 6,000 cubic yards of sediment.

**Principal-In-Charge, Flying Point Road Design-Build Culvert Replacement, Freeport, Maine.** Responsible for subsurface investigations, geotechnical design, report preparation and construction quality control for replacement of a culvert carrying Kelsey Brook beneath a 25-foot high roadway embankment on the R.J. Grondin / Gorrill-Palmer design-build team. The project includes replacement of a deteriorated culvert with an aluminum plate sectional culvert system supported on spread footings with aluminum plate headwalls. The site was underlain by heterogeneous marine deposits (medium stiff to stiff clay and loose to medium dense sand). Geotechnical challenges included global stability of the new embankment and culvert foundations due to shallow groundwater and weak marine deposits. Prepared reports summarizing slope stability and foundation evaluations at 50 Percent, 90 Percent, and 100 Percent completion. The design phase was completed and construction was underway in September 2011.

**Project Manager, Doane's Wharf, Kennebunk, Maine.** Responsible for subsurface investigation, foundation evaluations for residential cottage and commercial shop buildings, design of approximately 250 feet of new anchored, sheet pile retaining wall, and construction observation for a marina and lodging facility.

**WIND**

**Beaver Ridge Wind Turbine, Freedom, Maine.** Provided complete geotechnical investigation and foundation design services for three new 262-foot high, 1.5 MW wind turbines on Beaver Ridge in Freedom, Maine. A program of test borings was used to investigate subsurface soil, bedrock and groundwater conditions at the three proposed foundations. The borings revealed up to 30 feet of dense glacial till overlying hard, slightly weathered metasiltstone. Subsurface investigation data were used to develop soil and rock properties for use in foundation design.

**Project Manager, Spruce Mountain and Saddleback Ridge Wind Turbine Projects, Western, Maine.** Managed subsurface investigation and geotechnical construction services for two multi-turbine projects on remote ridges in western Maine including test borings, resistivity testing, laboratory soil and rock testing, engineering evaluations, geotechnical design basis report, geologic a hazard analysis report, and quality control for installation of foundations and testing of rock anchors.

**Professional Activities**

National Council of Examiners for Engineering and Surveying – Vice Chairman Geotechnical Subcommittee of Civil PE Examination Preparation Committee
American Society of Civil Engineers
Geoinstitute of the American Society of Civil Engineers
American Railway Engineering and Maintenance-of-Way Association

**Professional Development**

At Least 30 Professional Development Hours of Continuing Education per Biennium
OSHA Hazardous Waste Operations 40 Hour Safety Course
Mr. Cox has extensive experience in many aspects of civil engineering including dam safety and design, water supply, transportation, and geotechnical construction. In addition, he is also well-versed in the permitting process which accompanies large civil works, having prepared permit applications required by the U.S. Army Corps of Engineers, EPA, NEPA, MEPA, and others. Mr. Cox has worked on numerous dams performing such tasks as inspection, deficiency evaluation, planning, hydraulic, structural, and geotechnical design, contract writing, contractor submittal review, and construction observation. He has also acted as a field engineer on geotechnical projects which included earthwork, pile driving, and membrane installation. Before joining GZA, Mr. Cox was with The Benham Group where, in addition to working on dam projects, he was involved in highway planning and design. Mr. Cox served overseas with the Peace Corps for over two years as a water supply engineer. His duties included water system design and repair, extensive interaction with governmental and donor agency officials, and field visits into remote regions of the Himalayas. In 2005-2006, Mr. Cox proposed and facilitated a research trip for MIT graduate students to study water quality issues in Lake Yojoa in Honduras. Relevant project experience includes:

**HYDROELECTRIC PROJECTS**

**Project Manager, Clock Tower Place Hydroelectric Project Feasibility Study, Maynard, MA.** A project to rehabilitate and upgrade a non-functioning hydroelectric generation facility at an historic mill site on the Assabet River. Mr. Cox managed the preparation of a pre-feasibility study and worked with the Owner to secure a feasibility study grant from the Massachusetts Technology Collaborative (MTC). Mr. Cox then managed GZA’s preparation of a full Feasibility Study, indicating that a cross-flow turbine installation could provide up to 300kW of power production at the site. The study was submitted to the MTC and used in the Owner’s winning application for a Design and Construction grant. GZA also prepared technical Exhibits for FERC filings.

**Project Manager, Clock Tower Place Hydroelectric Project Phase 1 Design, Maynard, MA.** Following the completion of the feasibility study and construction grant application by GZA, the Owner was awarded over $500,000 in grant funds to design and construct the proposed hydroelectric project. Mr. Cox is currently managing the preparation of Phase 1 Plans and Specifications for the project as well as the preparation of a FERC Preliminary Permit Application.

**Project Manager, Blenheim-Gilboa Pumped Storage Un-Watering Project Investigations, Massena, NY.** A project to assist the New York Power Authority in considering the implications of a proposed program to un-water the pumped storage generation facility for maintenance and repair. NYPAC’s proposal is to drain virtually all of the
Upper Reservoir and completely dewater a concrete-lined vertical shaft of more than 1,000 feet in depth, as well as a horizontal tunnel section and four steel-lined penstock tubes. GZA conducted analyses to investigate potential impacts of unbalanced head conditions on concrete and steel liners and suggested potential methodologies for monitoring and mitigation.

**Project Manager, Robert Moses Power Dam Pre-Grouting Investigations, Massena, NY.** A project to investigate seepage and uplift in the foundation of the Robert Moses Power Dam, a large hydropower facility owned by the New York Power Authority (NYPA) on the St. Lawrence River. The dam is one-half of an international hydropower generation project which spans the U.S./Canada border. GZA reviewed existing information and data provided by NYPA to develop an understanding of possible dam safety issues created by foundation seepage in a soluble foundation layer under the concrete dam structure. GZA developed and presented a program for further investigations prior to any grouting program. The investigation program involved the design and implementation of a foundation coring program from within the dam inspection gallery. Multi-level piezometer instruments and sampling ports were then installed in vertical and inclined holes. The program also included packer based flow measurements for the existing relief wells and an extensive water chemistry testing and analysis component.

**Project Manager, Crescent Street Dam Hydropower Pre-Feasibility & Feasibility Studies, Athol, MA** A project to rapidly assess the potential for hydroelectric power generation at an existing dam on the Millers River. Power and energy potential were preliminarily evaluated along with estimated costs and simple payback period. Results of the study were included in a grant application prepared by GZA and submitted to the Massachusetts Technology Collaborative. The grant application was approved, leading to a full feasibility study, including technical and economic analysis of a number of project alternatives. The feasibility study showed the project to be viable, with the installation of a single new turbine/generator, supplemented by the existing operational unit chosen as the preferred alternative. A second MTC grant for $500,000 was awarded for final design and construction.

**Project Manager, Byron Weston Mill Dams No. 1 & No. 2 Hydropower Pre-Feasibility & Feasibility Studies, Dalton, MA** A project to rapidly assess the potential for hydroelectric power generation at two existing dams on the Housatonic River. Power and energy potential were preliminarily evaluated along with estimated costs and simple payback period. Results of the study were included in a grant application prepared by GZA and submitted to the Massachusetts Technology Collaborative. The grant application was approved, leading to a full feasibility study, including technical and economic analysis of a number of project alternatives. The feasibility study showed the project to be viable, with the installation of a new turbine/generator at the Byron Weston Dam No. 2 selected as the preferred alternative. A second MTC grant for $500,000 was awarded for final design and construction.

**Project Manager, Dodgeville Pond Dam Hydroelectric Resource Evaluation, Attleboro, MA** A project to assess the potential for hydroelectric power generation at an existing mill dam on the Ten Mile River. Power and energy potential were preliminarily evaluated along with estimated costs and simple payback period. Results of the study were included in a grant application prepared by GZA and submitted to the Massachusetts Technology Collaborative. The grant application was approved, and a full feasibility study is now underway.

**Project Manager, Museum of Science Hydrokinetic Power Resource Assessment, Boston, MA** A project to assess the potential for renewable energy generation using hydrokinetic (flowing water) technology at the Museum of Science on the Charles River in Boston. Mr. Cox identified the potential for hydrokinetic power at the site during an inspection of the dam structure where the museum is located. Mr. Cox worked with the Museum to generate interest in the project and then design and complete a preliminary resource assessment designed to investigate available technologies and estimate the power production potential at the site. Flow velocity measurements made be GZA ultimately led to the conclusion that the project would not produce sufficient power to warrant a full feasibility study.
DAM SAFETY & DESIGN

Project Manager, Ponkapoag Pond Dam Rehabilitation, Canton, MA  Managed the total project cycle for the rehabilitation of the DCR-owned Ponkapoag Pond Dam, a low embankment dam impounding a large size pond inside an environmentally-sensitive preserve.  The total scope of work included Phase I Inspection, Emergency Action Plan preparation, Phase II Engineering and Alternatives Analysis, Final Design, and Permit Application Preparation  Project site presented a number of challenges due to location within an ACEC and presence of multiple endangered species in the pond and at the dam site.

Project Manager, Upper Mystic Lake Dam Rehabilitation, Arlington/Medford, MA  A project to design and permit the rehabilitation of the DCR-owned Upper Mystic Lake Dam.  Design must address inadequate spillway capacity, insufficient slope stability, and potentially liquefiable soil conditions.

Project Manager, Unionville Pond Dam Expedited Interim Repairs, Holden, MA  A project to inspect the dam and design interim repairs to correct storm-induced damage to the structure.  Deterioration to the CMP spillway conduits had led to a loss of material from the dam and the formation of a sinkhole in the road on top of the dam.  GZA designed an interim repair project to line the existing conduits with large HDPE pipes and grout in place.  Water and traffic control were key issues.  Project was successfully implemented on time and under budget.

Project Manager, Dam Safety Emergency Response, State-wide Massachusetts  In October 2005 and again in March 2006, heavy rains cause emergency situations at many dams throughout Massachusetts.  At the request of the Massachusetts Office of Dam Safety, Mr. Cox personally responded to the Upper Flint Pond Dam in Tyngsborough, MA to provide dam engineering advice to the incident commander during near-overtopping events.  During the March 2006 event, Mr. Cox recommended, designed, and oversaw construction of an emergency bypass channel to help prevent overtopping of the dam.  Following the October 2005 events, Mr. Cox managed GZA’s efforts to rapidly inspect more than two dozen poor or unsafe conditions dams as part of the overall emergency inspection effort ordered by the Governor.

Project Manager, DCR-Owned Dam Inspections, State-wide Massachusetts  A project to inspect 60 dams owned by the Commonwealth of Massachusetts throughout the State.  Project included a very aggressive timeline for the submission of the inspection checklists, which was met by GZA.  Mr. Cox managed a project team of more than a dozen GZA engineers who inspected multiple dams and produced Phase I Inspection Reports using the new format mandated by the Massachusetts Office of Dam Safety.

Project Manager, Follow-Up Inspections of Poor and Unsafe Dams, State-wide Massachusetts  A project to perform 6-month follow-up inspections on 26 dams throughout the Commonwealth which had previously been classified as in “Poor” or “Unsafe” condition.  Inspections evaluated changes in condition since the previous inspection.  Where warranted, GZA made recommendations for immediate action judged necessary to protect the public safety.  GZA prepared a matrix which prioritized actions at the listed dam.  The matrix was used by the MA Office of Dam Safety to issue Dam Safety Orders requiring corrective action at the dams.

Project Manager, Whitehall Reservoir Dam Rehabilitation, Hopkinton, MA  Phase II inspection and investigations, including borings and hydraulic studies, at the failed Whitehall Reservoir Dam, which is managed by the Massachusetts Dept. of Conservation and Recreation.  Developed conceptual alternatives for repair and presented to owner and various stakeholders.  After achieving consensus on preferred alternative, completed and submitted multiple permit applications and attended public meetings in support of the applications.  Completed final design plans and specifications for repairs and improvements to the dam and upstream cofferdam.  Managed re-design efforts to respond to request from community to preserve historic gatehouse structure.  Provided DCR with construction oversight services during project implementation and through project completion.
Project Manager, Buckley Dunton Lake Dam Rehabilitation, Becket, MA. Inspection and rehabilitation of a failing dam owned by the Commonwealth of Massachusetts. The Department of Conservation and Recreation engaged GZA to provide inspection, designs, permit applications, and construction assistance for the expedited reconstruction of this dam in October Mountain State Park. Developed an innovative approach to repair design which is estimated to have saved the owner more than $160,000. Designed repairs, prepared technical specifications, and managed the permit application process. Provided construction-phase services during project implementation and through project completion. Prepared and presented paper detailing project at ASDSO national Dam Safety Conference.

Project Manager, Eleven Poor / Unsafe Dam Inspections, Southeastern MA. Inspection and condition verification of eleven dam previously found to be in “poor” or “unsafe” condition. The MA Office of Dam Safety engaged GZA to inspect and prepare inspection reports for dams of special concern. Dams were inspected on a rapid schedule and inspection reports prepared as per Office of Dam Safety Format.

Project Manager, Ashokan Dam Valuation Study, Ashokan, NY. A project undertaken for the NYC DEP to establish the current value of the Ashokan Dam (including the Olive Bridge Dam gravity structure and all earthfill dikes surrounding the reservoir) and ancillary structures for purposes of tax valuation. Managed the quantity estimate and condition assessment portion of the work which involved making independent estimates of the material quantities in the structures and assessing the current condition of each structure.

Project Engineer, Water Supply Dams West of Hudson, New York City Water Supply System Safety of Dams Phase II-level inspection project for NYC Dept. of Environmental Protection. Included Olive Bridge Dam (Ashokan), Gilboa Dam, Merriman Dam, Neversink Dam, Downsville Dam, & Cannonsville Dam. Reservoirs supply 90% of NYC’s water supply. Part of inspection team for dams (all Large, High Hazard structures) and associated water control structures. Served as GZA representative during diving and ROV underwater inspections. Designed preliminary geotechnical boring and instrumentation plan. Developed laboratory testing program for concrete and rock samples. Performed stability analysis of gravity structures, including Gilboa Dam and Olive Bridge Dam, using methodologies prescribed by USBR, USACE, and FERC. Interacted with the City of New York engineers both at headquarters and in the field to compile first comprehensive literature review of project. Prepared significant portions of comprehensive inspection reports, including inspection summaries, structural analyses, construction histories, and recommendations. Prepared conceptual designs and cost estimates for rehabilitation of Gilboa Dam.

Project Engineer, Gilboa Dam Interim Spillway Repair Project, Gilboa, NY. A project to repair large erosion holes at the toe of the masonry overflow portion of Gilboa Dam. Designed interim repairs to Gilboa Dam Spillway Discharge Channel, including mass concrete filling of major erosion holes at toe of dam and reinforced concrete channel paving. Performed survey to assess extent of damage and provide basis for design. Applied for and secured expedited permits from NYDEC for execution of work. Prepared specifications and engineer’s cost estimate. Design work completed on accelerated schedule.

Project Manager, Willow Mill Dam, South Lee, MA. A project to inspect and investigate the state of a run-of-the-river masonry mill dam, develop conceptual alternatives for needed repairs, then design and implement the project. Designed exploration program and acted as field engineer during geotechnical exploration phase of the project. Served as field engineer and logged borings through dam from a floating barge in the impoundment and installed vibrating wire piezometers. Performed gravity stability analysis as per FERC requirements. Wrote significant portions of final inspection report and developed cost estimates for conceptual design alternatives. Developed and submitted to client, a multi-year plan for implementing rehabilitation program. Prepared designs, technical specifications, and contract documents for multi-year repair and improvement project. Submitted applications for and obtained permits needed for dam repairs. Designed Phase 1 program to repair river outlet structure; Phase 2 program to buttress abutment and auxiliary spillway; Phase 3 program to face buttresses with stone façade; Phase 4 program to drill and install passive tie-down anchors; and Phase 5
masonry repointing program. Recommended potential contractors to Owner and assisted Owner in evaluating bids for both Phases. Managed GZA’s construction observation program and prepared final report upon successful project conclusion.

**Project Manager, Lakya Dam, Kudremukh Iron Ore Mine, Karnataka, India.** A project to investigate geotechnical and water resources problems at the Lakya Tailings Dam which could potentially immediately impact production at one of the largest mines in South Asia. The Lakya Dam is a 300-foot high, earthfill embankment which impounds hydraulically-placed tailings and provides a reservoir for beneficiation process water. Mr. Cox lead a GZA team on a site reconnaissance visit to the dam and mine to meet with the Owner and collect existing and field data. Upon return from India, Mr. Cox authored report describing three primary dam-related short-term impediments to continued mine production and offering alternatives for addressing each issue.

**Project Manager, McAdams Dam, Barnard, VT.** A project to design and construct a new dam for a private landowner for the purpose of creating a lake for recreation and fire protection. Worked with Owner and Architect to develop a series of conceptual designs for dam. Utilized subsurface data from GZA drilling program to set location and alignment of dam. Designed masonry-face concrete spillway to pass typical flows. Design flood accommodated by spillway and stormwater by-pass pipeline. Spillway designed to mimic visual appearance of nearby old “mill dams.” Designed adjacent earthfill embankment with toe drain to serve as primary water retaining structure. Designed program to blast and excavate highly fractured bedrock in abutment and replace with impervious fill material to act as seepage blanket. Prepared construction plans and limited specifications. Managed GZA’s construction observation program which worked with contractor during construction phase. Prepared final report after completion of dam and successful filling of impoundment.

**Project Manager, Palmer Dam Value Engineering and Peer Review, Stonington, CT.** Aquarion Water Company of Connecticut engaged GZA to perform a value engineering study and peer review of design calculations, plans, specifications, and contract documents prepared by another engineer for the rehabilitation of Palmer Dam. Managed project and coordinated the work of other engineers in the review of stability calculations, hydrologic and hydraulic analysis, and review of pump designs. Reviewed plan set, specifications, and contract documents and made a number of recommendations for suggested changes to project design and contracting procedures.

**Project Manager, Arlington Reservoir Dam, Arlington, MA** A project to further investigate deficiencies at a municipal dam and develop conceptual solutions. Managed phase II investigations and conceptual design study on the Arlington Reservoir Dam and swimming area dike. Developed geotechnical investigation program. Analyzed seepage through and stability of embankment and dike. Developed conceptual designs for rehabilitation and wrote report presenting findings and options.

**Project Engineer, Great Pond and Upper Reservoir Dams, Braintree, MA.** A project to investigate the state of two earthen water supply dams and develop conceptual alternatives for needed repairs. Analyzed the two dams, which are in series, for their response to 100-yr and ½ PMF floods using HEC-1 model. Developed rating curves for spillways under various flashboards configurations. Performed Incremental Damage Assessment using DAMBRK software in order to evaluate size of the Spillway Design Flood. Made conceptual recommendations, including cost estimates, for various remedial alternatives. Developed portions of EAP. Wrote dam operations & maintenance guide to be used by operations personnel.

**Project Engineer, Risk Indexing for DEM-managed Dams in Massachusetts.** A project to development a new method and associated computer model for prioritizing remedial actions at existing small embankment dams. Assisted with the testing of the computer model. Developed a prioritization list for ten dams for use by DEM Office of Dam Safety in requesting funding allocation. Wrote report and also presented paper at ASDSO national convention.
Project Engineer, Rainbow Pond Dam, Walpole, MA. A project to study an earthfill dam and develop conceptual alternatives for repairs. Developed conceptual design for spillway improvement. Prepared quantity and cost estimates for various remedial alternatives.

Project Engineer, MDC Dam Inspections, Massachusetts. Participated in inspection of multiple Metropolitan District Commission dams in eastern Massachusetts.

Professional Activities
ASCE
US Society on Dams
Assoc of State Dam Safety Officials

Publications


RESUME

Education

B.S., 2007
Environmental Resources Engineering,
Humboldt State University

Professional Registrations

Engineer-in-Training (EIT)
California Certification #123067

Certifications

40-Hour OSHA Hazardous Waste Operations
First Aid/CPR

Professional Organizations

Member, American Society of Civil Engineers

Areas of Specialization

Stormwater Permitting and Evaluations
Stormwater Systems Analysis and Design
Hydraulic Engineering
Computer Modeling
Surface Water Hydrology
Geographic Information Systems (GIS)

Jennifer A Pisani
Assistant Project Manager

Summary of Experience

Ms. Pisani is an environmental resources engineer with consulting experience in environmental policy, compliance, and water resources engineering. Her project experience includes Geographic Information Systems (GIS), dam break analysis, drainage design and evaluation, and open channel modeling. She has AutoCAD, GIS, HEC-HMS, HEC-RAS and Visual Basic programming skills.

Relevant Project Experience

Staff Hydrologist, Evaluation of Repair vs. Removal Options for Hammershop Pond Dam, Town of Sharon, Sharon, Massachusetts. GZA was contracted to provide the Town with a planning-level engineering assessment of the repair versus removal alternative for the dam. Ms. Pisani evaluated potential dam modifications within a HEC-HMS model of the watershed and built a HEC-RAS model of the existing conditions for additional evaluations of the possible changes.

Staff Hydrologist, Inflow Design Flood-Dam Safety Engineering Consulting Services Bargaintown Mill Pond Dam, County of Atlantic Division of Engineering, Northfield, New Jersey. GZA conducted an Inflow Design Flood (IDF) analysis in support of a filing with the NJ Department of Environmental Protection Bureau of Dam Safety and Flood Control to evaluate the appropriate Spillway Design Storm of the dam. Ms. Pisani evaluated the dam conditions under the high tide scenario with and without a dam break using HEC-RAS.

Staff Hydrologist, O’Hara Brook Rehabilitation Feasibility, City of Worcester, Worcester, Massachusetts. GZA was contracted to perform a feasibility study to evaluate the potential causes of sediment issues in the O’Hara Brook at Lake Quinsigamond and to develop a short list of potential solutions. Ms. Pisani performed the H&H study of the brook and developed a HEC-RAS model of the O’Hara Brook to evaluate the sediment transportation within the brook channel.

Staff Hydrologist, Rehabilitation of the Grupes Reservoir Dam, First Taxing District Water Department, Norwalk, Connecticut. GZA was contracted to evaluate alternatives for safety improvements to Grupes Reservoir Dam, leading to the preparation of final design drawings, technical specifications, and related bid document for construction. Ms. Pisani performed the dam break simulations in HEC-RAS for developing inundation mapping and analysis for the dam’s Emergency Action Plan (EAP).

Staff Hydrologist, Flood Hazard Re-evaluation of Nuclear Power Plant, Confidential Client. GZA was contracted to perform engineering services in support of a flood hazard re-evaluation of six nuclear power plants. Ms. Pisani developed a HEC-RAS model of a 130-mile stretch of the Arkansas River in support the probably maximum flood analysis of a facility.

Project Engineer, Construction Project Environmental Compliance Program (CPEC) Development and Implementation, Maine Turnpike Authority (MTA), Gardiner to York, Maine. Worked cooperatively with MTA staff and Engineering Contractors in developing and implementing CPEC program to ensure stormwater regulatory compliance obligations and other environmental regulations are met during all construction projects.

GZA GeoEnvironmental, Inc.
Project Engineer, Long Creek Restoration Project, Maine Turnpike Authority (MTA), South Portland, Maine. Worked cooperatively with MTA staff, Maine Department of Environmental Protection (DEP), and Cumberland County Soil and Water Conservation District (CCSWCD) personnel in delineate regulatory drainage basins for regulatory compliance in watershed district. Generated necessary drainage maps for field study and approval from regulatory agencies in the assessment of BMP options to protect natural resources and manage stormwater runoff from MTA right-of-way within the Long Creek Watershed.

Experience Prior to GZA
Prior to her experience with GZA Ms. Pisani participated in a wide range of projects while working for another engineering consulting firm.

Lead Engineering Designer, SR 202 and NE 124th Street Intersection Improvements; Redmond, Washington. Provided the preliminary stormwater management sizing of stormwater detention and treatment required, modeling in WWHMv3. The project includes several LID design approaches including bio-retention cells and porous concrete walkways. Participated in the development of the stormwater management and stream restoration design alternatives. Coordinated the team efforts for stormwater management, stream mitigation, and wetland mitigation analysis for the project. The project was to design improvements to the intersection of SR 202 (Redmond-Woodinville Road) and NE 124th Street for the city of Redmond, WA. The project also included a major realignment of a Class II stream, along with fish passage and habitat improvements, and possibly a constructed wetland. Other work includes signals, walls, illumination, and public involvement.

Staff Hydrologist, I-90 – Snoqualmie Pass East-Hyak to Keechelus Dam; Yakima, Washington. Ms. Pisani reviewed hydrologic and drainage techniques successfully implemented by the State of Washington and other governmental agencies in similar mountainous and cold climate regions. She completed a site specific USGS regression analysis to predict peak flows for the six creeks crossing the I-90. She was also a part of the team that provided the off-site hydrologic and hydraulic analyses for the project. These tasks involved SBUH modeling (StormSHED) of the small off-site drainage basins, sizing of culverts (HY8), and WDFW stream simulation sizing of fish passage culverts crossing the I-90 project. In addition, Ms. Pisani was part of the team that designed the highway conveyance system for the 5-mile project using StormSHED and InRoads. This project involves major realignment and widening of five miles of I-90 to six lanes. The work involved solving the complex drainage issues around Keechelus Lake.

Engineering Designer, Paine Field, Master Drainage Plan; Snohomish County, Washington. Performed hydrologic and hydraulic modeling on the Paine Field airport property as part of their updated master drainage plan for existing and future proposed developments.

Engineering Designer, Broadway Road; Snohomish County, Washington. Performed field assessment of drainage conditions for alternative analysis of road erosion along Broadway Road. Developed and modeled alternative designs in HEC-RAS to propose an engineered design for repairs needed.

Engineering Designer, Arbor at Pleasant Valley; Pleasant Valley, Oregon. Ms. Pisani delineated surface runoff to size the required detention ponds for the surface water management plan. She was part of the team that performed the hydrologic and hydraulic stormwater modeling in MGSFlood and XPSWMM. She also provided ArcGIS support by creating several maps and figures. The Arbor at Pleasant Valley is a planned unit development project in Oregon. The project will convert an 18-hole golf course into an 858 unit development surrounded by a 9-hole course.
RESUME

Aimee Dubois Mountain, GISP
Assistant Project Manager

Summary of Experience
Ms. Mountain is extensively experienced in GIS and data management techniques, specifically for public applications involving asset management and environmental tracking. Prior to joining GZA, Ms. Mountain was the GIS Coordinator for two municipalities in the State of Maine and was previously an Asset Management Technician for Portland Water District in Maine. Her recent work involved coordinating and developing goals and objectives for the use of GIS within a municipal infrastructure setting as well as developing procedures, formulating strategies, and implementing solutions to meet the Town’s GIS and database interoperability goals. Other work included incorporating stormwater management requirements, such as infrastructure mapping and inventory into computer generated maps, reports, analyses, and data in a well-organized format and assisting others with the use of the information. Ms. Mountain was also responsible for training municipal staff and working with them to develop applications, standards, databases, formatting mechanisms, etc. for a broad spectrum of infrastructure and environmental applications.

She has served on the Maine GIS User Group (MEGUG) Board of Directors from 2007 to 2014 and the Maine Library of Geographic Information (Maine GeoLibrary) Board of Directors from 2008 to 2013. As a result of this involvement, Ms. Mountain has been recognized as a leader in the Maine GIS community, specifically in her areas of expertise, Municipal Applications of GIS and Asset Management.

Relevant Project Experience
Stormwater Compliance Assistance, Maine Turnpike Authority (MTA), Kittery to Augusta, Maine. For more than 10 years, GZA has provided comprehensive environmental regulatory compliance services to MTA, a quasi-state agency created by Maine Legislature in 1941. During this time, GZA became an integral part of MTA’s stormwater management team that oversees operations, policies and compliance for the eight (8) Maintenance Facilities, plus six (6) Service Plazas, more than fifteen (15) Toll Plazas and numerous infrastructure (roadway, bridges, culverts, etc.) along MTA’s more than 100 miles of right-of-way (ROW) from Kittery to Augusta, Maine. GZA also provides stormwater compliance assistance for construction projects undertaken by MTA each year. GZA was instrumental in assisting the Authority in developing their Construction Project Environmental Compliance (CPEC) Program that is used to evaluate and track environmental compliance for construction projects; the CPEC Program includes flowcharts and checklists for evaluating and documenting compliance with environmental and stormwater obligations.

As Assistant Project Manager, Ms. Mountain’s responsibilities include construction project contract review, development of post-construction Operations & Maintenance (O&M) Plans for construction projects, and annual reports for each of the three major stormwater regulatory programs for which MTA is subject. Additionally, Ms. Mountain’s responsibilities include GIS technical support for mapping stormwater infrastructure and maintaining a data management repository for tracking environmental and stormwater compliance.

Education
B.A., 2001, Math and Economics
University of Maine, Orono

Registrations
GIS Professional
(GISP #6510)

Professional Activities
Maine GIS User Group (MEGUG)
Chair 2010-2013
Vice Chair 2008-2010
Board Member 2007-2014

Maine GeoLibrary
Municipal Rep. 2010-2013
Public Rep 2008-2010
Board Member 2008-2013

Areas of Specialization
Geographic Information Systems (GIS)
Data Management
SharePoint Development
Municipal Projects
Environmental Services

Relevant Professional Development
2011, Municipal Applications of GIS
University of Maine at Machias

GZA GeoEnvironmental, Inc.
Oil & Gas Industry Phase I Site Investigation in Potter, Tioga, and Centre County, Pennsylvania. GZA was the primary consultant on a Phase I environmental site assessment project for a major oil & gas company acquiring numerous well pads and facilities in Potter, Tioga, and Centre County, Pennsylvania. The investigation began with a desktop review and GIS was used to map out well locations via latitude and longitude coordinates. After the desktop review, Palmerton Group staff collected site reconnaissance data in the field, site access, photos, more accurate coordinates of well locations, and other site-specific information. The data collected in the field was synthesized into an organized format, which was then linked to the GIS data. State records from the Pennsylvania Department of Environmental Protection (PADEP) and well records from the Pennsylvania Internet Record Imaging System (PAIRIS) were also categorized and linked to the GIS data.

Along with well records and site reconnaissance information, spatial data such as, contours, soil types and classifications, government boundaries, hydrography, and transportation layers were added to the GIS to allow the user to view and gain valuable insight regarding the environments on and around each site. Ms. Mountain then used the compiled GIS data to develop an online mapping application for the client that serves up several GIS layers, site reconnaissance data, and state records that are easily accessed by clicking features on the map. The web mapping application allows the client to view spatial information, site records, well records, site reconnaissance data, and other data in an interactive and organized fashion. All of the records and data can be accessed directly from the web application, which allows the user to interact with various GIS layers and site records simultaneously.

Thatcher Brook Watershed Management Plan, City of Biddeford, Biddeford, Maine. GZA was awarded a contract by the City of Biddeford to assist in developing a Watershed Management Plan (WMP) for Thatcher Brook, an approximate 5.6-mile stream segment draining a 7.1-square-mile watershed to the Saco River. In coordination with the City’s stakeholders and project partners, watershed-specific information and data (e.g., water quality, geomorphology, impervious cover, land use, etc.) is being collected and compiled to provide the City with a clear path for restoring Thatcher Brook, which is designated as impaired for aquatic life by the DEP and is subject to a TMDL for percent impervious coverage. GZA is helping the City to balance responsible and sustainable growth practices with environmental protection and restoration efforts through the development of a community-supported WMP. As Assistant Project Manager, Ms. Mountain’s responsibilities include GIS coordination and technical support, water quality data compilation, and SharePoint site development to create a centralized data management system that can be accessed by all project partners and provide project management efficiencies.

GIS Assistance and Recommendations, Long Creek Watershed Management District (LCWMD), Maine. The LCWMD sought assistance from a GIS Specialist with public/non-profit and environmental applications experience to aggregate available data and provide recommendations for further development of their GIS. The LCWMD had existing GIS data that had been developed over the years in the form of shapefiles and various geodatabases and contracted with GZA to compile this into a comprehensive GIS database along with metadata, and identify data gaps and/or opportunities for future data collection. As Assistant Project Manager, Ms. Mountain worked with the LCWMD to inventory existing GIS data, develop a comprehensive GIS database with metadata, develop GIS recommendations, and coordinate the collaboration between LCWMD and GZA.

GZA is now assisting the LCWMD with implementation of the recommendations developed in the previous scope of work. As Project Manager, Ms. Mountain will work with the LCWMD staff to draft GIS layer and attribute standards, develop standardized map templates, update their existing GIS data to reflect relevant current conditions, develop Quality Assurance and Quality Control (QA/QC) measures for future GIS updates, and provide training to LCWMD staff on the newly established GIS standards.

Total Maximum Daily Load (TMDL) Assistance, Pease Development Authority (PDA), Portsmouth, New Hampshire. GZA was contracted to develop a basemap identifying impervious cover (IC) on PDA property to facilitate preparation of the salt reduction plan that is required as part of the approved TMDL for chloride within the Hodgson Brook watershed. As Assistant Project manager, Ms. Mountain was responsible for overseeing the development of the GIS basemap, assigning salt application rates (as identified in the TMDL) to mapped features, and calculating the approximate yearly salt load for the entire PDA property.
GIS Assistance and Recommendations, Town of Gorham, Maine. The Town sought assistance from a GIS Specialist with public/non-profit and environmental applications experience to aggregate available data and provide recommendations for further development of the Town’s GIS. The Town had existing GIS data that had been developed over the years in the form of shapefiles and various geodatabases and contracted with GZA to compile this into a comprehensive GIS database along with metadata, and identify data gaps and/or opportunities for future data collection. As Project Manager, Ms. Mountain worked with the Town of Gorham to inventory existing GIS data, develop and document layer and attribute standards, develop the comprehensive GIS database with metadata, develop GIS recommendations, and coordinate the collaboration between the Town and GZA.

Natural Resource Impact Assessment, Town of Rochester, New Hampshire. GZA was contracted by Wright-Pierce to complete a natural resource & protected species impact as a result of raising water level behind a water supply dam. This included analysis of baseline data sets and figures that represent existing surface water, wetlands, wildlife habitat and pond habitat present in and around Round Pond and the functions and values of these resource areas. As Assistant Project Management, Ms. Mountain developed a topographic model based off bathymetric survey data, LiDAR contours, and water depths collected by GZA field staff. Using the TIN and guidance from project team, Ms. Mountain developed proposed scenario data sets and figures to represent the resulting changes in resources and habitat types.

Stormwater Compliance Assistance, Maine Department of Transportation (MaineDOT), Kittery to Milford, Maine. GZA assisted MaineDOT staff in completing tasks outlined in their SWMP under the MEPDES MS4 General Permit. As part of GZA’s Stormwater Assistance contract, Ms. Mountain worked cooperatively with MaineDOT staff in developing stormwater management mapping methods as part of the facility’s statewide MS4 General Permit. As Assistant Project Manager, Ms. Mountain’s responsibilities included GIS technical support for mapping stormwater infrastructure, including conveyances and structural Best Management Practices (BMPs), as well as a data management repository for tracking stormwater compliance for all MaineDOT construction projects planned, constructed and maintained throughout the State.

Additionally, Ms. Mountain’s responsibilities included coordination of the collection of field data (i.e., mapping stormwater infrastructure) and existing municipal GIS stormwater data for the 28 regulated towns within the Urbanized Area in Maine. She was responsible for the development of the field data collection process, oversight of field staff, and Quality Assurance / Quality Control (QA/QC) of the data collected to meet MS4 mapping requirements, as well as BMP inventory and assessments.

Data Management and Migration of a Web-based Document Repository, The Salvation Army, Eastern Territory, United States. GZA was contracted to implement an Underground Storage Tank Program for the Eastern Territory of The Salvation Army, which spans across eleven states. GZA’s work on this project included site inspections, compliance audits, and specification preparation for tank removal, upgrades or replacement of approximately 300 tanks. Ms. Mountain’s responsibilities included development of a SharePoint site used for data collection throughout the project for pre-site visit preparation, on-site inspections, and compliance audit information. Ms. Mountain also developed an automated reporting function in SharePoint that produced site inspection reports for each tank.

Simultaneously, Ms. Mountain was tasked with migration of an existing web-based data and document repository with over thirteen years of documents for over 1200 properties to a new and improved SharePoint site. The new site includes features such as an interactive map which can be used to explore and discover property information as well as improved search functionality that allows the data to be searched by one of five available criteria: Property ID, Division, Address, City, or State.
RESUME

Bradley W. Tirone
Assistant Project Manager/Geologist

Summary of Experience
Mr. Tirone has over 20 years of multidisciplinary experience in the environmental-hydrogeologic field. Mr. Tirone has extensive on-site project management experience including site investigations, hydrogeologic investigations, road alignment environmental investigations, landfill monitoring, and environmental compliance and permitting work. His knowledge of groundwater - surface water-vegetation relationships greatly contributes to the GZA team. His interdisciplinary background in forestry and hydrology provide insight into relationships of land and water resources. Mr. Tirone’s relevant project experience includes:

Relevant Project Experience
Geologist/Site Remediation Project Manager, MaineDOT Project – Main Street (Route 201) Farmingdale, Maine. During the 2011 construction season Mr. Tirone managed MaineDOT construction contractor remedial activities in within four zones of the project corridor that had previously been identified as being contaminated with petroleum products. Mr. Tirone directed contaminated soil handling, reuse, temporary stockpiling, transportation, storage and disposal and, contaminated water handling, storage, treatment and disposal. Mr. Tirone was responsible for classification of contaminated soil/water and managing this waste in a manner that protected worker health and safety, public welfare and the environment. On behalf of his client, he maintained communications with MEDEP personnel in regard to site details – contamination volumes and disposal, contaminant locations, project schedule, confirmatory sample collection, and reporting. Mr. Tirone was able to carry out his site responsibilities for the MaineDOT and MEDEP, while helping to ensure that the construction contractor was able to maintain their schedule.

Geologist/Site Project Manager, Hydrogeologic Investigation & Water Resource Development – Helen Thompson School – M.S.A.D. #11, West Gardiner, Maine. Mr. Tirone was part of a two-person team that applied specific geophysical methods to investigate and identify both a near surface contaminant plume and bedrock fractures that had been impacted by a local salt storage facility, and consequently had impacted the school well (Public Water Supply). Using geological survey techniques, Mr. Tirone’s team successfully identified on the school property the location, depth, and rock type of a significant water-bearing target zone geologically isolated from the bedrock fractures impacted with high concentrations of chloride. GZA managed the drilling of a new water supply well and a 48-hour pumping test, which proved the well to yield 10-gallons per minute. GZA managed the licensing of the well for our client through the Maine Drinking Water Program.

Geologist/Site Project Manager, Fuller’s Market Hydrogeologic Investigation and Remediation, West Gardiner, Maine. The scope of work performed under contract to the MEDEP for this project consisted of several tasks and included performing a hydrogeologic characterization at this combination retail gasoline/diesel grocery store after it was determined that soils and groundwater had been impacted by a significant leak in a tank dispenser and other spills, and that one drinking water well in the immediate vicinity had been impacted with low concentrations of MTBE. The purpose of the field investigation was to characterize the aerial extent of petroleum contamination through interpretation of geologic, hydrogeologic, monitoring well data, and soil and groundwater chemistry derived from the site. Based on characterization data, recommendations were made to the MEDEP in regard to existing and potential impacts, and remediation efforts. Additional project tasks included identification of strategic locations of six soil and bedrock aquifer monitoring wells and management and scheduling of the drilling contractor, characterizing subsurface materials during drilling, and managing the construction, installation, and development details of each monitoring well. Further site assessment

Education
A.S., 1986, Pre-Professional Forestry, Paul Smith College
B.S., 1988, Resource Management/Forestry, S.U.N.Y. College of Environmental Science & Forestry

Professional Registrations
Class II Water Supply Systems Operator, Maine, 2153
1999, Certified U.S. Army Corps of Engineers Wetland Delineator

Areas of Specialization
Geology
Hydrology
Forestry
Water Resources
Groundwater
Surface Water
Vegetation

GZA GeoEnvironmental, Inc.
involved determination of the direction and gradient of groundwater and contaminant flow using monitoring well elevation data, in addition to estimating the mobility of contaminants through the existing subsurface materials based on soil characteristics. We subsequently managed remedial operations at the site for the MEDEP.

**Hydrogeologist/Assistant Project Manager, Butler, Maxcy, & Heath, Inc. Soil Removal / Remediation Project, Union, Maine.** Butler, Maxcy, & Heath, Inc. (BMH) is a wholesale distributor of #2 fuel oil, kerosene (K1), and propane in Union, Maine. Up until the time of remediation, the BMH facility consisted of three, 10,000-gallon aboveground storage tanks (ASTs) licensed to store 30,000-gallons of fuel. After contaminated soils were encountered by Mr. Tirone in August 2010 during preliminary design for secondary containment, a joint hydrogeologic investigation was conducted by GZA and the MEDEP to characterize site hydrologic conditions. Our assessment identified and characterized fuel oil as the primary source of contamination, and estimated a soil remediation volume of 1,400 cubic yards. GZA managed remediation contractor and field records. A total of 1,476 cubic yards of contaminated soil was hauled from the site for treatment/recycling.

**Professional Activities**
American Water Works Association (AWWA)
New England Water Works Association (NEWWA)
Environmental and Engineering Geophysical Society (EEGS)

**Professional Development**
40 hr OSHA Site Safety Training, 8 hr Refresher – Current

**Publications**


**Presentations**
MAINTAINING the 75 thousand dams and impoundments that control water quality and supply for communities across the nation requires in-depth knowledge of the environmental and socioeconomic factors impacting these aging structures. The effective application of civil, geotechnical, structural and mechanical engineering solutions results in enhanced storage and supply systems. By building multifaceted engineering capabilities, GZA has been able to provide comprehensive water resource services to meet the current and future needs of our clients in the public and private sectors.

GZA's experience includes earth, rock, stone-masonry, timber and concrete dams. By applying proven methods and new technologies, we combine innovative approaches with practical engineering solutions to upgrade the infrastructure of water supplies. As a result, private and public suppliers can address water system needs cost-effectively while providing for public health and safety. With every system having a unique history and various demands, GZA's range of services are tailored to meet the specific needs of our clients. From designing new water supply systems to repairing or removing dams and hydraulic-control structures, our scope of services include every aspect involving the management and preservation of watersheds and water resources.

Understanding our clients' immediate and long-term objectives results in comprehensive solutions designed to meet current and future demands on water resources.
GZA has a proven record of success in complying with guidelines of the Federal Energy Regulatory Commission (FERC), and has FERC-qualified dam safety consultants.

CIVIL & GEOTECHNICAL ENGINEERING

GZA's engineers and hydrologists provide an impressive mix of capabilities applicable to the range of water resource projects. We offer the necessary civil, geotechnical and structural experience to design, construct and repair water supply systems and infrastructures.

Our environmental engineers contribute to these projects by assessing the potential impacts of meteorological events, construction techniques, and impending supply and storage demands. Clients benefit from our combined expertise that provides a scope of services related to permitting of dam safety and system-wide improvements.

HYDROLOGY & HYDRAULIC ENGINEERING

Public awareness of potential dam hazards has increased due to major dam failures over the past three decades. While dam systems are constructed to preserve and control reservoir resources, the power of these massive bodies of water can destroy life and property during extreme weather events. Understanding the potential impacts of dam failure and assessing the capacities of reservoir inlet and outlet structures can assist communities in planning for adverse conditions.

GZA has prepared emergency action plans (EAPs) and other emergency procedures for major water suppliers by providing dam breach simulation, floodwave routing, and emergency notification and action planning. Our hydraulic engineers and hydrologists use current computer simulation software, such as DAMBRK and digital mapping technology, to produce defined, practical inundation maps which show estimated flood impacts under hypothetical dam breach scenarios.

The ability to handle flood flows is a critical component of dam safety. Common deficiencies include inadequate spillway and outlet capacities. Advances in hydraulic assessment techniques enable our engineers to estimate watershed response to extreme meteorological events and to evaluate the hydraulic efficiency of existing dams. Through computer modeling, our staff can determine the hydraulic capacity of a dam's outlet systems, assess the potential for overtopping, and simulate dam breaches to estimate floodwave routing.
ENVIRONMENTAL CONSULTING & PERMITTING

On behalf of our clients, GZA's engineers and scientists routinely work with local, state and federal regulators to obtain permits associated with the preservation of wetlands and other water resources. These processes range from routine permitting assignments to complex submittals, such as those required for dam removal when impacts on wetlands, fisheries, and other natural and historic resources must be considered by local, state and federal authorities.

CONSTRUCTION SERVICES

Our staff uses civil engineering knowledge and construction management skills to complete dam construction, repair, rehabilitation and removal projects. GZA's staff can oversee the entire project, including all contractor obligations and contract administration, or can simply oversee project work to ensure compliance with design plans and specifications. In any scenario, GZA offers the full-service capabilities to handle each aspect of dam safety and construction projects.

Included in our construction management expertise are the in-house skills needed to solve seepage and stability problems by using a variety of techniques, such as grouting, pressure-relief wells and tie-down anchors.
- Dam Inspection
- Prioritization of Dam Safety Actions
- Inundation Analysis
- Sediment Quality Analysis & Management
- Emergency Action Planning
- Dam Removal & Repair
- Engineering Design
- Remedial Construction
- Specialty Foundation Design/Build
- Construction Management
- Instrumentation & Monitoring
- Environmental Permitting
- Automated Instrumentation System Implementation
- Operational & Maintenance Plans
- Bathymetric & Underwater Surveys
- Risk Indexing

In addition to completing more than a thousand dam inspections, including over 200 Phase I safety inspections for the U.S. Army Corps of Engineers, GZA provides emergency action planning, rehabilitation design, and water resource management services. From private suppliers to municipal clients, our capabilities address the growing demands on small and large water supply systems.
Inspection and Engineering Evaluations of 8 Large, High-Hazard Gravity and Embankment Dams
RAYMOND, NEW HAMPSHIRE

GZA completed surficial inspections, geotechnical and structural analyses, reports for 8 large, high-hazard gravity and embankment dams owned and operated by the Aquarion Company of Connecticut.

The dams vary in height from 50 feet to 130 feet and were constructed between 1905 and 1941 for water supply storage or distribution purposes. GZA completed visual inspections of the embankments and concrete gravity structures, along with underwater surveys of the upstream faces of the concrete gravity dams and gatehouses.

GZA’s inspections lead to development of recommended maintenance measures and repairs, further geotechnical, structural and hydraulic analyses to address various issues, recommendations for instrumentation improvements, monitoring measures and emergency action planning.

This project demonstrates GZA's depth of geotechnical and civil engineering experience in inspection and evaluation of large earth embankments and gravity dams.
Wachusett Reservoir Dam Spillway & North Dike Improvements
Clinton, Massachusetts

Wachusett Dam is a critical element in the metropolitan Boston water supply. The stone masonry dam and two earthen dikes were designed in the 1890s and constructed at the turn of the century. The stone masonry gravity structure is about 140 feet high and has a crest length of 850 feet. Normal pool storage capacity is approximately 65 billion gallons. Changes in design standards for the spillway test flood and seismic issues for the dam and dikes resulted in a study to recommend improvements.

Working under contract with the Massachusetts Water Resources Authority (MWRA), GZA has completed design improvements to the spillway and discharge channel to safely handle the Probable Maximum Flood (PMF). The spillway capacity was inadequate for the increased inflow generated by an HMR52-based PMF. The existence of an old granite arch bridge crossing the spillway channel creates a hydraulic restriction leading to backwater and weir submergence effects at the extreme flood discharges generate by the updated PMF. These spillway discharge channel restrictions would submerge the spillway weir and reduce discharge capacity by up to 25 percent. The original spillway design never considered (or could have imagined) flows in the magnitude of the current PMF. The topography and geology of the low point along the reservoir rim, where the overtopping would occur, would not lead to catastrophic failure of the dam; however, improvements were necessary to satisfy dam safety criteria and to improve operational flexibility and worker safety. Also, the MWRA desired to eliminate the original manual installation of stop planks and replace it with a more up-to-date means of controlling the reservoir level.

Various combinations of spillway discharge channel improvements, crest modifications, and reservoir rim-raising were evaluated by GZA engineers. Aesthetic constraints to maintain the character and historic significance of the original structures were also factored into the design process. The approved design involves a 2 foot lowering of the existing granite masonry spillway lower bay crest and installation of a 100 foot long by 5 foot high bottom-hinged, stainless steel crest gate. Mechanical and electrical controls for the gate are housed in the Bastion structure on the dam’s left abutment.

To provide supplemental discharge capacity under the PMF and prevent weir submergence, an excavated bedrock auxiliary channel was constructed along the left overbank section of the discharge channel.

After concluding that a slippage failure would occur along a portion of the reservoir’s North Dike under design earthquake conditions, GZA designed embankment improvements to widen the dike crest by 70 feet over a longitudinal distance of 750 feet. This addition to the North Dike provides residual crest freeboard in the event of a seismic slope failure.

The spillway and dike improvements for this $5 million construction project were successfully completed in the Summer of 2008.
Warners Pond Dam Design Improvements  
Concord, Massachusetts

GZA was retained by the Concord Public Works in 2006, to provide dam safety assessment and produce bidding documents dealing with the engineering design repairs/improvements to the Warners Pond Dam. The dam is located at the union of the Nashoba Brook and Fort Pond Brook, at the south end of the pond. Warner’s Pond lies within a 47 square mile drainage area. The dam, which impounds a 57 acre recreational lake, is approximately 300 feet long and 9 feet high (maximum) and was constructed with earth embankments, a stone masonry spillway, and a concrete auxiliary spillway. This Significant Hazard dam was in dire need of repair as it was considered to be in poor condition due to a collapsed masonry spillway training wall exposing the earth embankment to spillway flows, and due to extremely heavy brush and tree growth on the embankments.

The results of GZA’s hydrologic analysis indicated that the entire dam would be overtopped by about 0.3 feet under the 100-year spillway design flood. Overtopping the dam in its original condition would likely lead to rapid erosion of the earth embankments and ultimately result in an uncontrolled breaching of the dam. Observations by GZA indicated that some past overtopping had likely occurred. Significantly expanding the spillway, lowering the normal pool, or raising the dam were not viable alternatives due to the configuration of the dam and recreational use of the pond. Thus, GZA successfully developed a design using reinforced turf matting to safely allow the dam embankment to overtop during severe storms including the 100-year flood. The implementation of overtopping protection, in lieu of raising the dam and/or increasing spillway capacity, was a cost effective solution for the dam given the site conditions and the dam’s configuration, hydraulic characteristics, and hazard classification.

To improve slope stability and seepage issues, the existing embankments were flattened by removing existing vegetation and surficial organic material, and filling with properly placed and compacted materials to achieve a 2 horizontal to 1 vertical (2H:1V) rip rap, upstream slope and a 2.5H:1V grassed downstream slope. A 10-foot wide embankment crest was also provided to further stabilize the embankment and to provide adequate access for CPW equipment to perform maintenance and to adjust the new concrete sluiceway stop-logs, which were part of GZA’s design. Provide access or emergency or future repairs The topography and geology of the low point along the reservoir rim, where the overtopping would occur, would not lead to catastrophic failure of the dam; however, improvements were necessary to satisfy dam safety criteria and to improve operational flexibility and worker safety. Also, the MWRA desired to eliminate the original manual installation of stop planks and replace it with a more up-to-date means of controlling the reservoir level.

GZA led the public hearings with local stakeholders during the design phase, and successfully assisted CPW in securing the necessary environmental permits for the project. During construction in 2008, GZA was retained by CPW in a limited consultant capacity, when unanticipated subsurface conditions required some limited changes to configuration and materials of the upstream slope of the left embankment.
Lake Ladore Dam

PROJECT DESCRIPTION

The Salvation Army (Owner) contracted with GZA GeoEnvironmental, Inc. (GZA) to perform investigations to document current deficiencies at Lake Ladore Dam. Our investigative services lead to the preparation of design plans, specifications, contract bid documents and related permits for the complete rehabilitation and repair of the Dam. GZA recently completed assisting the Salvation Army with the construction phase of this 2 million dollar rehabilitation project.

In accordance with Pennsylvania DEP Office of Dam Safety regulations, the Lake Ladore Dam is Classified as a “B-1”, Intermediate size and High hazard structure. The dam is a 330-foot long, 28-foot high hybrid structure made from connecting an original earth and dry masonry structure to a concrete gravity structure constructed approximately 50 downstream, and ultimately filling the area between the two structures with soil. The original dam was constructed in 1860 and the concrete gravity dam was built in 1907. The fill between the two dams was placed in the mid-1920s.

GZA’s investigatory and design work included:

- Hydraulic and Hydrologic evaluations and spillway capacity analysis.
- Gravity stability analyses including cracked base analysis.
- Grouting methodology through concrete and bedrock to mitigate seepage.
- Tie-down anchor design and new-structural concrete facing design.
- Repair methodologies for deteriorated concrete within the spillway.
- Design and repair of the Low-level outlet pipe and gates.
- Articulated block overtopping erosion control protection during extreme rain events.

GZA’s approach implemented a cost effective combination of mass concrete and tie-down anchors to both repair deteriorated concrete and improve stability to acceptable factors of safety. Permeation grouting was performed in the existing concrete to repair cracks and fissures, as well as in the underlying bedrock to effectively mitigate seepage. Articulated block overtopping protection was installed within an approximately 6,000-square-foot area upstream and west of the left end of the gravity dam.

GZA provided Engineer-of-Record and fulltime Resident Engineering Services throughout the 12 months of construction which had to be staggered over a two-year period in order to accommodate the Salvation Army’s summer camp activities.

Successful implementation of the design has resulted in a fully functioning dam meeting all Office of Dam Safety requirements allowing the dam to be considered as capable of operating in **GOOD** standing for many decades to come.

GZA’s investigatory and design work included:

- Increase factors of safety against overturning and sliding for gravity dam via.
- Mitigate seepage through and under the gravity dam through permeation grouting program.
- Repair and improve deteriorated concrete at downstream face of gravity dam and spillway.
- Rehabilitate and/or replace existing 14-inch diameter low-level outlet pipe and gates.
- Provided suite of dam engineering services, including technical analyses, design of repairs, preparation of drawings and specifications, and on-site resident engineering assistance throughout construction implementation.

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**Project Highlights**

- Increase factors of safety against overturning and sliding for gravity dam via.
- Mitigate seepage through and under the gravity dam through permeation grouting program.
- Repair and improve deteriorated concrete at downstream face of gravity dam and spillway.
- Rehabilitate and/or replace existing 14-inch diameter low-level outlet pipe and gates.
- Provided suite of dam engineering services, including technical analyses, design of repairs, preparation of drawings and specifications, and on-site resident engineering assistance throughout construction implementation.
Featherbed Dam Evaluation and Conceptual Repairs Investigation  
NORTH KINGSTOWN, RHODE ISLAND

The Town of North Kingstown engaged GZA GeoEnvironmental to perform a visual inspection, a hydraulic and hydrologic evaluation, and an engineering evaluation of remedial alternatives for the Featherbed Dam. The crest of the dam forms Featherbed Lane and is currently closed to traffic due to overtopping damage that occurred in March 2010.

GZA performed a visual inspection of the dam and identified dam safety deficiencies. GZA performed a hydraulic and hydrologic evaluation and found that the dam has insufficient capacity under the 100-year flood. GZA identified the following primary alternatives for addressing dam safety issues:

- Controlled Overtopping
- Enlarging and Lowering Spillway
- Partial Breach

GZA looked at each of these alternatives with and without the option of restoring vehicle access to Featherbed Lane. GZA estimated the cost of performing repairs to range between $430,000 and $680,000. The alternative of controlled overtopping, in conjunction with restoration of vehicle access was found most practicable.
EPA New England and New England Water Works Association hereby present

Hillier & Associates Inc.

of Augusta Maine, with

Water Supplier Business Honors

as a member of the EPA-NEWWA Drinking Water Protection Business Program,
for their innovative and cooperative efforts to protect Maranacook Lake, Augusta Maine

Ira Leighton, Acting Administrator, 
EPA New England

Ramond Raposa, President, 
New England Water Works Association