Migration of Explosives at the Massachusetts Military Reservation, Cape Cod, MA

Presented by

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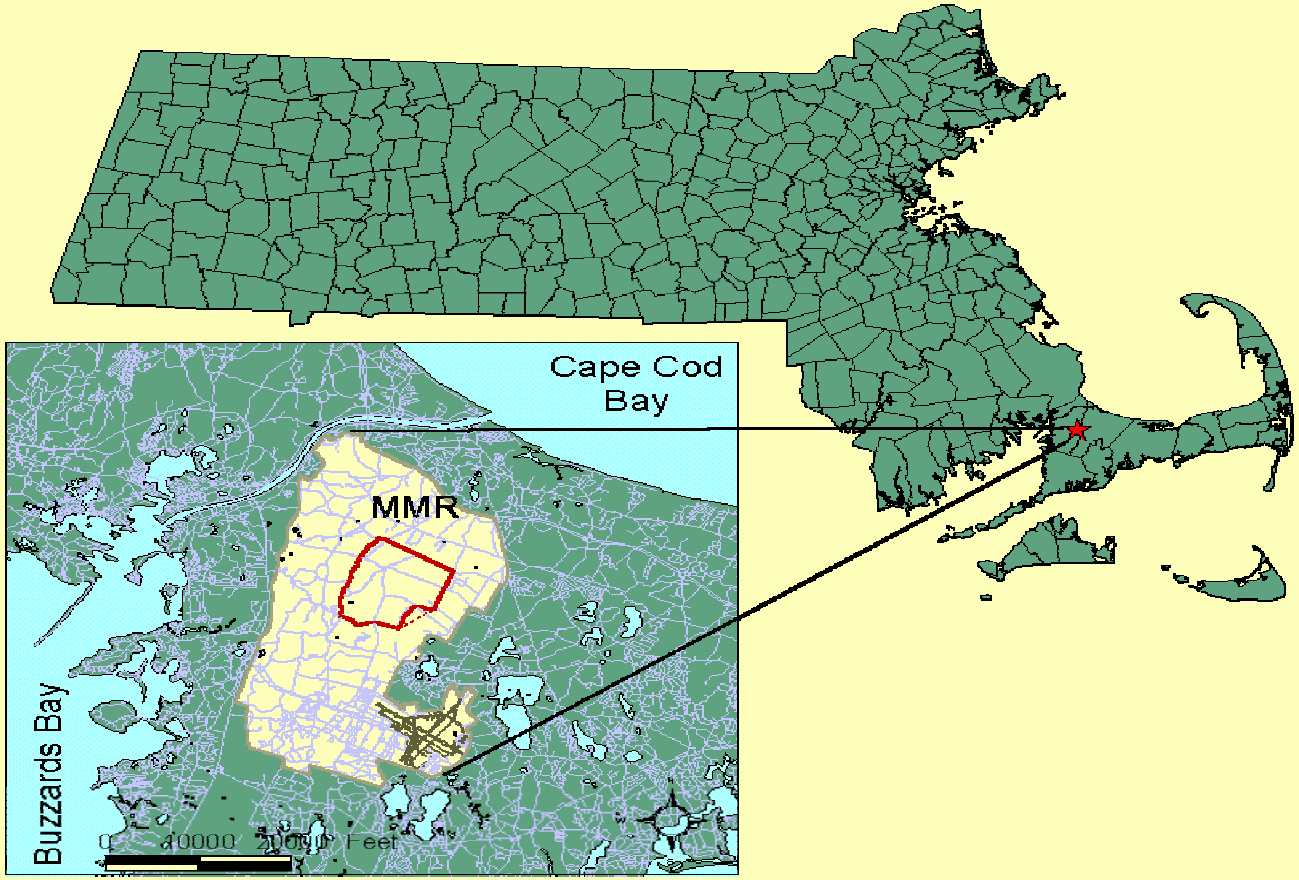
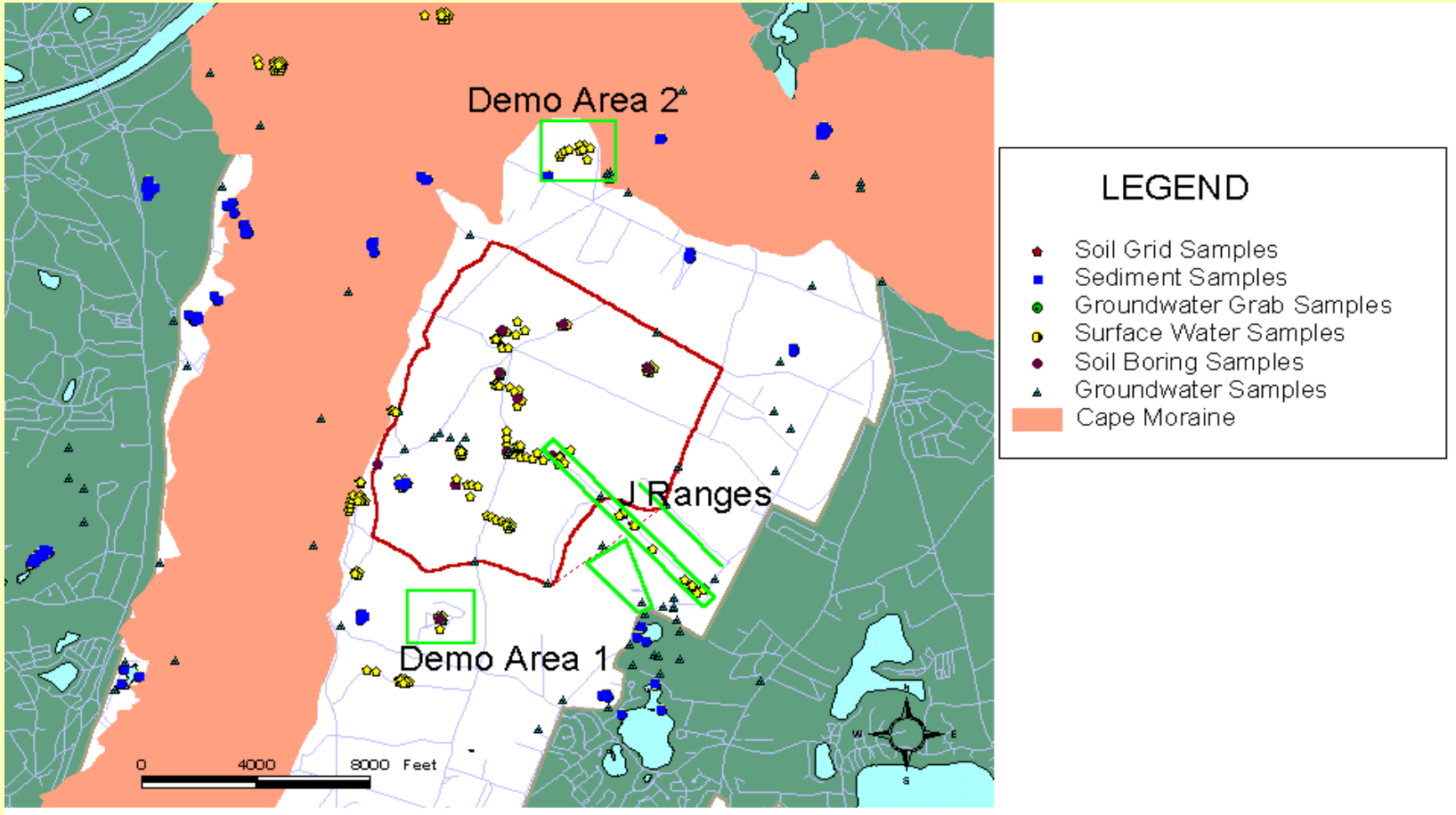
Introduction

Training and Impact areas have received ordnance discharge from small arms, guns, hand grenades, artillery, mortar, and ordnance demolition for the last 50 years. Environmental concerns related to Impact Area activities led to an Administrative Order under the SDWA between the U.S. EPA and NGB to investigate the effects of training operations on groundwater quality.

Location Map



Site Location Map



History of Site Use

- Nature of Usage
- Frequency of Usage
- Potential Contaminants of Concern

Nature of Usage

- Impact Area
  - Artillery Rounds
  - Mortars
  - Rockets
- Small Arms Ranges (42)
  - Rifles, Shotgun, Pistol, and Machine Guns
  - Grenades
- Demolition Areas (2)

Frequency of Usage

- Training and Impact Areas used since 1911
- Designed to house 30,000 troops
- Records from 1989 indicate 6456 mortars and 1799 artillery rounds fired into the Impact Area
  - munitions usage could exceed 200 x during wartime
  - an artillery round contains ~ 2.5 lbs of explosives

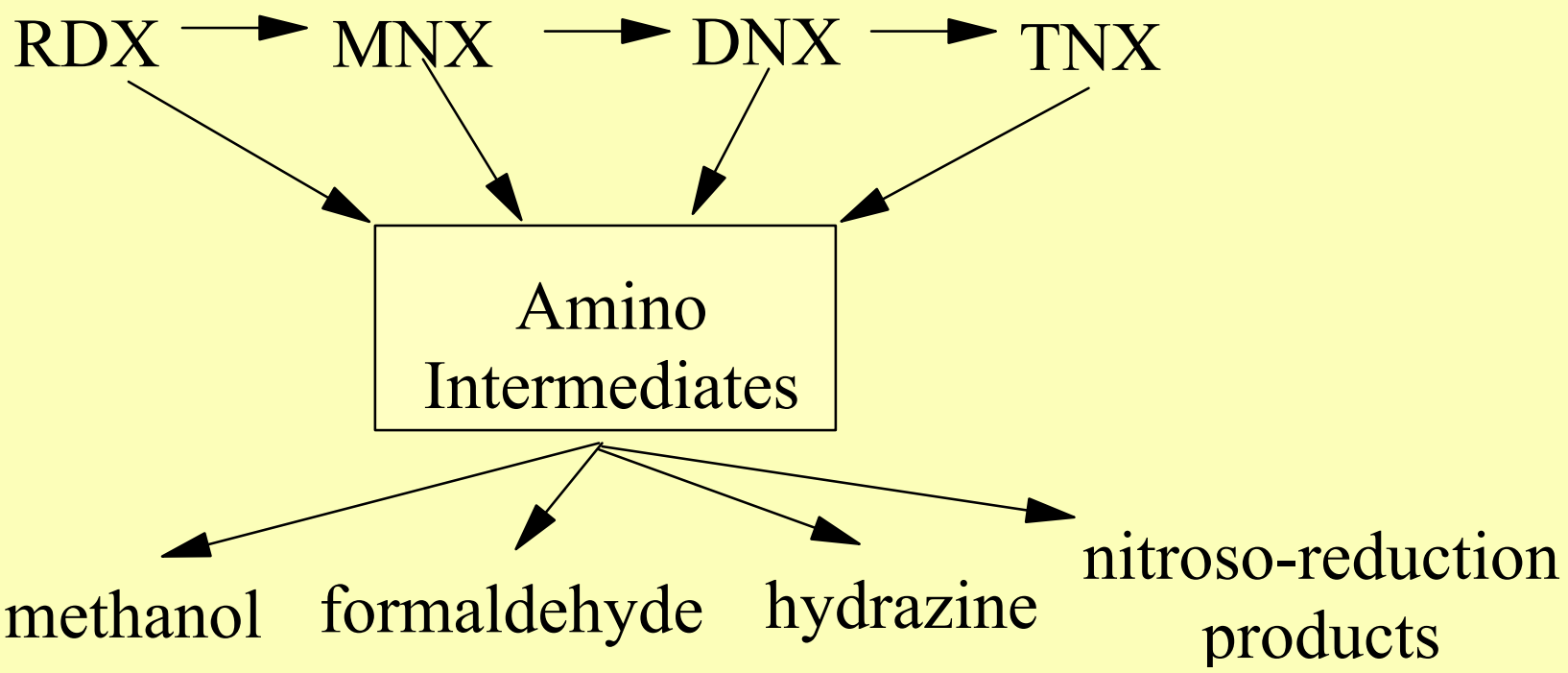
Potential Contaminants of Concern

- hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
- octahydro-1,3,5,7-tetranitro-1,3,5,7-tetraocine (HMX)
- 2,4,6-trinitrotoluene (TNT)
- TNT Degradation Products
- pentaerythritol tetranitrate (PETN)
- picric acid

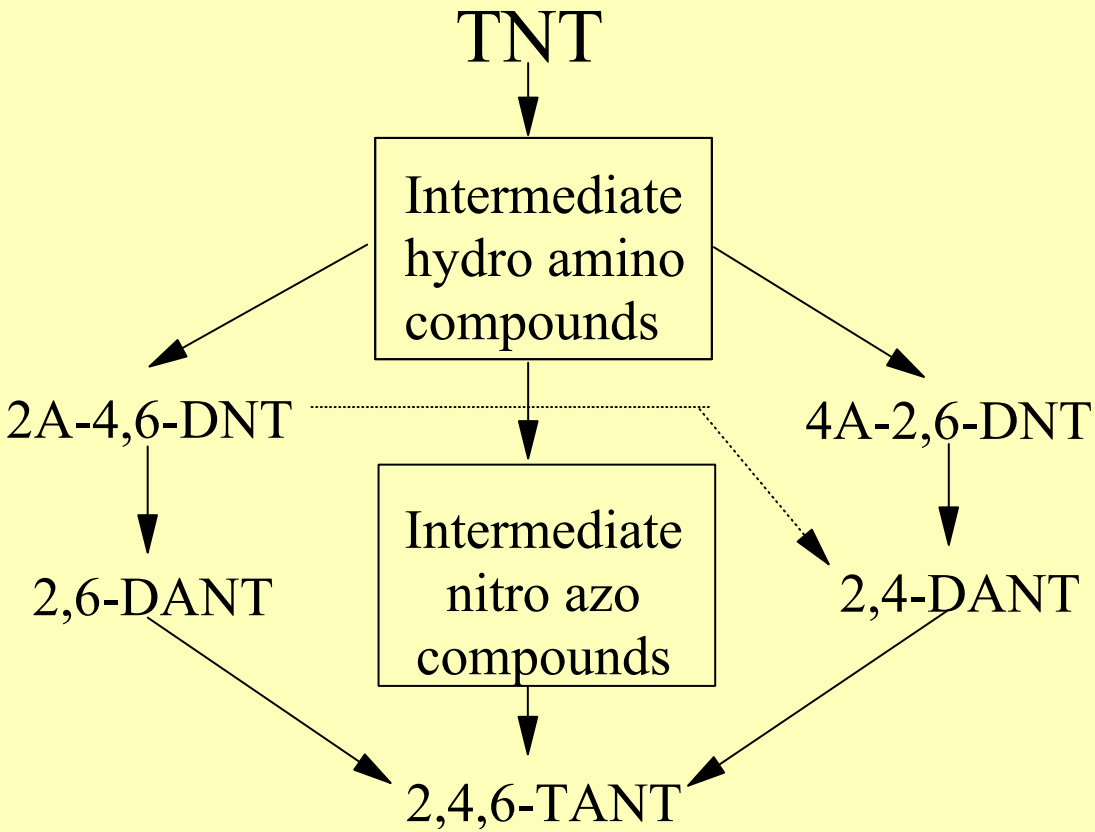
Explosive Properties

- Crystalline solid at room temperature
- Low water solubility
- Low vapor pressure
- Susceptibility to photolysis and biological degradation

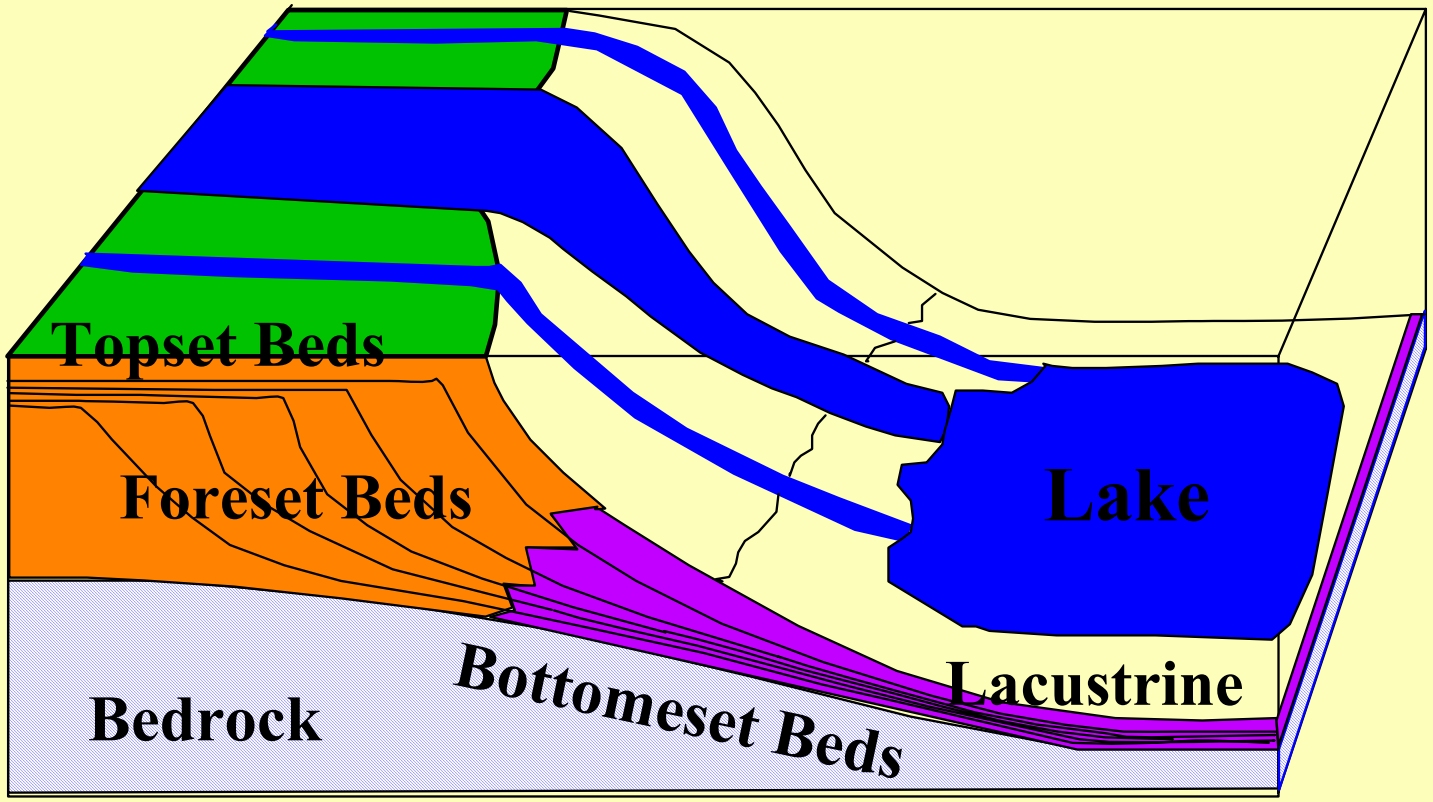
RDX Transformation Pathways



TNT Transformation Pathways

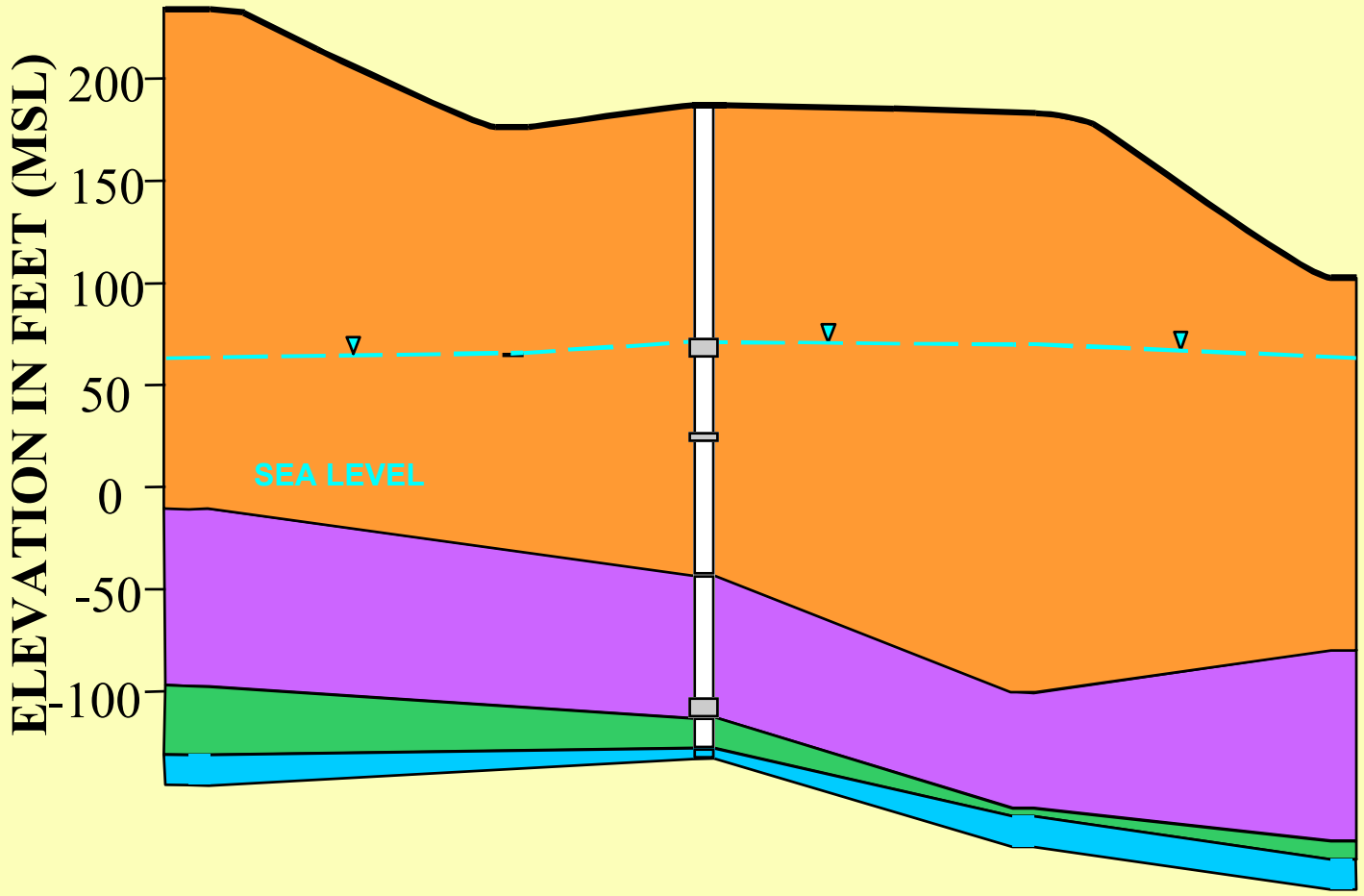


Sedimentary Sequence at MMR



Modified from Smith and Ashley, 1985

Conceptual Cross-Section



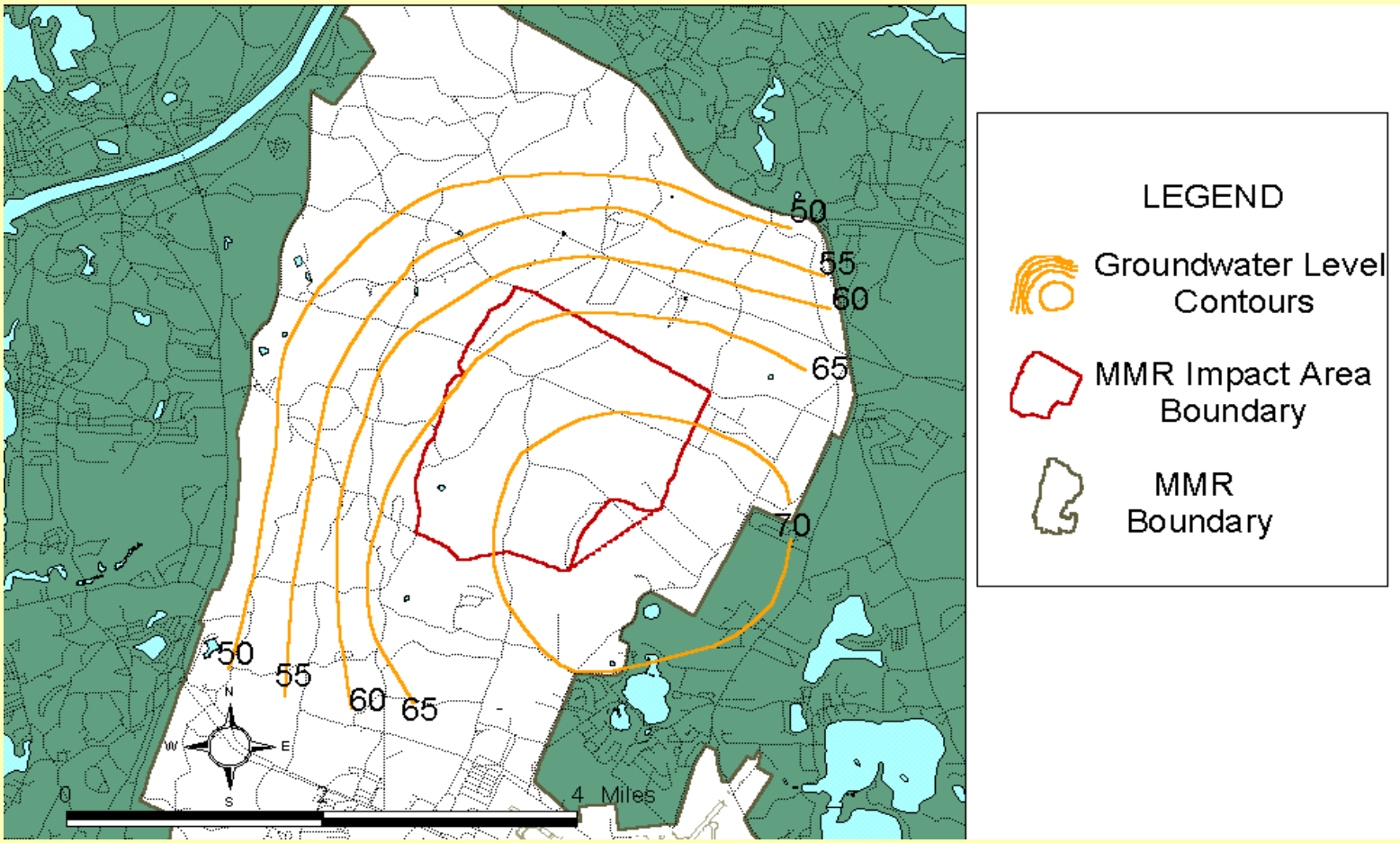
LEGEND

- VC Sand and Gravel
- VF Sand, Silt, and Clay
- Till
- Bedrock
- Water Table
- Well Screen

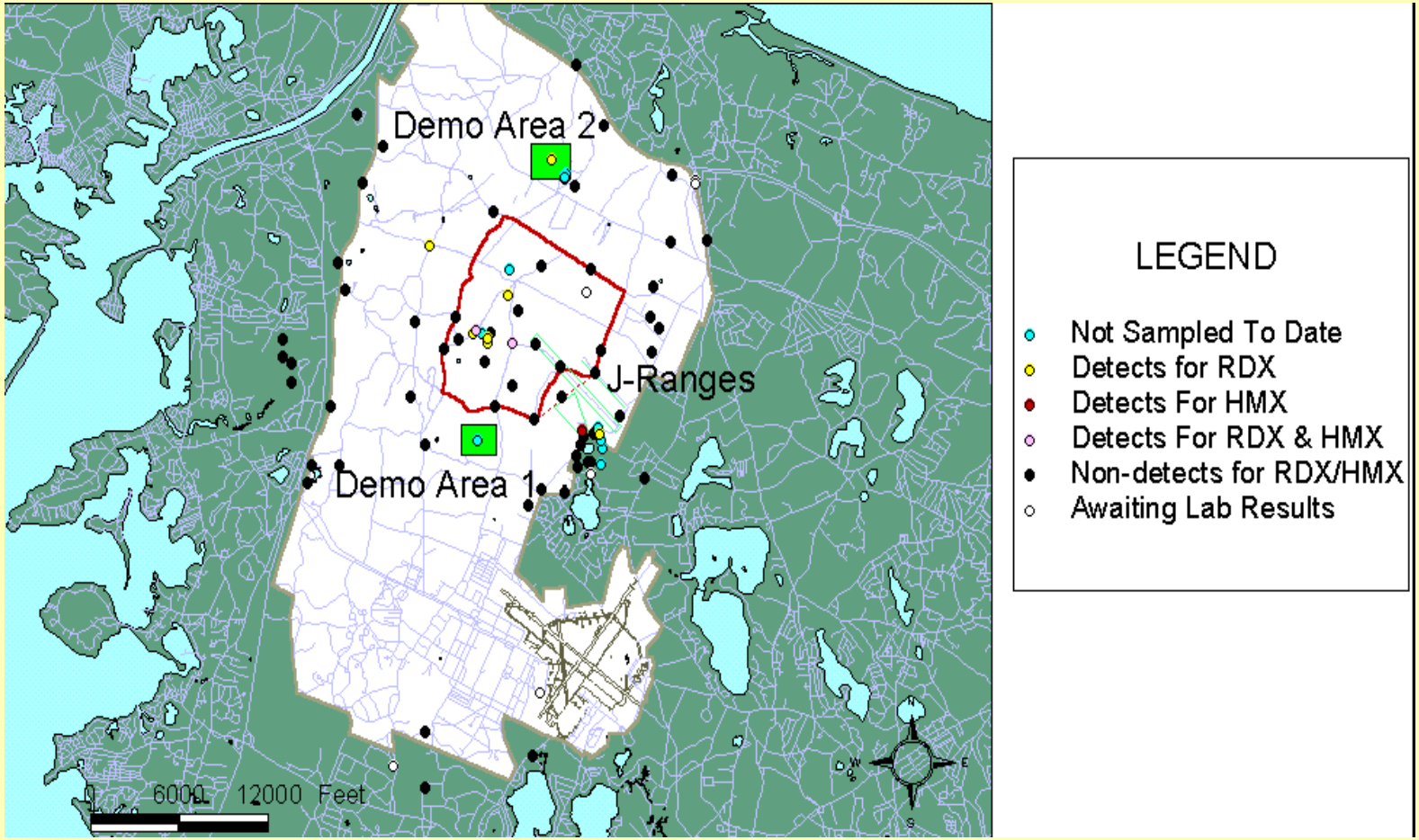
0 3000

HORIZONTAL SCALE:
1INCH = 3000 FEET
VERTICAL SCALE: 1" = 75'

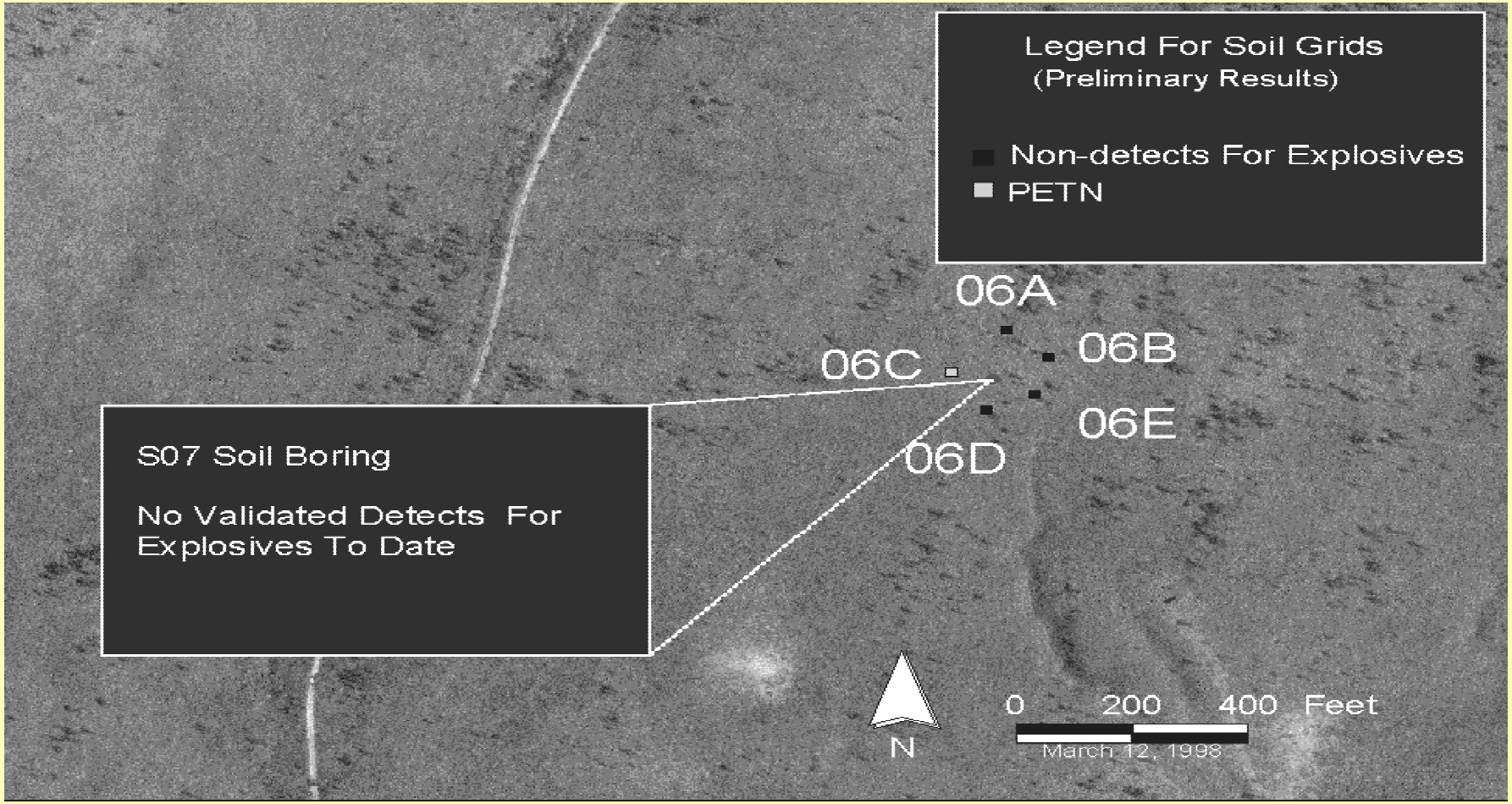
MMR Water Table



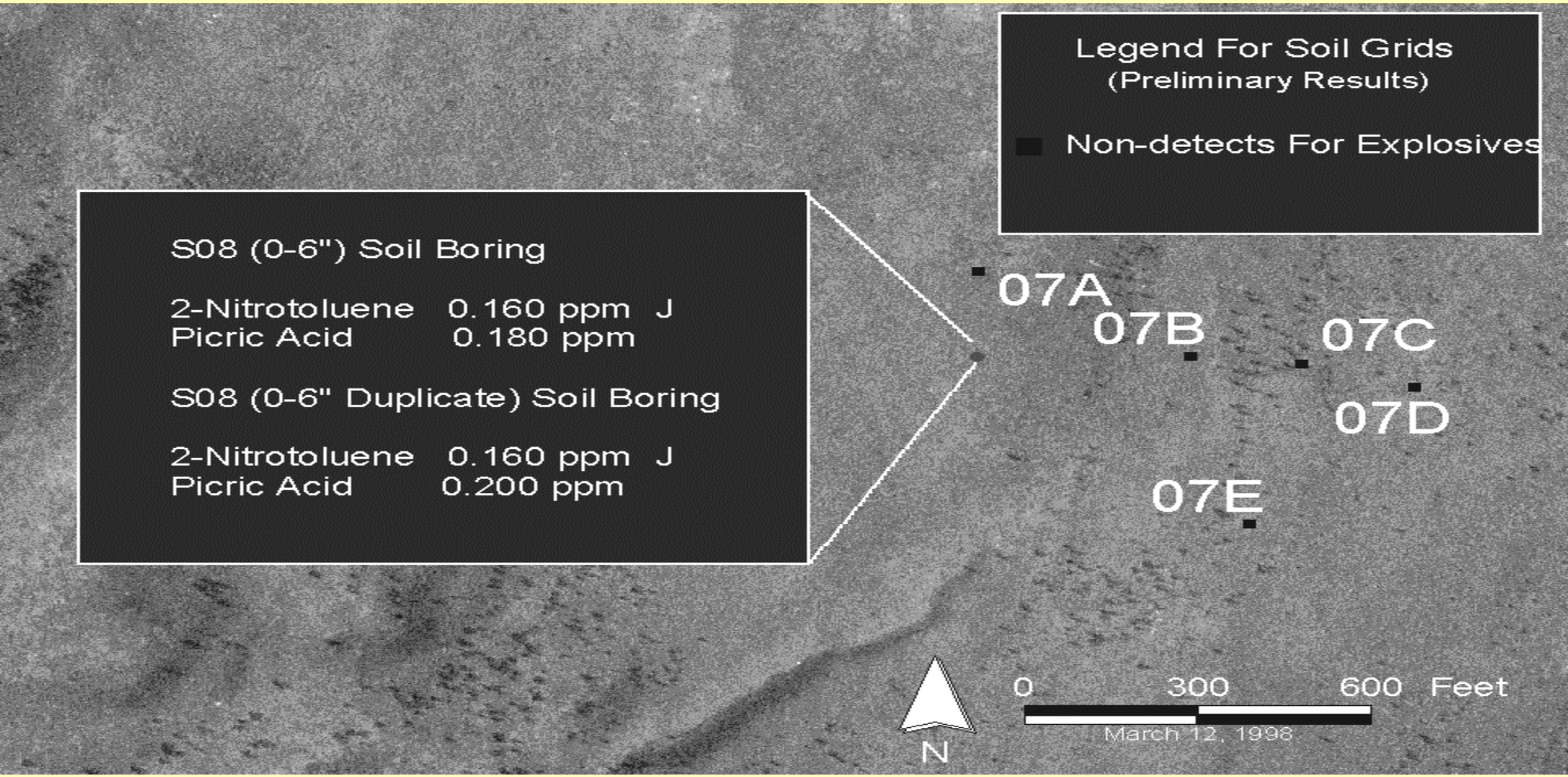
Groundwater Explosive Detects



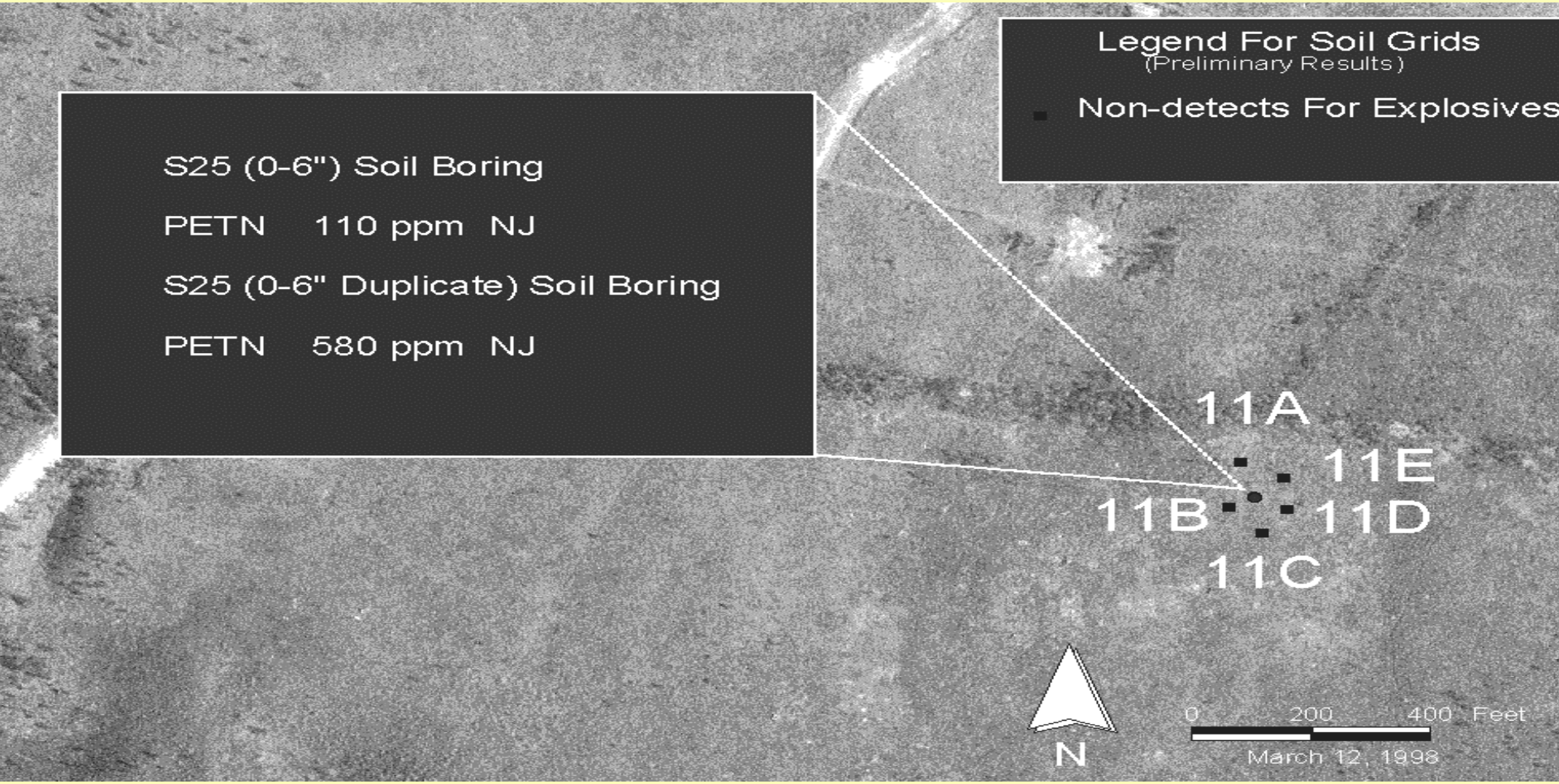
Soil Explosive Detects Area 6



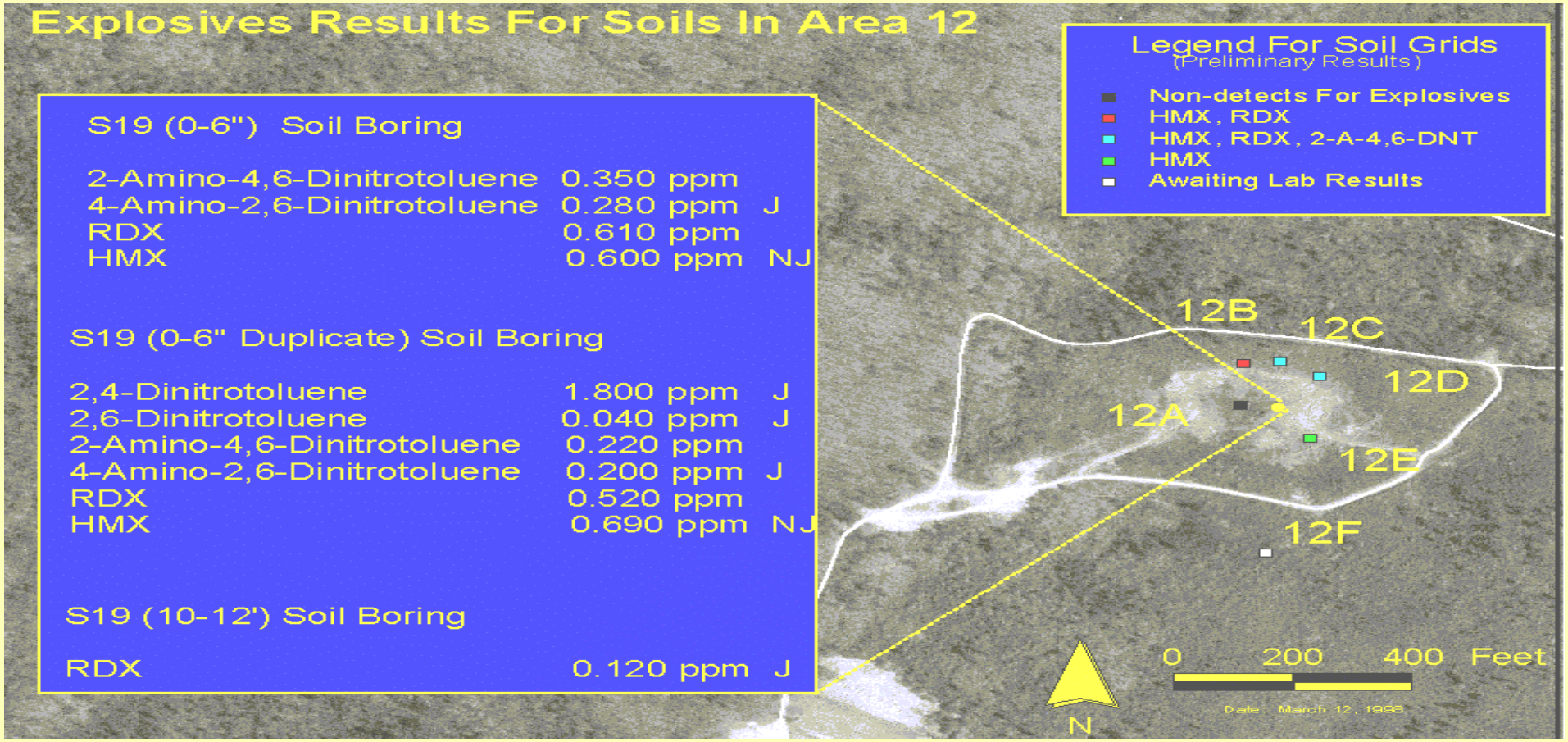
Soil Explosive Detects Area 7



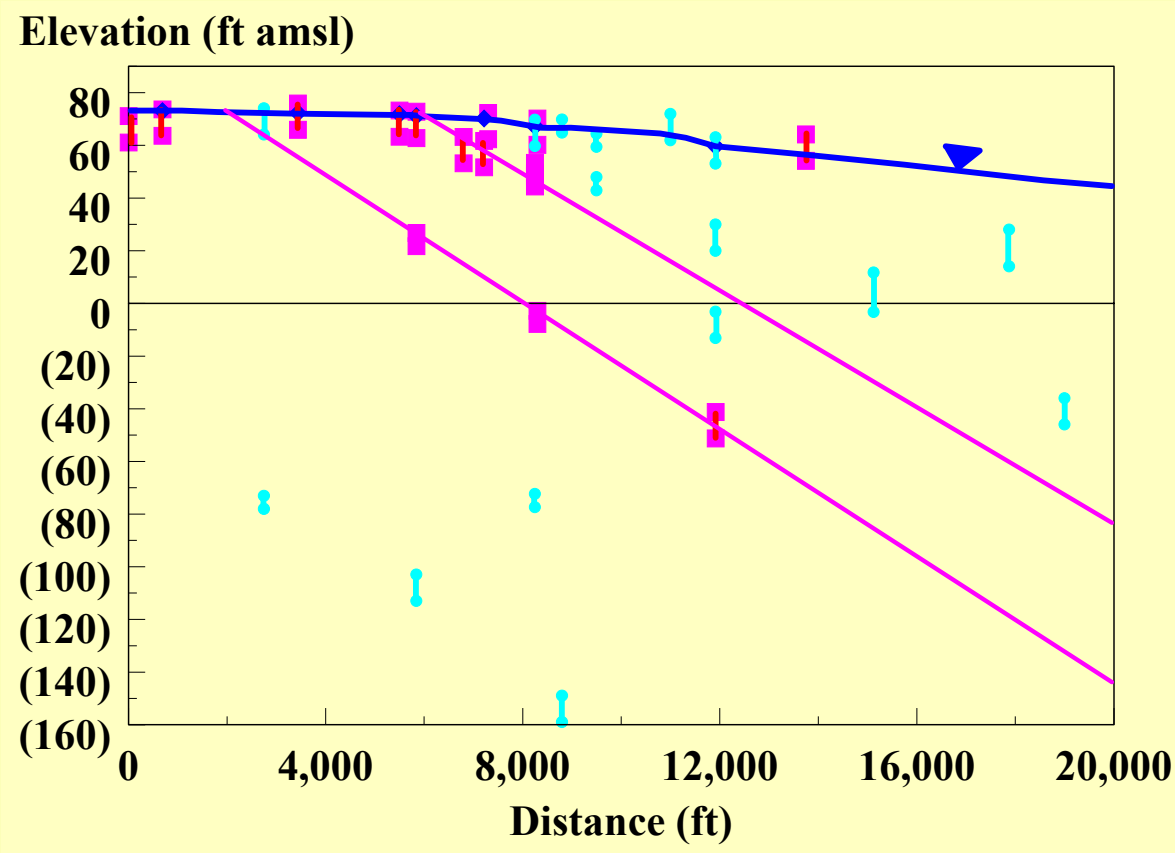
Soil Explosive Detects Area 11



Soil Explosive Detects Area 12

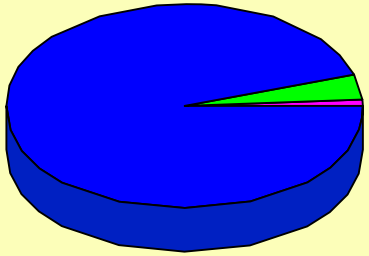


Explosive Depth Relationship

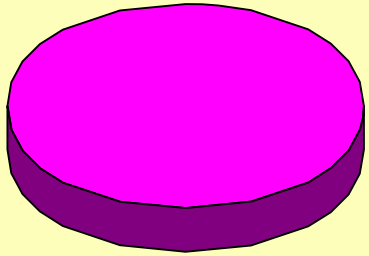


Explosive Distribution

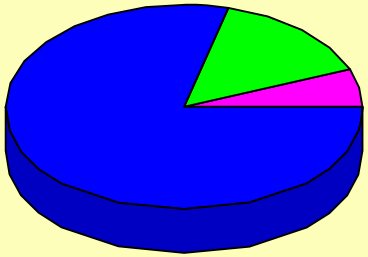
Well 1S



Well 1M, 2M, 23M1, 25S
CS19-6, CS19-5



CS19-9

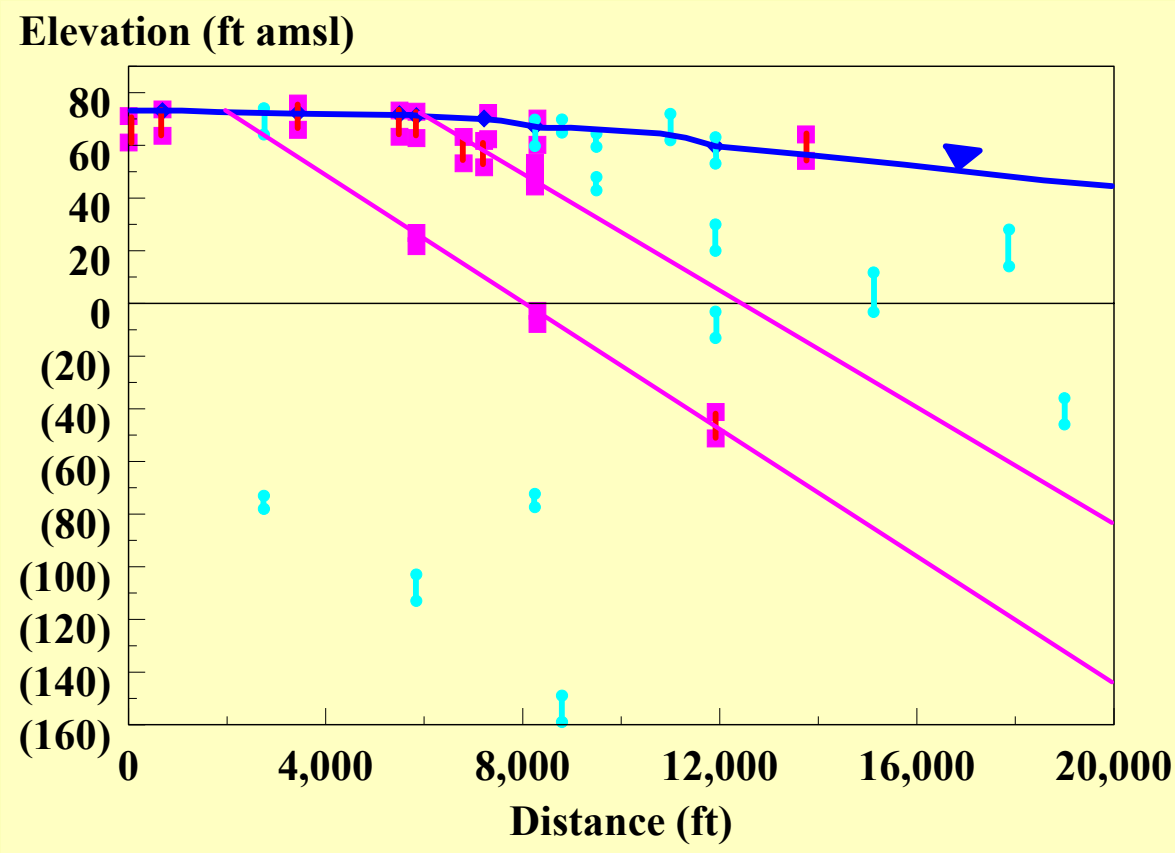


RDX

HMX

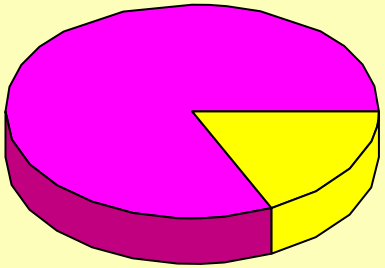
PETN

Explosive Depth Relationship

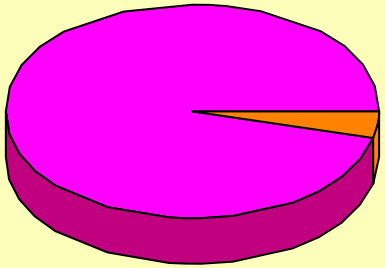


Explosive Distribution

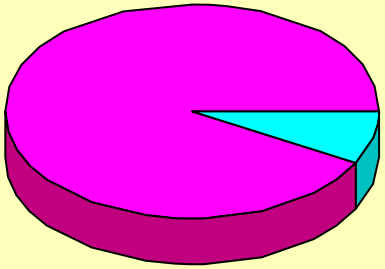
Well 16S

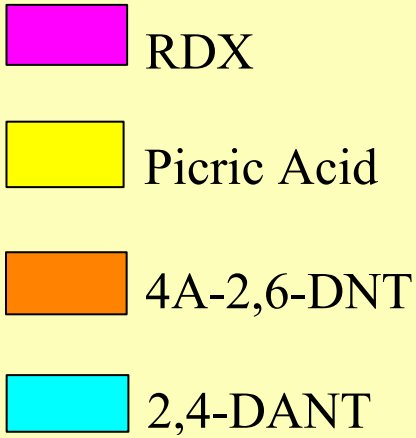


Well 30S

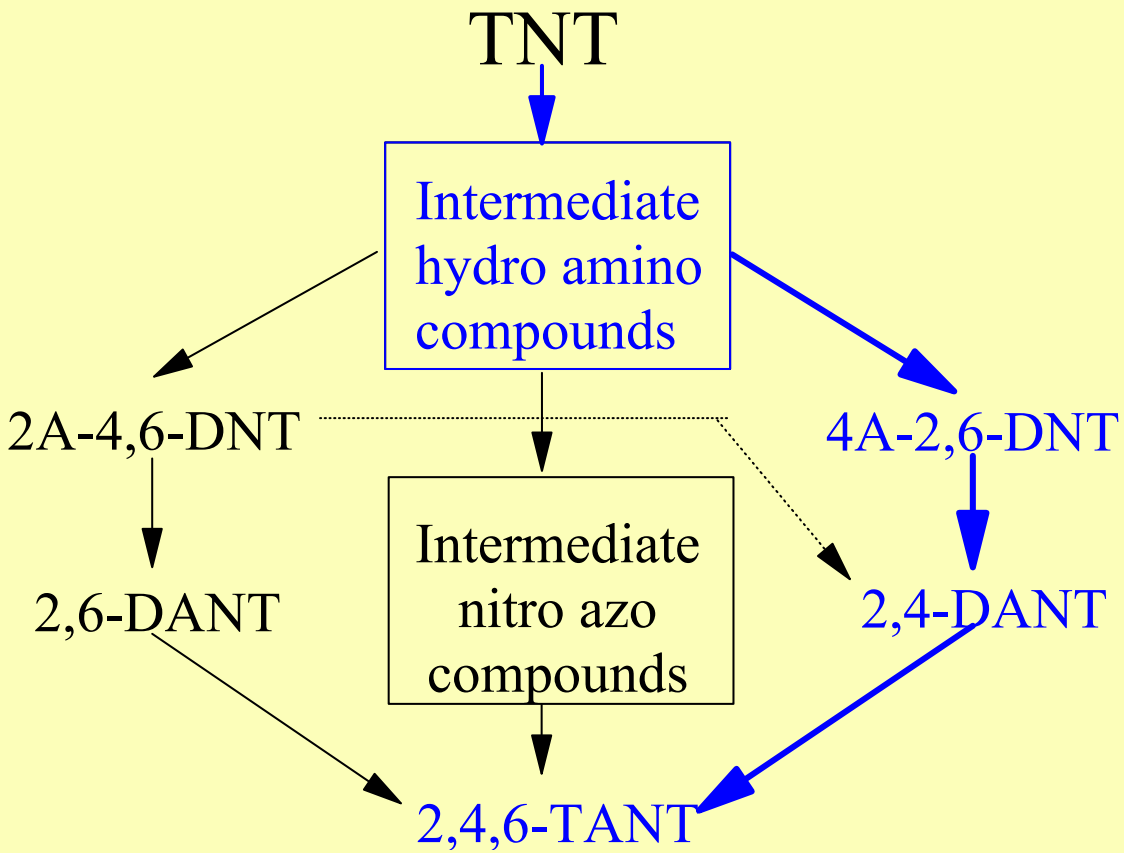


FS19-WT13





TNT Transformation Pathways



Conclusions

- Explosives present in surface soils
- Limited explosive subsurface soil contamination
- Absence of TNT suggests active biodegradation
- Groundwater contamination of RDX and HMX
- Groundwater explosive distribution may suggest multiple sources