

# **Gunners Brook: Phase I Flood Mitigation Study (Final)**

**Prepared for:**

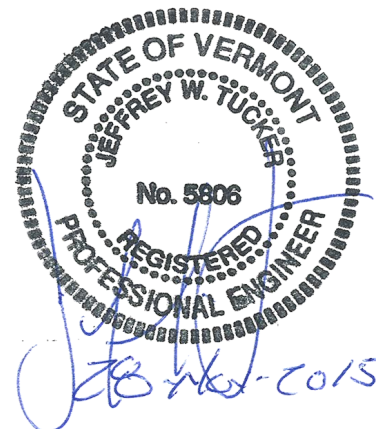
**The City of Barre, VT**

**Prepared by:**

**DuBois & King, Inc.  
28 North Main St.  
Randolph, VT 05060**



**November 28, 2015**



## Table of Contents

<b>Executive Summary .....</b>	<b>2</b>
<b>1.0 INTRODUCTION .....</b>	<b>1</b>
1.1 Project Overview and Location .....	1
1.2 Objective .....	1
1.3 Scope of Work.....	2
1.4 Project Coordination.....	2
1.5 Site Walkover & In-Stream Review .....	3
1.6 Prior Reports.....	4
<b>2.0 MITIGATION MEASURES EVALUATED .....</b>	<b>4</b>
2.1 Large Woody Debris Rack .....	4
2.2 Woody Debris & Streambed Management Plan.....	5
2.3 Harrington Avenue Floodplain Management Plan .....	5
.....	5
<b>3.0 OPINION OF PROBABLE COSTS .....</b>	<b>8</b>
<b>4.0 NEXT STEPS .....</b>	<b>8</b>
<b>5.0 LIMITATION OF REPORT .....</b>	<b>9</b>

### ATTACHMENTS

- PHOTOGRAPHS
- LOCATION MAP
- LARGE WOODY DEBRIS RACK (LePage Site)
- HARRINGTON AVENUE FLOODPLAIN MANAGEMENT PLAN
- ITEMIZED OPINION OF PROBABLE COSTS

## EXECUTIVE SUMMARY

The purpose of this Phase I Flood Mitigation Study is to identify and evaluate specific proactive and mitigative measures aimed at reducing the potential and frequency for flooding as a result of woody debris jamming in Gunners Brook in the vicinity of Brook Street / Harrington Avenue in the City of Barre and the reduction of associated frequency of flood damages. The following is a summary of this study.

- The City presented a draft of this report at a public informational meeting on October 29, 2015 at Alumni Hall. Approximately 25 people were in attendance, including neighborhood residents, property owners and other City officials. Mayor Lauzon, City Manager Mackenzie and DuBois & King, Inc. Project Manager Jeffrey Tucker presented an overview of the findings and recommendations of this report. All in attendance stated they had a copy of the report.
- There was an informative question and answer session following the presentation. Questions regarding specifics such as work at Harrington Avenue, removal of the bridge, primary and secondary debris racks, and management of the restored floodplain and debris catchment area, etc. Mayor Lauzon discussed options for funding the planned stormwater maintenance program, next steps and approximate schedule of implementation. The general sentiment of the attendees was that the proposed plan provides a responsive approach to mitigation of the flooding in this neighborhood. It was observed that the City had made substantial proactive planning progress in a short period of time since the July flood. Those in attendance endorsed the plan as proposed by the City.
- The City recognizes the short and long-term objective of reducing flooding and flood-related damages along the developed reaches of Gunners Brook will be largely achieved primarily through the restoration of the urban floodplain to the extent possible, which requires the buyout and removal of vulnerable buildings, encroachment fill (back yards) and walls that have been placed over the past century and beyond. This process will take multiple years, likely decades, because of the required large financial expenditures to accomplish this objective.
- The purpose of this study is to initiate the short-term objective by identifying and advancing specific measures that can be implemented over the next 24 months that is expected to reduce the potential for flooding and flood damages within the extended Harrington Avenue neighborhood due to the jamming of woody debris.
- Several in-depth in-stream assessment and planning inspections were conducted in August and September 2015. Team members included officials from the City of Barre, Vermont Agency of Natural Resource River Management, Central Vermont Regional Planning Commission and river engineers and scientists from DuBois & King and Bear Creek Environmental.
- Several sites for the location of trash racks to retain large woody debris (and reduce the potential for this debris to enter into the urban sections of Gunners Brook) were identified and discussed. The first site is adjacent to the LePage Gravel Pit off Farwell St. The second site is located at the Harrington Avenue area.

- This study identifies three (3) of the higher priority structures to be removed and the associated floodplain to be restored at Harrington Avenue and Reid St.
- A woody debris and streambed management plan was discussed with VANR River Management officials. There is consensus and support for the mitigative measures identified and the City expects approval to implement the measures following the development of a formal management plan and the process of review and coordination to refine design details and procedures.
- The City should use the recently completed Vermont Economic Resiliency Initiative (VERI) study as a long-term flood mitigation master plan for Barre's North End flood zone. Specific mitigative measures to be implemented as part of Phase I follow. The City recognizes the necessity of property owner support and plans to coordinate with property owners early in the next steps of this project.
  - Large Woody Debris Rack (adjacent to LePage gravel pit)
  - Woody Debris & Streambed Management Plan
  - Harrington Avenue Floodplain Management Plan
    - ✓ Targeted property & building acquisition & removal
    - ✓ Floodplain restoration and debris catchment area
    - ✓ Harrington Ave. bridge deck removal
    - ✓ New (Secondary) large woody debris rack
    - ✓ Improved channel geometry / dimensions
- The conceptual project cost estimate to implement this first phase is approximately \$1,006,000. Contingent upon funding availability, the measures are expected to be designed, permitted and implemented within the following 24 months.
- The implementation of the above-identified measures will not reduce rainfall precipitation or the associated volume or flood discharges from the watershed. Properties that are currently subject to flooding will remain subject to flooding. However, the project will reduce repetitive flood events caused by debris accumulation at "choke-points."
- The above-identified measures are intended to:
  - Remove several buildings from the floodplain, thus reducing repetitive structure damages,
  - Establish procedures and regulatory authorization for the City to collect and remove woody debris from the brook and banks in a proactive manner to reduce the volume of this debris from entering the developed reaches of Gunners brook,
  - Provide a trash rack, channel improvements and catchment area to reduce the potential for large woody debris to collect and jam, thus reducing the potential for and frequency of woody debris-induced flooding,
  - Provide a catchment area for the large woody debris to collect, be stored and subsequently accessed and removed by the City.

## **1.0 INTRODUCTION:**

### **1.1 Project Overview and Location**

Gunners Brook is a tributary to the Stevens Branch of the Winooski River. It has a drainage area of approximately 8.1 square miles at its confluence. The headwaters of the brook originate in the highlands of Barre Town and Plainfield with steep terrain. The main stem of the brook flows generally southwest and parallel to Vermont Route 14 as it crosses into the City of Barre near the Hope Cemetery area. A location map is attached to this report.

The watershed's land use is predominately rural and forested until the brook reaches the area just upstream of the upper Brook Street Bridge. From there until its confluence with the Stevens branch, the land use is predominately urban with a much flatter slope.

The forested nature of the watershed provides a seemingly unlimited source of woody debris (trees, brush, logs, branches, etc) that during times of flood events is transported into the brook and over time to points downstream. Some of this woody debris is trapped and stored along the floodplain of the brook and at various road crossings, as evidenced by periodic plugging of culverts and associated of overtopping of roads and adjacent flooding.

Extreme and intense rainstorms within the watershed have the potential to result in flash flooding and associated aggregation of woody debris. This debris has, and will likely again, collect and jam within the narrow confines of the brook within the urban floodplain downstream of the upper Brook Street Bridge unless proactive mitigation measures are taken.

This scenario occurred in May 2011 and most recently during the evening of July 19, 2015, when intense rainfall fell over the watershed. Flash flooding occurred along the lower sections of Gunners Brook and large woody debris jammed at the Harrington Avenue bridge. The channel was largely blocked with debris, sending floodwaters into the adjacent floodplain, causing significant flood damage to a number of homes and associated infrastructure in the Harrington Avenue, Brook Street and Maple Street neighborhoods.

### **1.2 Objective:**

The objective of this study is to identify and evaluate measures to reduce the risk of woody debris associated flooding within the Gunners Brook reach generally extending from the upper Brook Street Bridge (at the intersection with Maple Avenue) to its confluence with the Stevens Branch, with a focus on the Harrington Avenue area. Multiple flood mitigation strategies are proposed in the vicinity of Harrington Avenue in an effort to reduce the risk of flood damage and to improve public safety. A phased, but timely approach to implementing these measures is recommended to allow time to secure necessary funding.

### **1.3 Scope of Work**

In general, the scope of work associated with this investigation includes a review of relevant available information, fieldwork, hydraulic modeling, engineering and stream channel and floodplain design, and coordination with local and state officials. The project is a continuation of groundwork initiated by the Vermont Economic Resiliency Initiative<sup>1</sup>, and is meant to further develop flood mitigation strategies and projects along Gunners Brook for implementation in the short and long term.

### **1.4 Project Coordination**

Coordination has generally occurred between City officials, State officials at the Vermont Agency of Natural Resources (River Management), Department of Housing and Community Development and the Vermont Emergency Management Agency and the technical teams of DuBois & King, Inc. (D&K) and Bear Creek Environmental (BCE).

The City has coordinated with VANR River Management officials as part of this project development. This has included a detailed site walk along the brook from the LePage gravel pit to the lower Brook Street Bridge with Shayne Jaquith (VANR River Management) and subsequent discussions and written documentation of the project specifics with Shayne and Patrick Ross, P.E., (VANR River Management). VANR has regulatory authority over any activity within Gunners Brook and written approval from VANR will be required prior to implementation.

We also discussed the concept of an annual debris/sediment removal program within the urban reach of Gunners Brook, approximately from the Upper Brook St Bridge to the Stevens Branch. This program will establish the protocols and frequency for debris and sediment removals on an on-going, long-term basis.

For example, the amount of debris / sediment removal would not exceed more than 1 to 2 feet. In several areas, sediment may be removed in the center of the brook, tapering the removal to the edges to reduce the potential for undermining the walls that line the brook along the corridor. Concern was expressed about removing some of the existing grade control structures that exist today on Gunners. There are many embedded pieces of granite that currently protect the bottom of the brook from incising. Uncontrolled removal of these blocks has a high potential to induce uncontrolled and severe head cutting, resulting in further undermining of the walls and instability along the entire reach.

As a result of these discussions, it is believed VANR recognizes and concurs with the need to develop and implement a woody debris and stream management plan along Gunners Brook, possibly from the LePage Gravel Pit to the Stevens branch. These officials are supportive (subject to the review and approval of details) of installing two woody debris trash racks, a primary rack at the LePage site and a secondary rack at Harrington Avenue. They advised the City will be responsible for the maintenance of each site and will be required to inspect and remove debris on an ongoing basis. They suggested that, as part of the management plan, the City mobilize excavator-

---

<sup>1</sup> [http://accd.vermont.gov/strong\\_communities/opportunities/planning/resiliency/VERI](http://accd.vermont.gov/strong_communities/opportunities/planning/resiliency/VERI)

type equipment to each trash rack site in advance of a severe storm warning so debris can be quickly removed as soon as safely possible.

### **1.5 Site Walkover & In-Stream Review**

A detailed site walkover of the brook was conducted on August 6, 2015 by officials from the City, VANR River Management and Central Vermont Regional planning Commission, joined by the project technical team of engineers and scientists from D&K and BCE. The walkover began at the LePage Gravel Pit and continued to the lower Brook Street Bridge.

The objective of these in-stream reviews was to conduct a hands-on review of the current condition of the brook and to identify and discuss opportunities for debris control and to reduce the potential for debris jamming. The team conducted a detailed in-stream review of a number of features and conditions within the brook, including the amount and location of large woody debris, channel dimensions and the condition of the banks and retaining walls. Also, this site walkover facilitated hands-on discussions with VANR River Management officials regarding what could and could not be conducted for work in the brook.

A follow up walkover along the brook occurred on August 27, 2015 with City officials and river engineers from DuBois & King. This walkover focused on identifying and marking specific areas of woody debris in the brook to be subsequently removed under City direction for the purpose of reducing the potential for debris jamming during the next flood event. The following key points were addressed during the two walkovers:

- Specific stream permitting requirements with VANR River Management officials and the feasibility of the issuance of these permits.
- Areas to remove excessive woody debris (large trees) and loose granite debris from the stream that could contribute to blockage during the next flood event.
- Identified and reviewed specific areas to locate large woody debris trash racks with consideration to access, volume and maintenance.
- Reviewed the condition of the laid-up granite walls through this reach and identified specific locations for channel widening and floodplain restoration.
- Identified feasible building buyout opportunities that maximize floodplain restoration and debris storage opportunities.

There are several areas in the brook where head cutting and erosion is occurring. For example, much of the bed armor was removed following the July 2015 flood and stabilization with grade control or new bed armor of these areas may be warranted depending on how the brook responds and adjusts. There are opportunities for the use of local, low cost materials to provide stabilization. For example, large woody debris (logs) could be embedded in the channel where the stream bank eroded and channel bed material was removed. As a point of reference, there is a man-made

grade control structure under the Main St Bridge (sewer main pipeline) near the Beverage Baron.

Existing retaining walls: The retaining walls along both sides of Gunners Brook from Brook St to the confluence with the Stevens Branch widely vary in material and condition. The walls types include reinforced concrete, waste concrete blocks, large granite blocks, slabs of granite laid on its side and small pieces of stacked granite. Based on historical research, the City has previously determined the walls are owned by the adjacent property owners, and as such, these owners are responsible for the maintenance and repair of the walls. The majority of the retaining walls are in various modes of failure. There is opportunity, especially in the vicinity of Harrington Avenue, to remove some of these failing walls and replace them with a flood resilient design that improves channel dimensions and floodplain function.

### **1.6 Prior Reports**

There are several relevant reports that have been prepared in the immediate area by others over the past several years. The following reports were obtained and the information considered when developing this report. They include (not limited to):

- Vermont Economic Resiliency Initiative, Prepared by the Vermont Department of Housing and Community Development, dated July, 2015.
- Flood Insurance Study for Washington County, Vermont March 19, 2013.

## **2.0 MITIGATION MEASURES EVALUATED:**

The following is a summary list of the mitigation measures identified and evaluated for this project, followed by a detailed discussion of each.

- Large Woody Debris Rack (adjacent to LePage Gravel Pit)
- Woody Debris & Streambed Management Plan
- Harrington Avenue Floodplain Management Plan
  - ✓ Targeted Property Acquisition & Building Removal
  - ✓ Floodplain restoration
  - ✓ Harrington Ave. Bridge deck Removal
  - ✓ New (Secondary) Large Woody Debris Rack
  - ✓ Improved channel geometry / dimensions

**2.1 Large Woody Debris Rack**, located in the vicinity of the LePage Gravel Pit. The purpose of this engineered trash rack is to arrest further downstream movement of large woody debris and to serve as an area where the debris can collect during a flood and then be subsequently removed by the City. A site plan and schematic of this trash rack is appended to this report illustrating its locations and style. Key components of this trash rack include:

- Catch and retain the majority of woody debris migrating down Gunners Brook from further upstream and reduce the potential for this debris to enter into the urban floodplain of Gunners Brook.



- City access (with Owner's permission) to the trash rack and debris storage area would be provided off Farwell St and through the LePage Gravel Pit road system. Permanent easements to construct and maintain the debris rack would be required from all property owners affected by the trash rack.
- A structural steel H-pile, driven into the streambed along with welded cross bars and bracing would serve as the frame for the trash rack.
- Initial coordination with officials from the VANR Rivers Management Program has occurred and verbal, preliminary concurrence to construct and maintain a trash rack has been received. Formal authorization from VANR and the Army Corps of Engineers through the permit process will be required as part of final design.

**2.2 Woody Debris & Streambed Management Plan.** This plan consists of cutting and removing trees and brush from the brook and those along the stream bank that are in imminent danger of falling into the brook. The purpose of this plan is to reduce the amount of woody debris from entering the brook, which in turn is intended to reduce the potential for accumulation and jamming downstream.

- The removal would focus along the brook from the above referenced LePage debris rack to the confluence with the Stevens Branch.
- The City will be responsible for having a trained team walk the brook and conduct the woody debris removal on an annual basis and following significant rain events. Woody debris would be chainsaw-cut and likely deposited into the adjacent woods in rural areas or in urban areas it could be collected and hauled away or shredded into mulch on site. Property owner permission is to be secured at the beginning of this program.
- Streambed Maintenance: Large-scale removal of in-stream material is not allowed under VANR regulations; however the rules do allow individual property owners to remove up to 50 cubic yards of channel material above the waterline with limitations. Field discussions with VANR River Management officials suggest they would work with the City to consider applying this removal limit to a City-managed annual maintenance program within the more flood prone areas along Gunners Brook.

**2.3 Harrington Avenue Floodplain Management Plan.** The primary objective of this mitigative measure is to reduce the potential for woody debris to collect and jam in an uncontrolled manner. This objective is advanced by first reducing the volume of debris from entering the area (see measures described above) and also providing a secondary debris control and storage and access area at Harrington Avenue and with associated channel improvements. The reader is referred to sheet 3 of the attached drawings that illustrate the following discussion.

The existing Harrington Avenue bridge deck effectively serves as a woody debris rack, as evidenced by the multiple times debris jams at this site. However, it is an uncontrolled situation because much of the debris remains in the channel, sending floodwaters into the floodplain. Additionally, there is limited direct access to the

woody debris field at the height of a storm event. Removal of the bridge deck without an accompanying mitigation measure will simply displace the problem further downstream and create additional flood problems at different locations and should not be allowed.

### **Targeted property acquisition and building removal**

The first step is to acquire the four (4) properties identified below and remove the three (3) buildings. While there are a number of buildings that are subjected to repeated flooding and damages, these 4 properties are considered to be the highest priority because the floodplain on which they are located is a key component to this mitigation measure. These (and other) properties have experienced damage during flood events as recently as July 2015 and their removal is a substantial first step towards improving public safety and reducing future flood damage.

The buildings to be removed are located at 17 and 19 Harrington Avenue and at 14 Reid Street. Acquisition of the property and removal of the buildings will allow the City to regrade the site, recapture the floodplain, install the woody debris trash rack, access the site to remove debris and maintain the floodplain moving forward.

**Note:** The City Council has authorized the City Manager, with the assistance of the Permits Administrator, to prepare and submit a Federal Hazard Mitigation Grant Program (HMGP) Grant Application (\$500,000 +/-) for the buy-out, demolition and disposal of these three buildings. The three (3) affected property owners have been contacted by the Manager and each have formally indicated their desire to participate in his buy-out program. City staff is working with the State of Vermont Division of Emergency Management and Homeland Security (DEMHS) and the Central Vermont Regional Planning Commission (CVRPC) to submit this application on/before the November 6, 2015 submission deadline. If the application is successful, the State and Federal review process and notification of award could take six (6) to eight (8) months (July 1, 2016 +/-). Thereafter, completion of the grant award process and the federally managed appraisals, property transfers, closings, and the asbestos abatement/demolition process for three properties could take another 8 months or so.

Consistent with the July 2015 VERI Report and to the extent funding can be secured, we believe additional properties should be acquired and buildings removed from the floodplain. We expect these additional properties would be acquired in subsequent phases of this project, as funding allows.

Properties in a potential Phase 2 buy-out could include 85 and 87 Brook Street (and possibly others) depending upon funding. However, absent some currently unidentified source/influx of funding, a Phase 2 buy-out of any magnitude, **if it were to occur**, is extremely premature to discuss at this time and is likely two (2) to three (3) years, if not substantially more, away from implementation.

## **Floodplain Restoration & Channel Geometry Improvements:**

Following building removal, the next step is to restore approximately 300 feet of the left floodplain upstream of Harrington Ave. and about 100 feet downstream. The design intent is to remove historical fill to the maximum practical extent, create a storage area for the woody debris and silts / sediments to collect and settle, to provide access for its removal, to create a more flood resilient channel bank and improve channel dimensions through this area. The primary components to restore the floodplain include:

- Modify (lower) the left bank of the brook to allow floodwater and woody debris to readily access the floodplain. The intent is to widen the channel to a bankfull width and establish a flood resiliency bank condition,
- Excavate the accumulated silt and sediment in the area and regrade the land,
- Remove the Harrington Ave. bridge deck, the left abutment and approximately 150 feet of channel improvements downstream of Harrington Ave. Widen the channel in the immediate vicinity of the bridge from its constricted 19-ft to approximately 27-ft. Install a stepped left channel wall.
- The left bridge abutment and downstream wall will be lowered as would a short section of wall on the inside (right) bend of the brook just downstream. The intent is to remove some of the historical encroachment fill by lowering the existing walls and creating a wider channel to better match bankfull conditions.
- Create a restored floodplain on the east side of the channel to serve as a catchment area for woody debris to settle and for the deposition of excess sediment during a flood event.

## **Woody Debris Trash Rack at Harrington Avenue:**

- Concurrent with the removal of the Harrington Ave. bridge deck is the installation of a new woody debris trash rack. As stated above, the bridge deck should not be removed without a new trash rack because debris will likely be shifted, exacerbating existing conditions further downstream.
- The trash rack will be designed to catch large woody debris that would be mobilized in the reach of Gunners brook between the LePage site to Harrington Ave. There is a significant inventory of woody debris in this reach and while the objective is to reduce this inventory through the Woody Debris and Streambed Management Plan (see description above), the trash rack will serve as an additional measure to reduce potential for woody debris jam-caused flooding.
- Unlike the LePage site, a different styled trash rack is recommended, one that would be suitable for a residential area. There are a number of material and shape configurations that would be evaluated during the next phase of this project. The individual piers of the trash rack would be located in both the channel of the brook as well as the floodplain upstream of Harrington Ave.

- The design intent is for woody debris to be retained on the trash racks and settle into the restored floodplain. With floodwaters able to access the floodplain upstream of Harrington Ave., woody debris will have better opportunity to float into this area, reducing the volume of material jammed in the channel itself. The rack piers in the floodplain will reduce debris movement further downstream.

**3.0 OPINION OF PROBABLE COSTS:**

A conceptual-level engineering sketch (plan and cross section) and an opinion of probable cost for the mitigation measure have been prepared. The engineering sketches are intended for conceptual definition and planning / estimating purposes; they are not suitable for construction.

An itemized construction cost estimate is appended to this report. The costs (rounded) are summarized as follows:

Property Acquisition, Building Abatement & Removal.....	\$500,000
New Large Woody Debris Trash Rack (LePage & Harrington).....	\$115,000
Harrington Ave. Floodplain Restoration & Channel Improvements.....	\$115,000
Subtotal .....	\$730,000
Contingency (20%).....	\$146,000
Administrative, permitting, design and construction management allowance .....	\$130,000
Total Estimated Project Costs .....	\$1,006,000

**4.0 NEXT STEPS:**

The next steps towards advancing the project into implementation include:

- Obtain funding. The City has been actively coordinating with State officials and is preparing grant applications for Phase 1 property buyouts through the HMGP Grants and other funding sources.
- Continue with the coordinate with directly affected property owners at each mitigative measure site.
- Prepare a final design of the flood mitigation measures.
- Prepare and submit permit applications with VANR River Management and federal officials. Coordinate and work with the officials towards the issuance of the permits.
- Acquire the Phase 1 properties and remove the buildings.
- Construct the large woody debris rack at LePage Gravel Pit.
- Remove Harrington bridge deck and implement floodplain management plan (build second trash rack, widen channel and restore floodplain).

- Train city personnel on debris management strategies and implement the Woody Debris and Streambed Maintenance Plan.

## **5.0 LIMITATION OF REPORT:**

The City of Barre, Vermont and its consultants for the Gunners Brook Short Term Mitigation Study have prepared this preliminary report exclusively for their respective use. This report is not intended to be used or relied upon by any other party whatsoever. Any use of this report by a party without the express written consent of DuBois & King and the City of Barre, Vermont shall be at the user's own risk and without liability to DuBois & King.



**Project team gathers at LePage Gravel Pit on August 6, 2015**



**View of Gunners Brook at LePage Gravel Pit area**



**Large woody debris pile in Gunners Brook, upstream of Brook St.**



**Large woody debris pile in Gunners Brook, upstream of Brook St.**



**Gunners Brook adjacent to Buzzi's Garage**



**Left bank failed during July 2015 storm**





**Bank restoration area just upstream of Harrington Ave.**



**Left floodplain restoration area**



**Severe channel constriction at Harrington Ave. bridge**



**Channel just downstream of Harrington Ave. to be restored**



Large Woody Debris Rack adjacent to LePage Gravel Pit

**Legend**

- Stream Stationing
- Gunners Brook Centerline

400 200 0 400 Feet

**Woody debris and Streambed Management Plan**

- Remove applicable large woody debris between LePage Gravel Pit and Harrington Ave.
- Targeted channel bed management between Upper Brook Street bridge and confluence with Stevens Branch

Large Woody Debris Rack and Restored Floodplain/Flood Debris Storage Area

Acquire four (4) properties

Remove Harrington bridge deck and left (looking downstream) retaining wall to widen channel

Confluence with the Stevens Branch

© 2015 DigitalGlobe Image courtesy of USGS Earthstar Geographics SIO © 2015 Microsoft Corporation

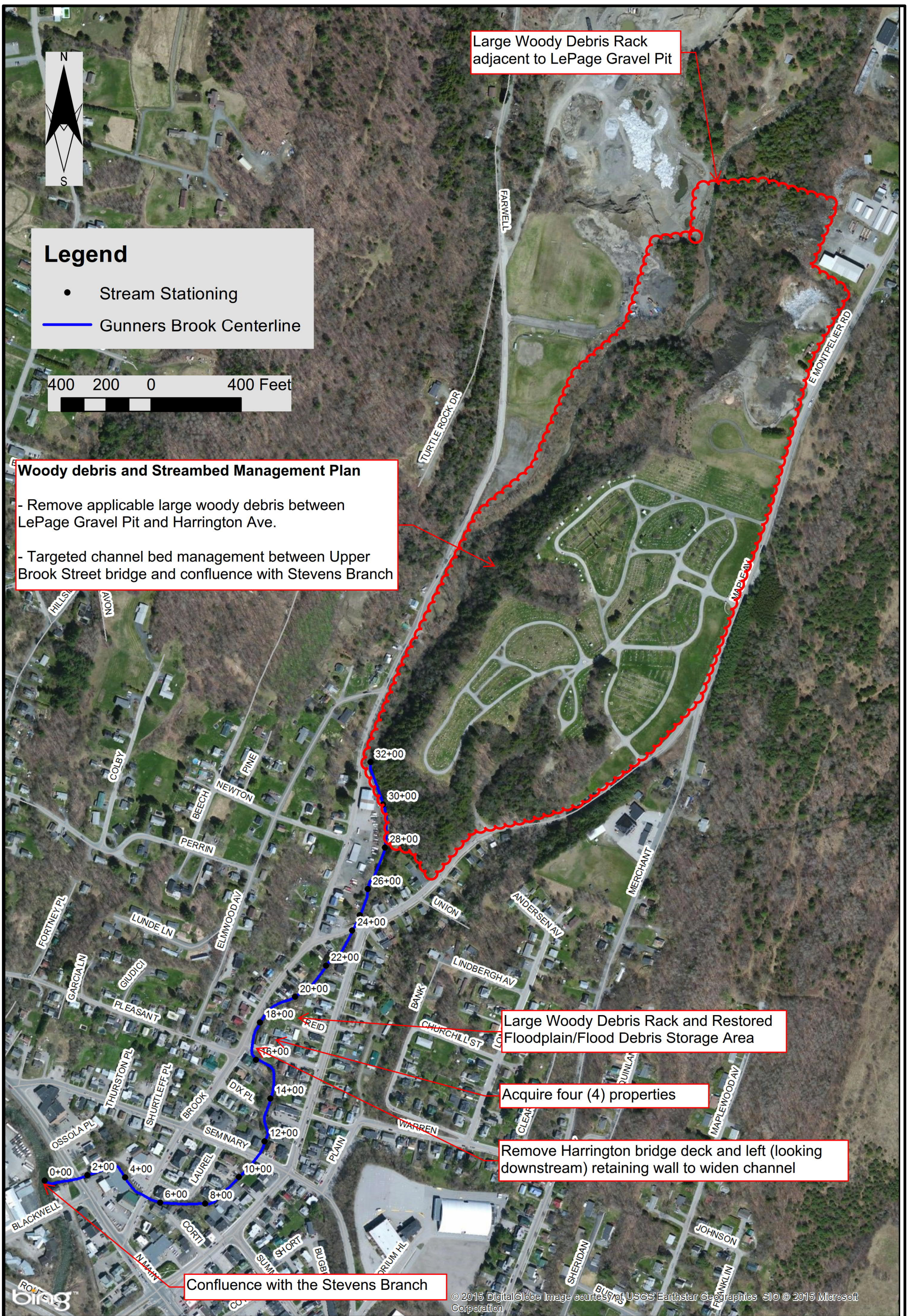
**DuBois & King** inc.  
ENGINEERING • PLANNING  
MANAGEMENT • DEVELOPMENT

**LOCATION MAP - GUNNERS BROOK  
SHORT TERM MITIGATION STUDY**

CITY OF BARRE, VERMONT  
WASHINGTON COUNTY  
2015

DRAWN BY: CJK  
CHECKED BY:  
PROJ. ENG: CJK  
SHEET NO: 01

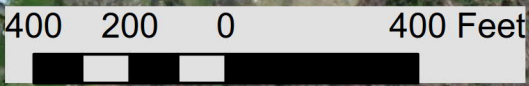
DATE: 10/16/2013  
PROJECT NO: 923098L



Large Woody Debris Rack adjacent to LePage Gravel Pit

**Legend**

- Stream Stationing
- Gunners Brook Centerline



**Woody debris and Streambed Management Plan**

- Remove applicable large woody debris between LePage Gravel Pit and Harrington Ave.
- Targeted channel bed management between Upper Brook Street bridge and confluence with Stevens Branch

Large Woody Debris Rack and Restored Floodplain/Flood Debris Storage Area

Acquire four (4) properties

Remove Harrington bridge deck and left (looking downstream) retaining wall to widen channel

Confluence with the Stevens Branch

© 2015 DigitalGlobe Image courtesy of USGS Earthstar Geographics SIO © 2015 Microsoft Corporation

**DuBois & King** inc.  
ENGINEERING • PLANNING  
MANAGEMENT • DEVELOPMENT

**LOCATION MAP - GUNNERS BROOK  
SHORT TERM MITIGATION STUDY**

CITY OF BARRE, VERMONT  
WASHINGTON COUNTY  
2015

DRAWN BY: CJK  
CHECKED BY:  
PROJ. ENG: CJK  
SHEET NO: 01

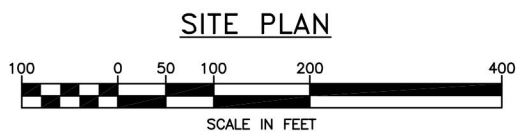
DATE: 10/16/2013  
PROJECT NO: 923098L



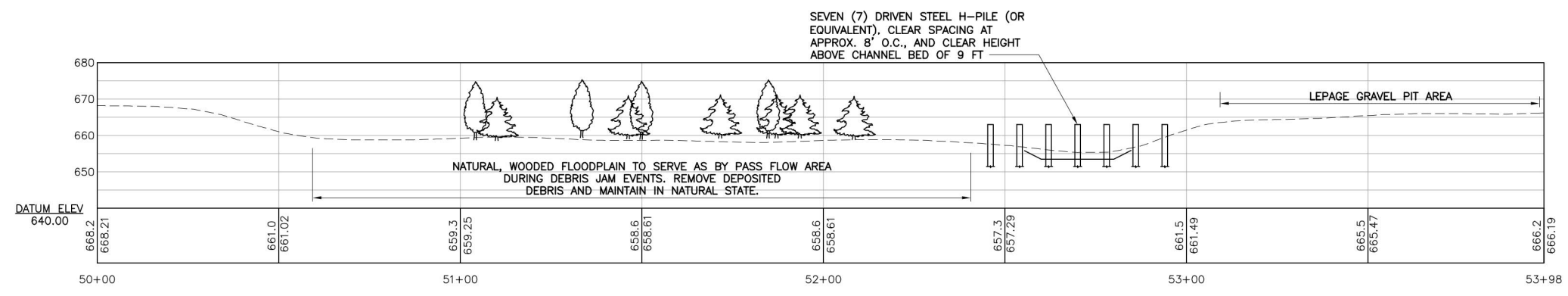
LOCATION FOR LARGE WOODY DEBRIS RACK ADJACENT TO LEPAGE GRAVEL PIT



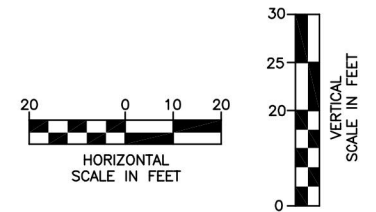
WOODED FLOODPLAIN TO SERVE AS BYPASS FLOW AREA



SITE PLAN



LARGE WOODY DEBRIS RACK ELEVATION (LOOKING DOWNSTREAM)



**DuBois & King inc.**  
 ENGINEERING • PLANNING • MANAGEMENT • DEVELOPMENT  
 28 NORTH MAIN ST.  
 RANDOLPH, VT 05060  
 TEL: (802) 728-3376  
 FAX: (802) 783-7101  
 www.dubois-king.com  
 SO. BURLINGTON, VT  
 SPRINGFIELD, VT  
 BEDFORD, NH  
 LACONIA, NH  
 © Copyright 2014 DuBois & King Inc.  
 PROFESSIONAL SEAL

**NOT FOR CONSTRUCTION PRELIMINARY PLANS**

NO.	DATE	DESCRIPTION	BY	CK'D

CITY OF BARRE  
 6 NORTH MAIN STREET  
 BARRE, VERMONT  
 05641

GUNNERS BROOK:  
 PHASE I FLOOD MITIGATION STUDY  
 CITY OF BARRE, VERMONT

SHEET TITLE  
 LARGE WOODY DEBRIS RACK  
 SITE PLAN

DRAWN BY SANZ	DATE SEPT 2015
CHECKED BY JWT	DAK PROJECT # 923098
PROJ. ENG. CJK	DAK ARCHIVE #

SHEET NUMBER

**02**

SHEET 02 OF 04

I:\923098\Gunners\dwg\923098\_Debris Control\_Structure.dwg 10/16/2015 1:31 PM

**NOT FOR  
CONSTRUCTION  
PRELIMINARY  
PLANS**

NO.	DATE	DESCRIPTION	BY	CK'D

CITY OF BARRE  
6 NORTH MAIN  
STREET  
BARRE, VERMONT  
05641

GUNNERS BROOK:  
PHASE I FLOOD  
MITIGATION STUDY  
CITY OF BARRE,  
VERMONT

SHEET TITLE

HARRINGTON  
SITE PLAN

DRAWN BY SANZ	DATE OCT 2015
CHECKED BY CJK	D&K PROJECT #
PROJ. ENG. JWT	D&K ARCHIVE #

SHEET NUMBER

**03**

SHEET 03 OF 04

APPROXIMATE LIMITS OF RESTORED FLOODPLAIN/  
FLOOD DEBRIS STORAGE AREA

LEFT (LOOKING DOWNSTREAM) BANK  
RUBBLE/BERM TO BE REMOVED AND  
RIVER BANK RESTORED TO BANK  
FULL LEVEL.

LARGE WOODY DEBRIS RACK,  
FIVE (5) DRIVEN STEEL H-PILE  
(OR EQUIVALENT), CLEAR  
SPACING AT APPROX. 8' O.C.,  
AND CLEAR HEIGHT ABOVE  
CHANNEL BED OF 7 FT.

HARRINGTON AVE. BRIDGE DECK,  
AND RETAINING WALL TO BE  
REMOVED. WIDEN CHANNEL  
FROM 19 FT TO 27 FT.

NEW BARRIER/FENCE  
DEAD END HARRINGTON AVE.

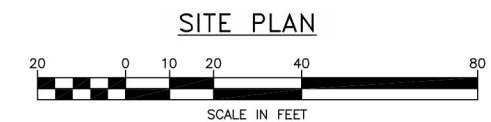
NEW WALL (STACKED GRANITE  
BLOCK OR EQUIVALENT)

NEW BARRIER/FENCE  
DEAD END HARRINGTON AVE.

EXISTING WALL ON RIGHT  
SIDE (LOOKING DOWNSTREAM)  
TO BE REMOVED AND NEW  
FLOOD RESILIENT BANK TO  
BE CONSTRUCTED

EXISTING BUILDINGS TO BE REMOVED  
19 HARRINGTON AVE  
17 HARRINGTON AVE  
14 REID STREET  
14A REID STREET

EXISTING BUILDING TO REMAIN



I:\V22098L\_Gumera\dwg\022098L\_Harrington\_Ave.dwg 10/16/2015 1:46 PM

NO.	DATE	DESCRIPTION	BY	CK'D

CITY OF BARRE  
6 NORTH MAIN  
STREET  
BARRE, VERMONT  
05641

GUNNERS BROOK:  
PHASE I FLOOD  
MITIGATION STUDY  
CITY OF BARRE,  
VERMONT

SHEET TITLE

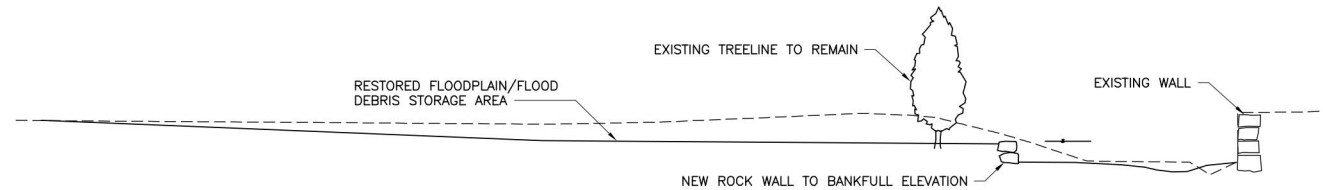
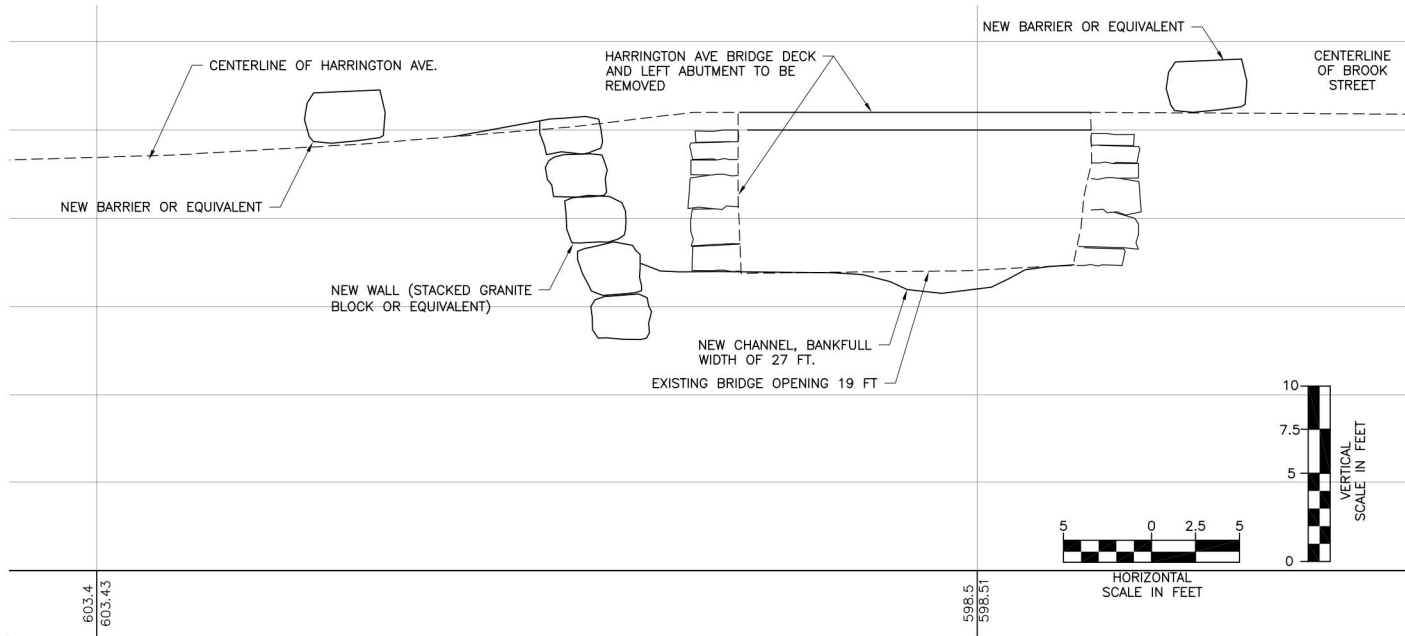
HARRINGTON  
CROSS SECTIONS

DRAWN BY SANZ	DATE OCT 2015
CHECKED BY CJK	D&K PROJECT #
PROJ. ENG. JWT	D&K ARCHIVE #

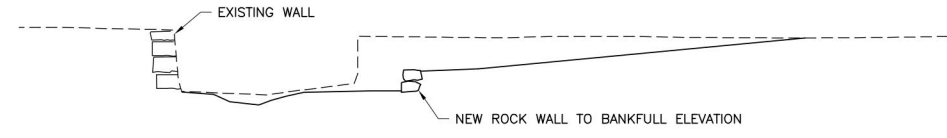
SHEET NUMBER

**04**

SHEET 04 OF 04



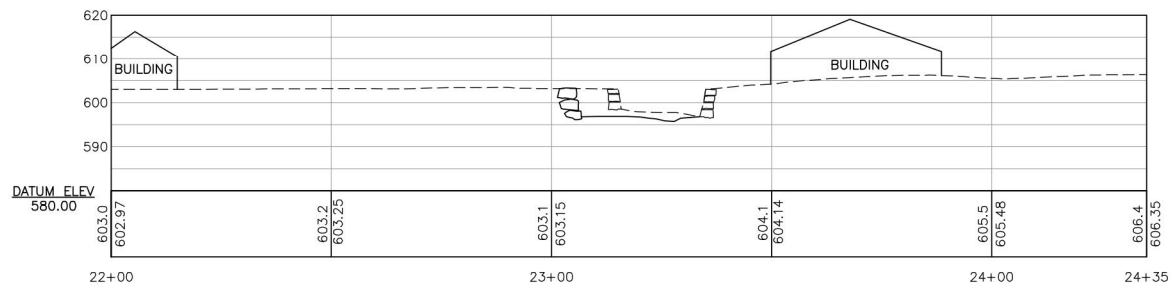
**A** TYPICAL SECTION



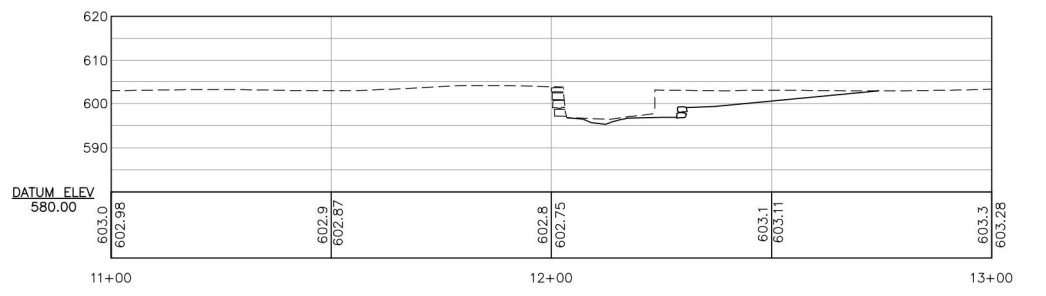
**B** TYPICAL SECTION



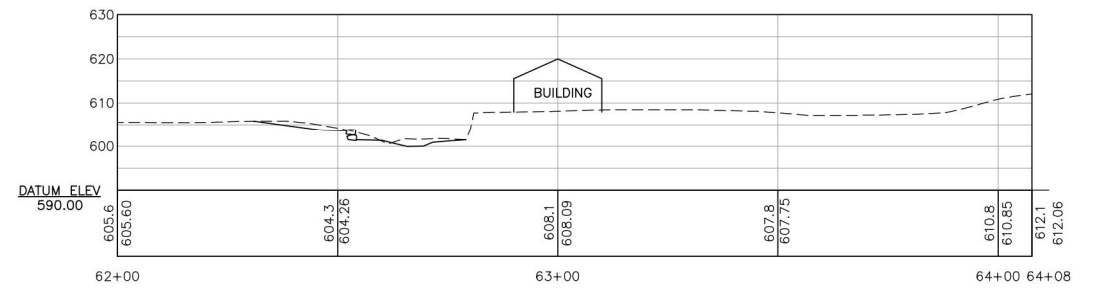
RS 1667



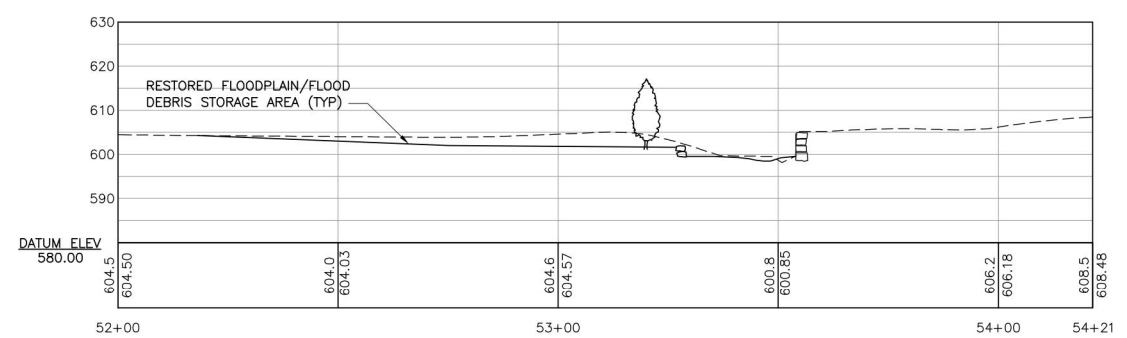
RS 1613



RS 1494



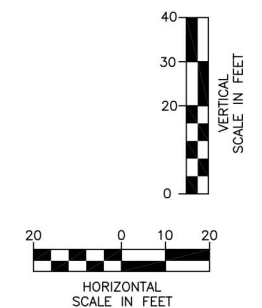
RS 1978



RS 1856



RS 1730



I:\P22098L\_Cumera\dwg\p22098L\_Harrington\_Ave.dwg 10/16/2015 12:23 PM

**Gunners Brook**  
City of Barre, Vermont

**Phase 1 Flood Mitigation Study**  
**Draft: Opinion of Probable Cost**

Item #	Item Description	Quantity	Unit	Unit Cost	Total
<b>Property Acquisition, Abatement &amp; Building Removal</b>					
1	Stabilized Temporary Construction Access	1	LS	\$5,000	\$5,000
2	Property Acquisition (19 Harrington Ave.)	1	LS	\$88,700.00	\$88,700
3	Demolition & Disposal (19 Harrington Ave.)	1	LS	\$30,000.00	\$30,000
4	Property Acquisition (17 Harrington Ave.)	1	LS	\$75,490.00	\$75,490
5	Demolition & Disposal (17 Harrington Ave.)	1	LS	\$25,000.00	\$25,000
6	Property Acquisition (14 Reid St.)	1	LS	\$138,700.00	\$138,700
7	Demolition & Disposal (14 Reid St.)	1	LS	\$40,000.00	\$40,000
8	Property Acquisition (14A Reid St.)	1	LS	\$9,400.00	\$9,400
9	Building Asbestos Surveys & Abatement (Allowance)	1	LS	\$85,000.00	\$85,000
<b>Subtotal, Property Acquisition, Abatement &amp; Building Removal</b>					<b>\$497,290</b>
<b>Large Woody Debris Trash Racks</b>					
10	Large Woody Debris Trash Rack (LePage Gravel) 7- 1.0'x35' Driven Pile piers	1	LS	\$58,500.00	\$58,500
11	Large Woody Debris Trash Rack (Harrington) 5- 1.0'x 35' Driven Piles	1	LS	\$38,300.00	\$38,300
12	Permanent Easements	2	LS	\$5,000.00	\$10,000
13	Mobilization / Demobilization (8%)	1	LS	\$8,544.00	\$8,544
<b>Subtotal, Large Woody Debris Trash Racks</b>					<b>\$115,344</b>
<b>Harrington Ave. Floodplain Restoration &amp; Channel Improvements</b>					
14	Harrington Bridge deck removal	1	LS	\$10,000.00	\$10,000
15	Left abutment & left wall removal	200	LF	\$35.00	\$7,000
16	New block wall	150	LF	\$75.00	\$11,250
17	Harrington Ave. Utility Relocation / Removal	1	LS	\$5,000.00	\$5,000
18	Common Excavation (new block wall)	160	CY	\$10.00	\$1,600
19	Structural Backfill (new block wall)	160	CY	\$36.00	\$5,760
20	Channel Improvements (left bank reconfiguration)	300	LF	\$30.00	\$9,000
21	Repair existing damaged walls (Allowance )	200	LF	\$25.00	\$5,000
22	Permanent Easements	1	LS	\$30,000.00	\$30,000
23	Stream bank Stabilization (left bank @ RS 26+00 to 28+00)	1	LS	\$10,000.00	\$10,000
24	Silt Fence	300	LF	\$8.00	\$2,400
25	6" Topsoil Placement & Grading (Stripped from On-Site)	315	CY	\$30.00	\$9,450
26	Seed (1 lb./1000 SF)	17	LB.	\$8.75	\$149
27	Mulch (Hay/Straw) (2 tons/Acre)	1	TON	\$600	\$600
28	Fertilizer (500 lb./Acre)	200	LB.	\$2.75	\$550
29	Mobilization / Demobilization (8%)	1	LS	\$8,620.70	\$8,621
<b>Subtotal, Harrington Ave. Floodplain Restoration &amp; Channel Improvements</b>					<b>\$116,379</b>

Note:

Sub-Total	\$729,013
Contingency (20%)	\$145,803
Total Estimated Construction Cost	\$874,816
Permitting, Design & Construction (15%)	\$131,222

In providing opinions of probable construction cost, the Client understands that D&K has no control over the cost or availability of labor, equipment or materials, or over market conditions or the Contractor's method of pricing.

**Total Project Costs**      **\$1,006,039**

Estimate Preparation Date: 16-Oct-2015  
Prepared by: cjk