

EVALUATION OF ROCK REINFORCEMENT AT BARRON MTN., WOODSTOCK, NH.

Phase I – Completed

Phase II – Pooled Fund Study

New York DOT

Connecticut DOT

New Hampshire DOT

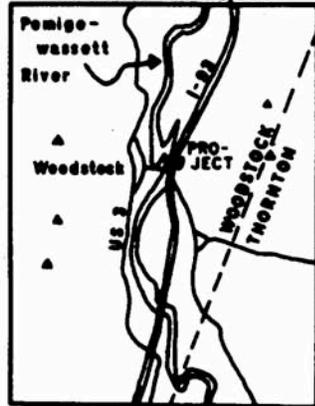
72°

PROJECT LOCATION MAP Woodstock, New Hampshire

45°

45°

INSET SCALE - 1:62,500



River

COOS

Berlin*

M A I N E

44°

44°

V E R M O N T
C o n n e c t i c u t

GRAFTON

Plymouth*

CARROLL

S U L L I V A N

BELKNAP

S T R A F F O R D

MERRIMACK

Concord*

43°

43°

C H E S H I R E

HILLSBORO

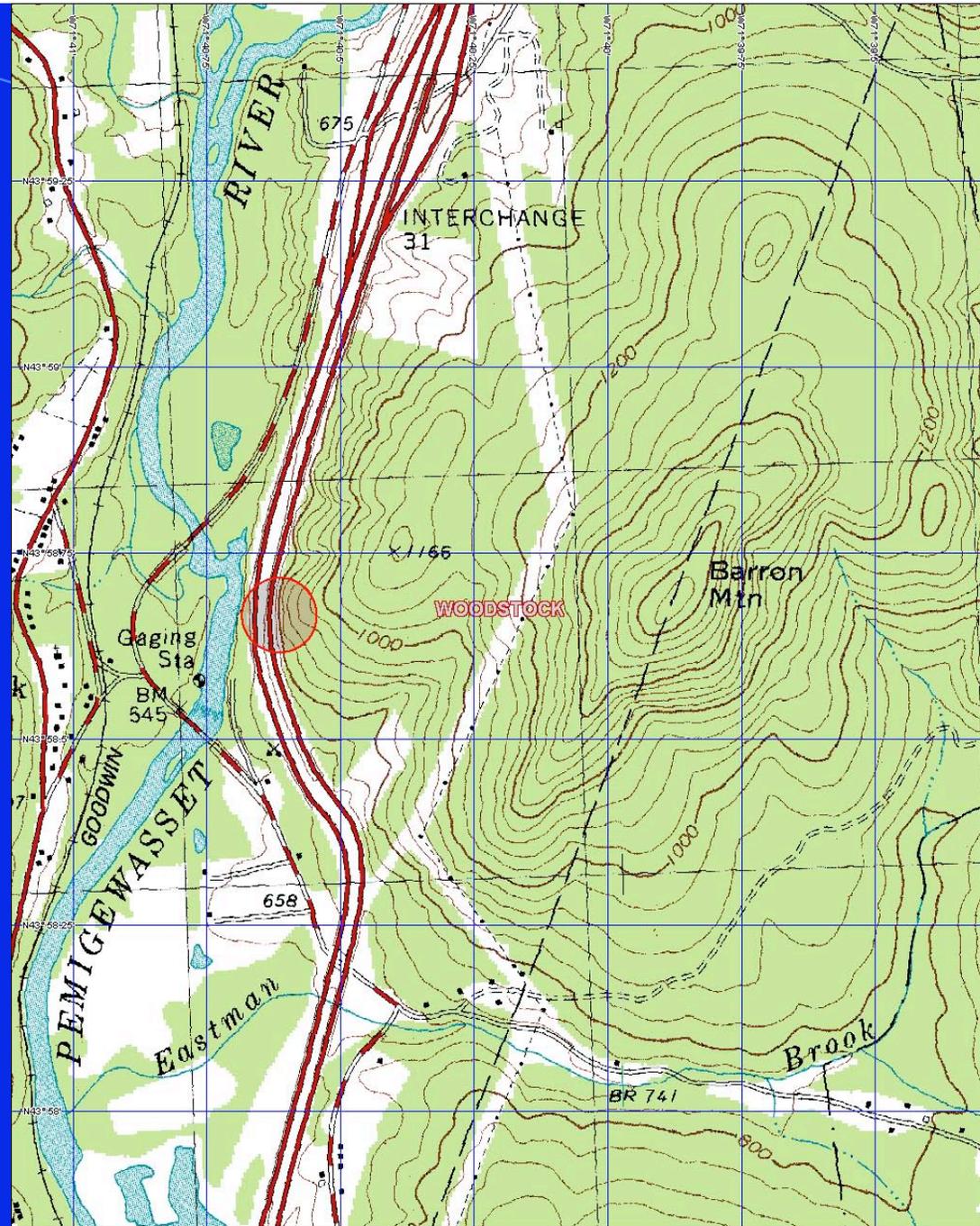
Manchester

R O C K I N G H A M

M A S S A C H U S E T T S

Fig. 1

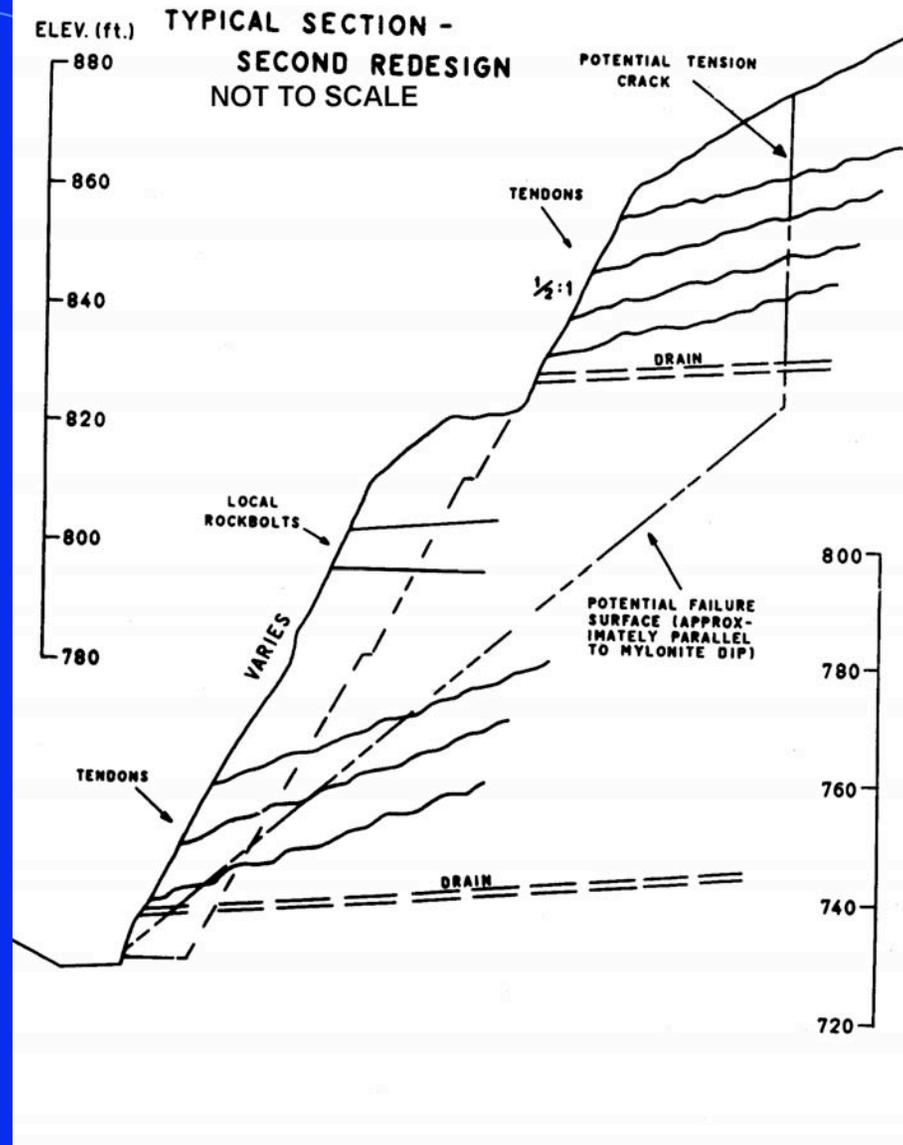
PROJECT LOCATION MAP



3-D TopoQuads Copyright © 1999 DeLorme Yarmouth, ME 04096 Source Data: USGS 350 ft Scale: 1:12,900 Detail: 14:0 Datum: WGS84



East View of Rock Cut Along I-93 NB



Cross Section of Barron Mtn. Rock Cut



Pre-stressed Rock Bolts



Passive Tendons

Rock Reinforcement Evaluation – Phase 1

- **Assessment of Corrosion Potential**
 - **Ground water**
 - **Weathered rock**
- **Assessment of Rock Reinforcement**
(Nondestructive Testing performed on 22 rock bolts and 20 tendons)
 - **Electrochemical Tests (half cell potential, polarization current)**
 - **Mechanical Tests (impact, ultrasonic)**



DATA ACQUISITION (NDT)



SEP 16 2003





PHASE 1 Findings

- **Corrosive Environment**
- **30% of sampled rock bolts loss of pre-stress**
- **10 to 15% loss of cross section**
- **Tendons better condition than rock bolts**
- **Quality of cements grout along tendons more consistent than resin grout along rock bolts**
- **Remaining service life of rock bolts 15 years and tendon 20 years**

Rock Reinforcement Evaluation – Phase 2

- **Invasive Testing (verify the results of NDT)**
 - **Lift-off tests**
 - **Physical, chemical and metallurgical testing of steel and grout samples retrieved from exhumed reinforcements (5 bolts, 2 tendons)**
- **GRANIT integrity test (type of NDT impact)**
- **Additional NDT testing on other elements**

Phase 2 Work Schedule

- **GRANIT Test**
- **Scaling**
- **Drilling replacement holes**
- **Assemble and install rock reinforcement**
- **Grout**
- **Lift-off Test**
- **NDT testing of rock reinforcement above slide area**
- **Over-coring & exhuming bolts and tendons**
- **Testing retrieved reinforcement and recovered grout**



GRANIT NDT TESTING



27 9 2004



28 9 2004



Scaling Loose Rock



7 10 2004 3





REMOVAL OF UNSTABLE BLOCK



7 10 2004





7 10 2004



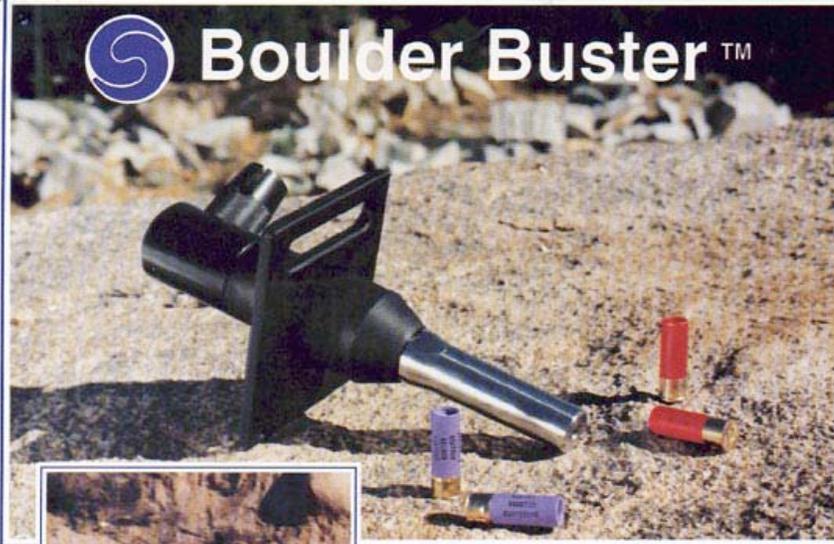
7 10 2004



Portion of Rock Bolt



Boulder Buster™



The better solution in rock breaking.

The Boulder Buster™ is a compact, cost effective and portable piece of equipment which is extremely useful in the splitting and breaking of rocks, boulders as well as the demolition of concrete structures. The sheer convenience of operation and low operating costs make the Boulder Buster™ the first choice in standby rock breaking equipment.

Advantages

- Safe and simple to operate
- Energy efficient
- No damage to structures and equipment
- Very low concussion
- Insignificant toxic gasses
- Low velocity fly rock and very little scatter
- No blasting licence required
- Light-weight and compact
- Cost effective

Applications

- Secondary breaking in mines and quarries
- Civil construction
- Demolition
- Site clearing
- Swimming pool excavations
- Trench digging
- Farming operations
- Dimensional stone dressing and sizing

BOULDER BUSTER



Drilling Holes for Replacement Bolts and Tendons



4 10 2004



6 10 2004





2004 10 7



Preparing Tendons



6 10 2004



Preparing Rock Bolts



Installing Rock Tendons



2004 10 7



Installing Rock Bolt



2004 10 7



NDT Testing above slide area



Lift-off Test on Existing Bolts



Proof Test on New Rock Bolts



Drill Rig for Over-coring Rock Reinforcement



Drill Casing and Diamond Bit



Over-coring



16 10 2004





Recovered Rock Bolt



Resin Grout on Rock Bolt



Recovered Resin Grout



18 10 2004

Corroded Rock Bolt

Acknowledgment

- **Researcher - McMahon & Mann Consulting Engineers, P.C., Buffalo, NY**
- **NDT GRANIT Integrity System – AMEC Group Ltd., United Kingdom**
- **Rock Bolt Specialty Contractor – JANOD Contractors, Quebec, Canada**







2004 10 13