Comprehensive List of Chemicals Likely to be Found at Military Ranges - A Case Study of Camp Edwards, Massachusetts

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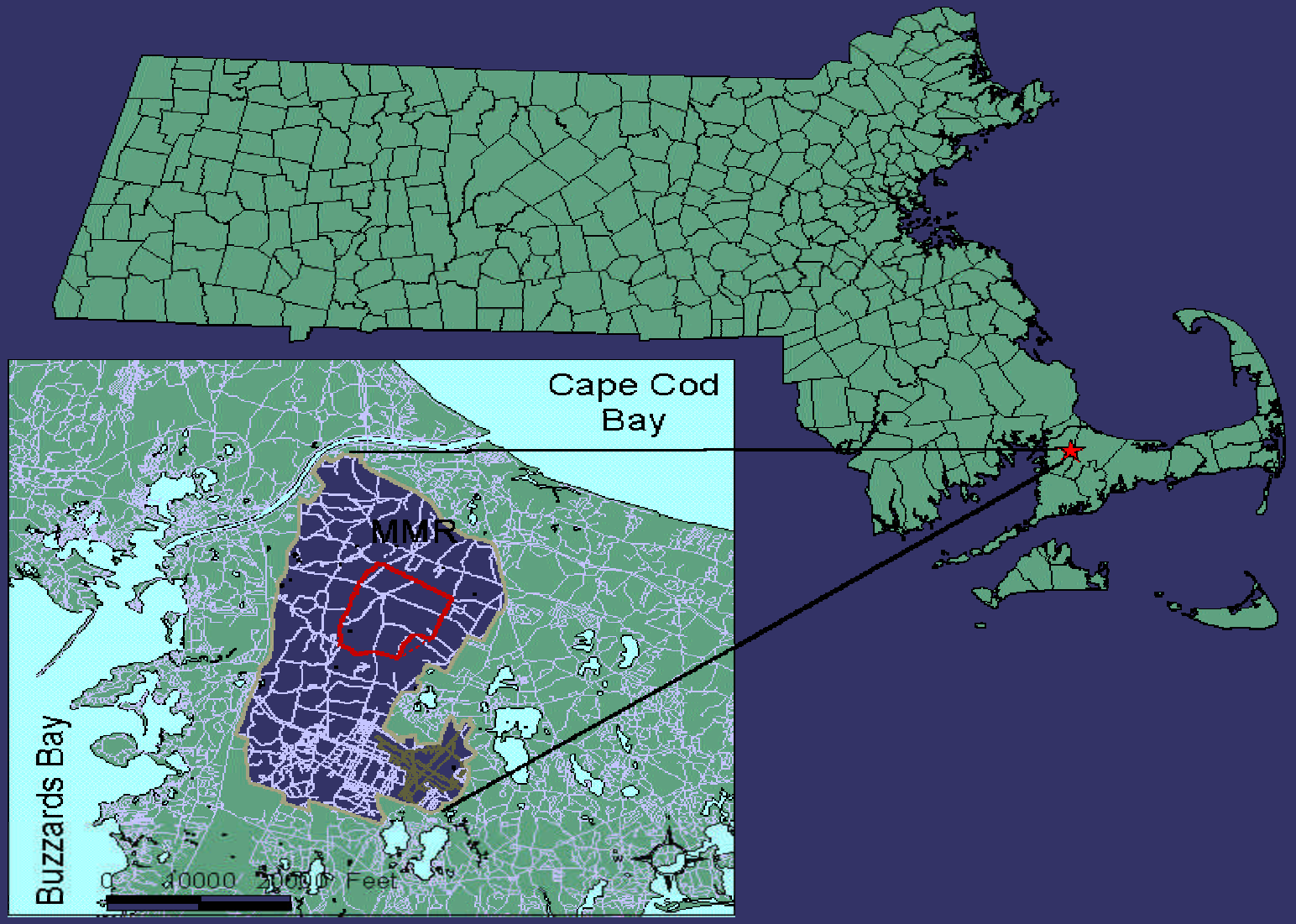
Location of Camp Edwards



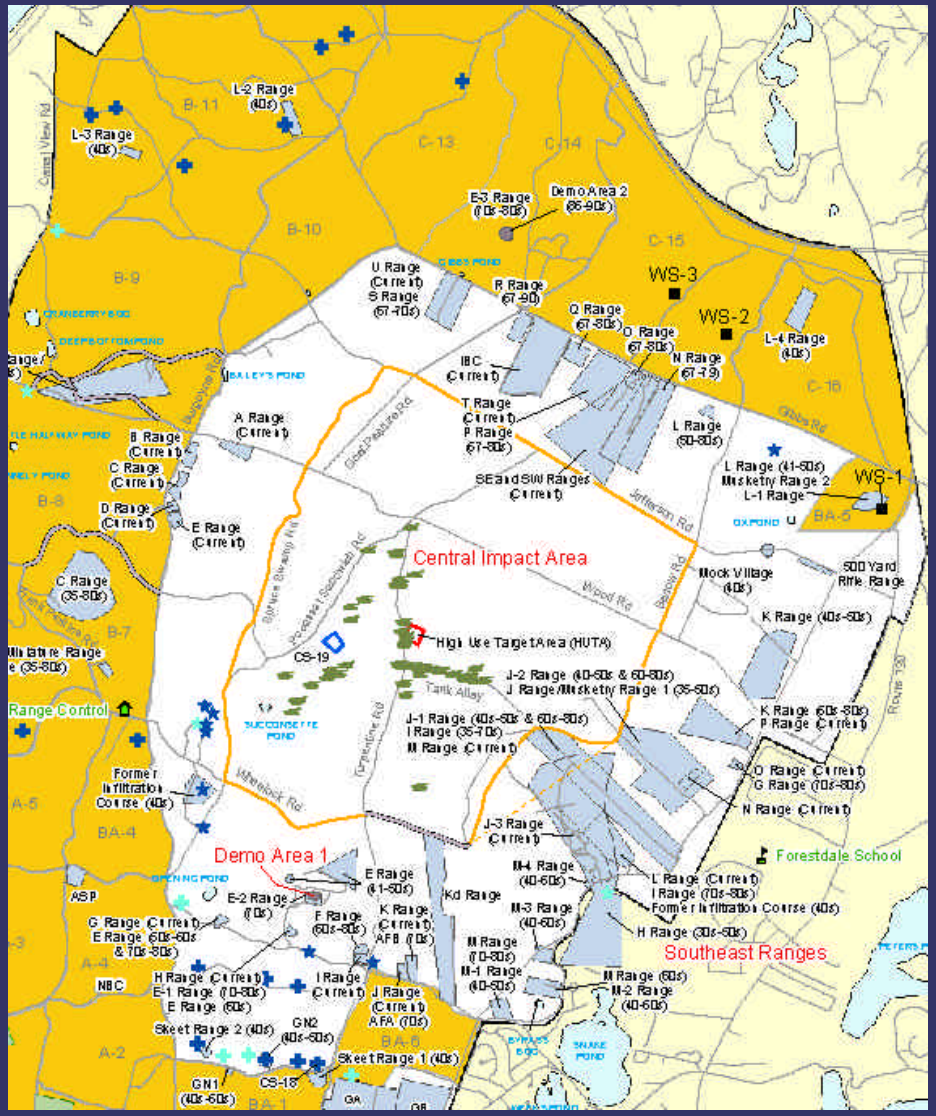
Site History

- Training and Impact Areas used since 1911
- Activities included small arms, machine gun, artillery, mortar, ground to ground rocket, air to ground rocket, open burning/open (OB/OD), detonation of explosive ordinance, and pyrotechnics training
- Designed to house 30,000 troops during WWII
- USEPA banned artillery and mortar training in 1997 through an Administrative Order
- Camp Edwards exhaustively studied

Introduction

- Over 200 compounds analyzed
  - Explosives
  - Volatile organic compounds (VOCs)
  - Semi-volatile organic compounds (SVOCs)
  - Pesticides/Herbicides
  - Polychlorinated biphenyls (PCBs)
  - Polychlorinated napthalenes (PCNs)
  - Dioxins/Furans
  - Metals
  - Other (White Phosphorous, Cyanide, Dyes, Anions)
- Tentatively identified compounds (TICs) exhaustively evaluated

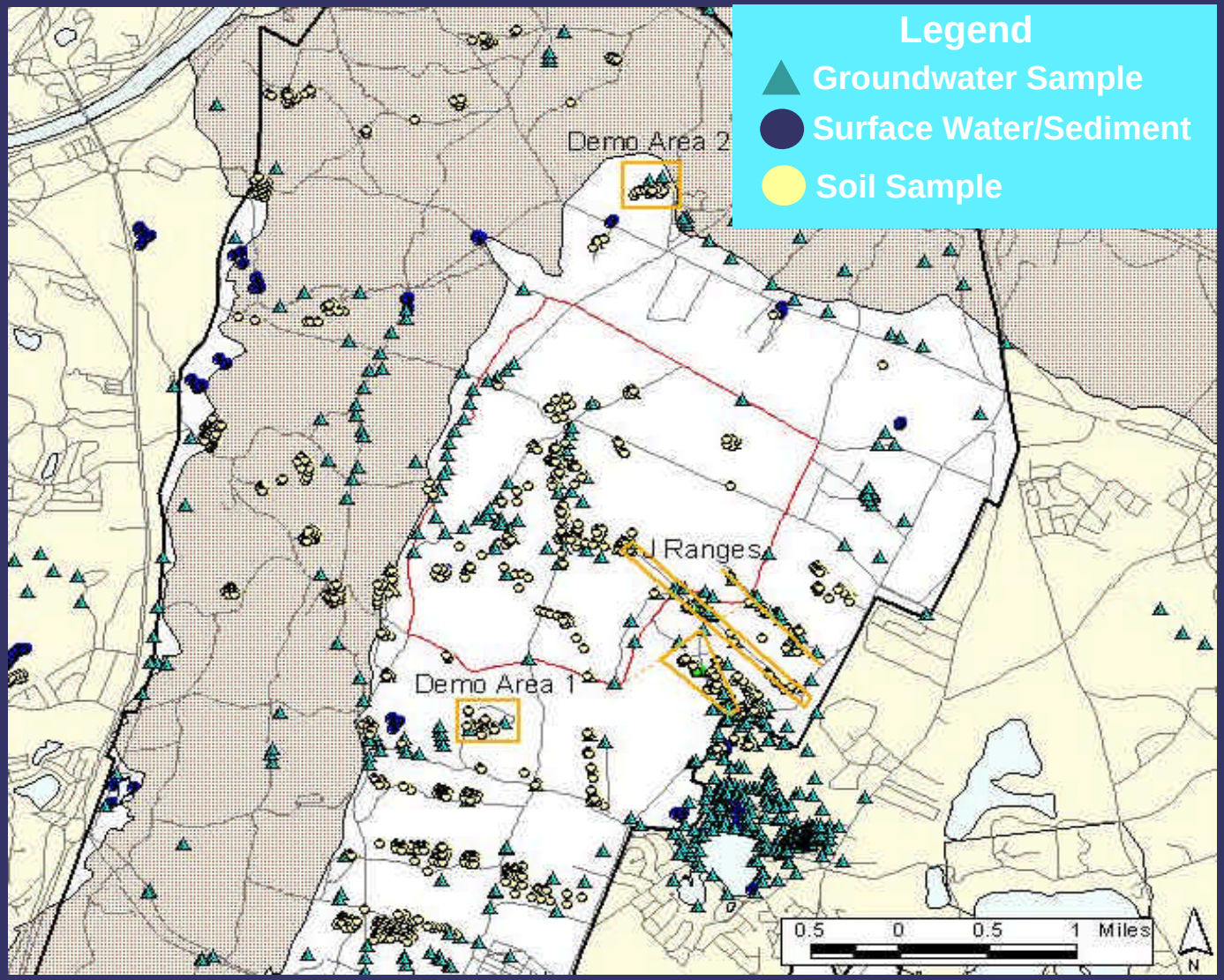
Training Areas at Camp Edwards



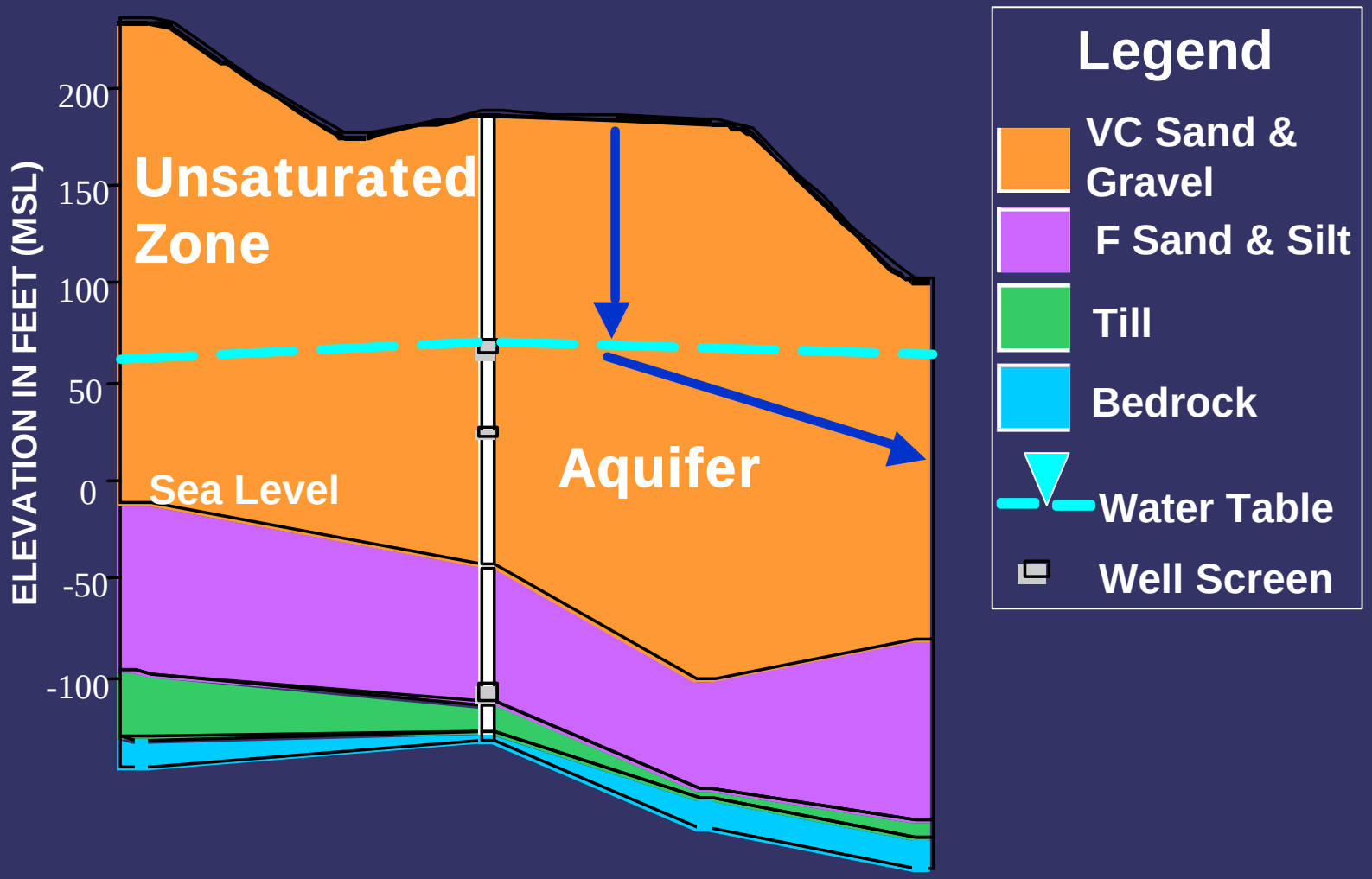
Samples Collected by Media

- 7,800 surface soil samples (0 to 2 ft)
  - 1,989 individual locations
  - 182 areas of investigation;
- 1,533 soil boring profile samples (10 to 300 ft) from 146 borings
- 69 sediment samples from 19 water bodies
- 64 surface water samples from 19 water bodies
- 5 storm water samples from the perimeter of the Impact Area
- 3,959 groundwater profiling samples from 256 borings
- 1,467 groundwater samples
  - 651 monitoring wells at 256 locations

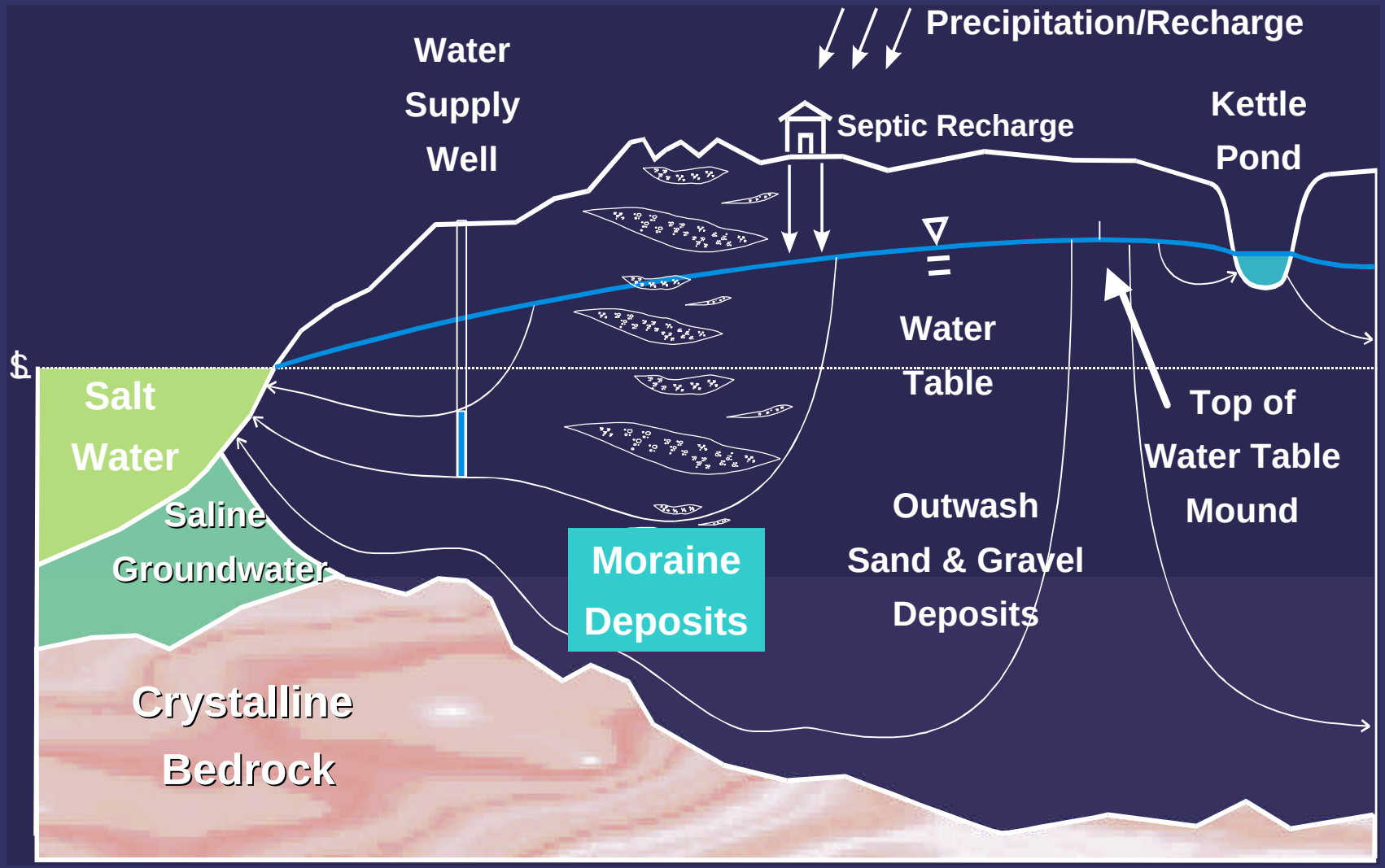
Sample Locations at Camp Edwards



Lithology at Camp Edwards



Hydrogeological Conceptual Model



Soil Analytical Methods

Analytes	Methods
VOC (except background locations)	OLC 02.1
Explosives (except background locations)	8330
Metals	6010
Cyanide	ILM04
Pesticides/PCBs	OLC02.1
SVOC (Note: changed to modified 8270 in 2000)	OLC02.1
Herbicides	8151
Phosphate-phosphorous	365.2
Nitrate/Nitrite-nitrogen	353.2
Ammonia-nitrogen	350.2
MTBE	8021
EDB	504.1
VOCs	OLM 03.01

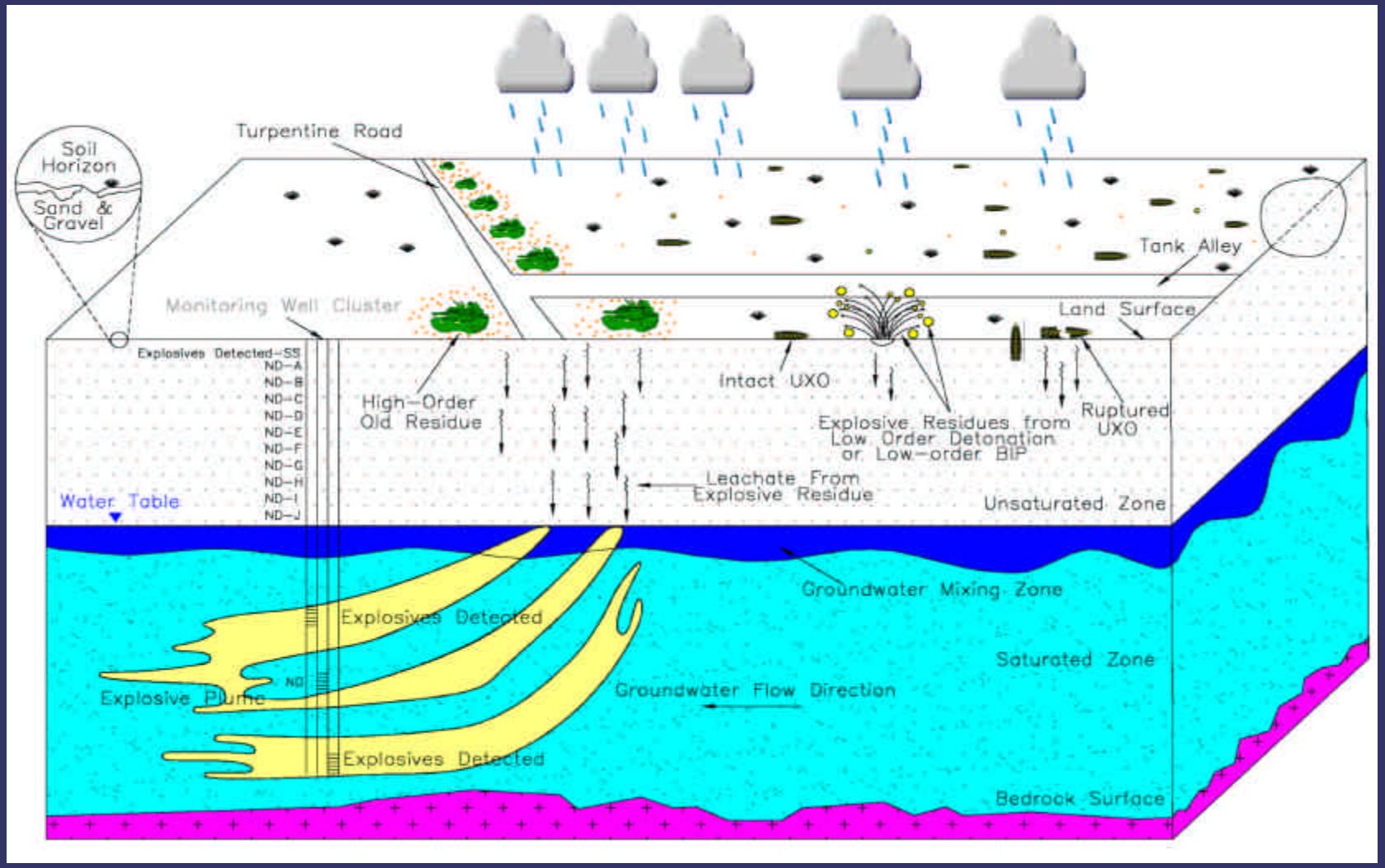
Groundwater Analytical Methods

Analytes	Methods
VOC (except background locations)	OLC 02.1
Explosives (except background locations)	8330
Metals	6010
Cyanide	ILM04
Pesticides/PCBs	OLC02.1
SVOC (Note: changed to modified 8270 in 2000)	OLC02.1
Herbicides	8151
Hardness as Calcium Carbonate	130.1
Phosphate-phosphorous	365.2
Nitrate/Nitrite-nitrogen	353.2
Ammonia-nitrogen	350.2
MTBE (except background locations)	8021
EDB (except background locations)	504.1

Explosive Analyte List for Camp Edwards

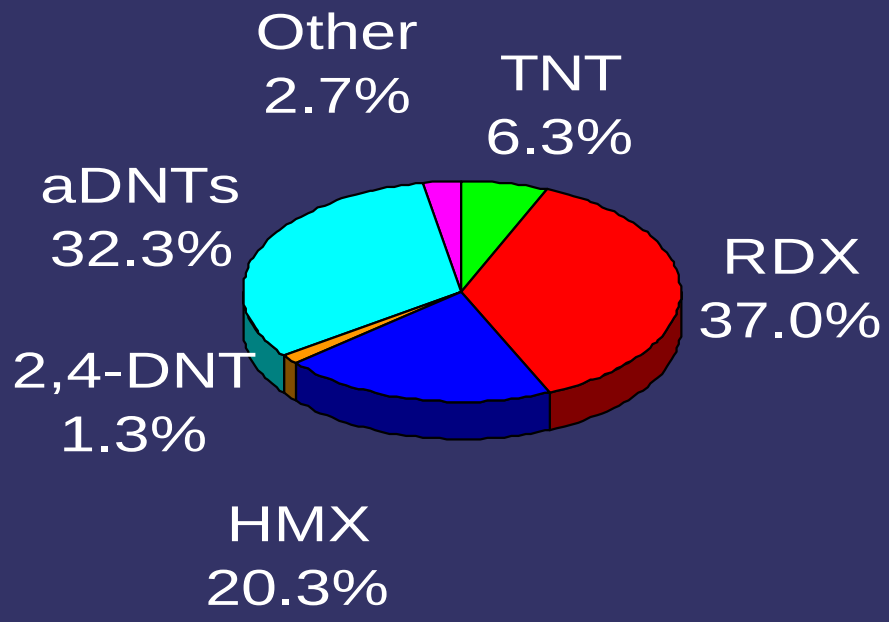
1,3-dinitrobenzene
1,3,5-trinitrobenzene (TNB)
2-amino-4,6-dinitrotoluene (2A-DNT)
4-amino-2,6-dinitrotoluene (4A-DNT)
2,4-diamino-6-nitrotoluene (2,4-DANT)
2,6-diamino-4-nitrotoluene (2,6-DANT)
2,4-dinitrotoluene (2,4-DNT)
2,6-dinitrotoluene (2,6-DNT)
2-nitrotoluene (2-NT)
3-nitrotoluene (3-NT)
4-nitrotoluene (4-NT)
dinitroso-hexahydro-1,3,5-triazine (DNX)
nitroso-dinitro-hexahydro-1,3,5-triazine (MNX)
tri-nitroso-hexahydro-1,3,5-triazine (TNX)
octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
nitrobenzene
Nitroglycerine (NG)
pentaerythritol tetranitrate (PETN)
Picric acid (PA)
hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
2,4,6-trinitrotoluene (TNT)
tetryl

Contaminant Transport Conceptual Model

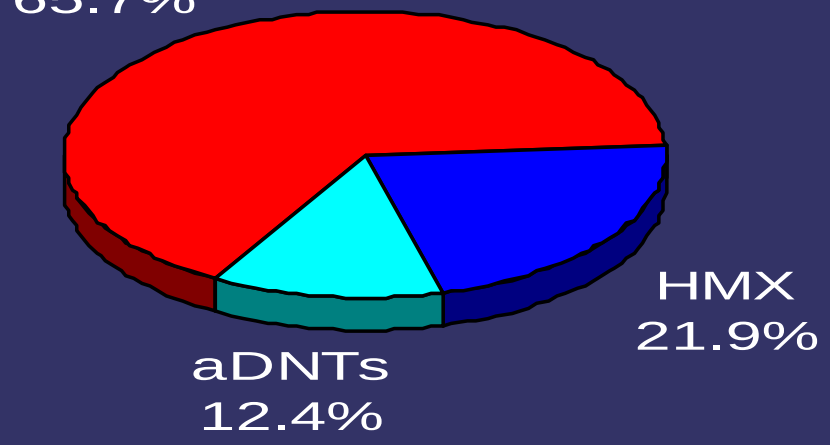


Impact Area Explosive Distribution

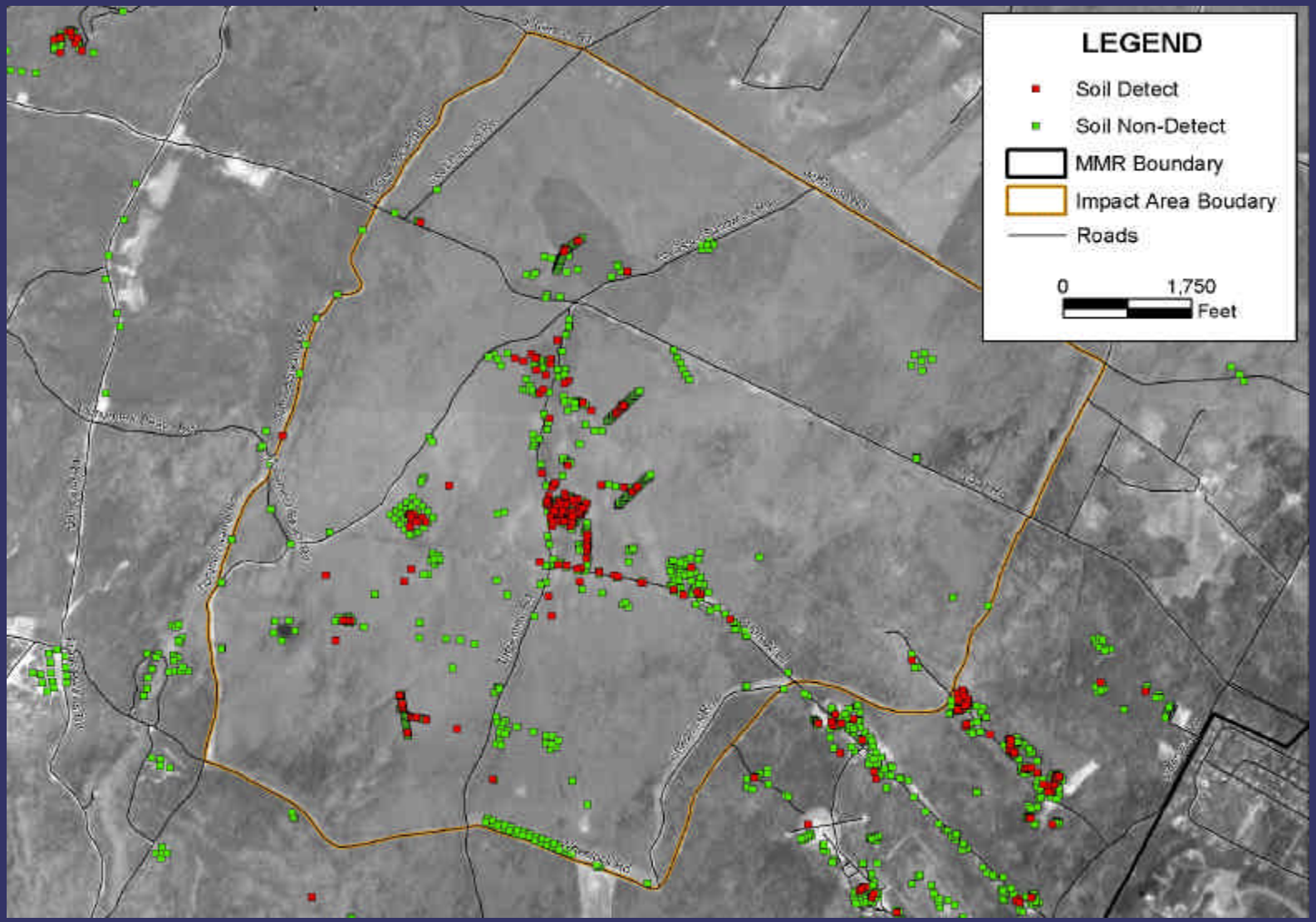
Soil



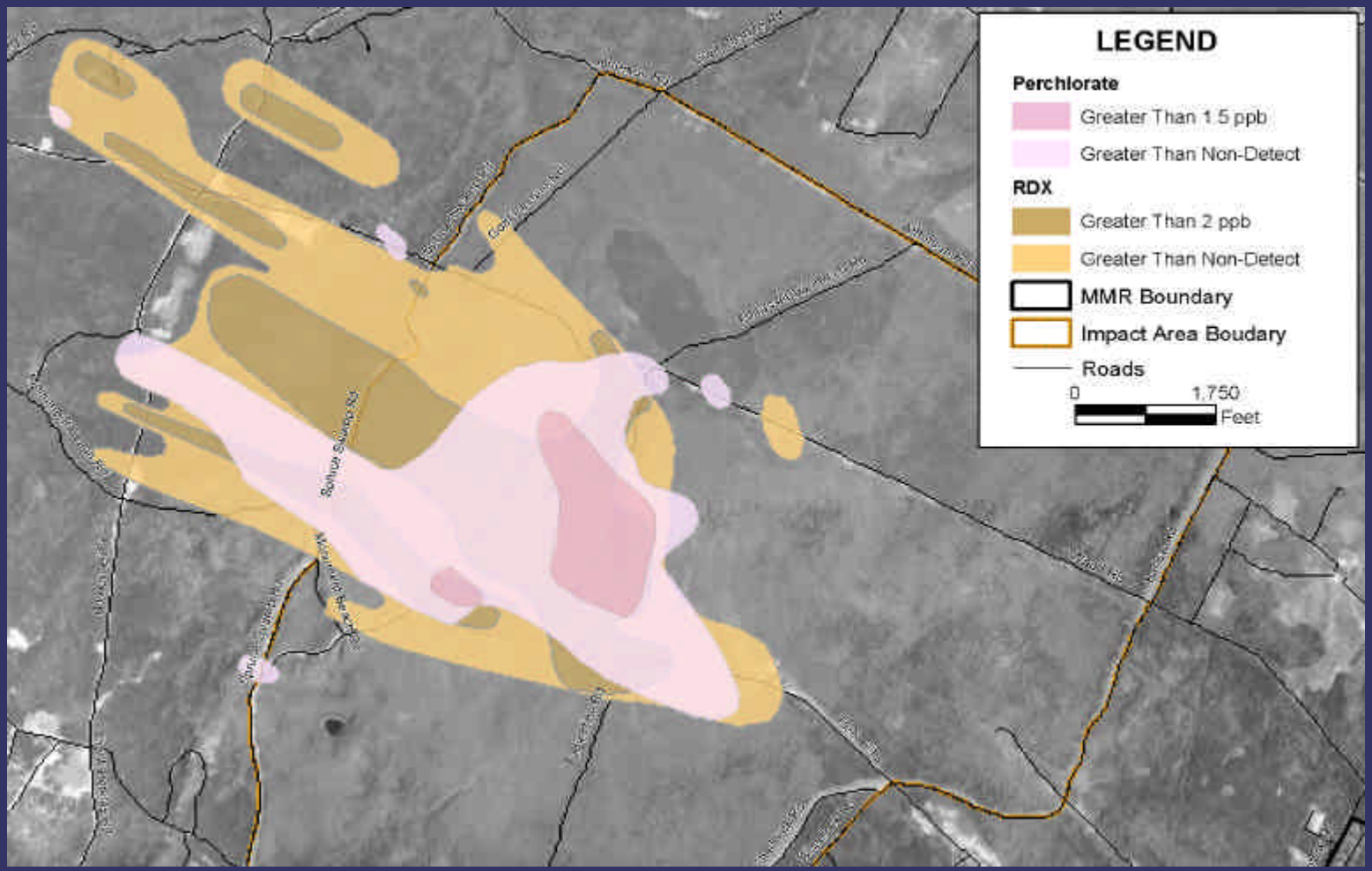
Groundwater



Explosive Soil Detections in the Impact Area



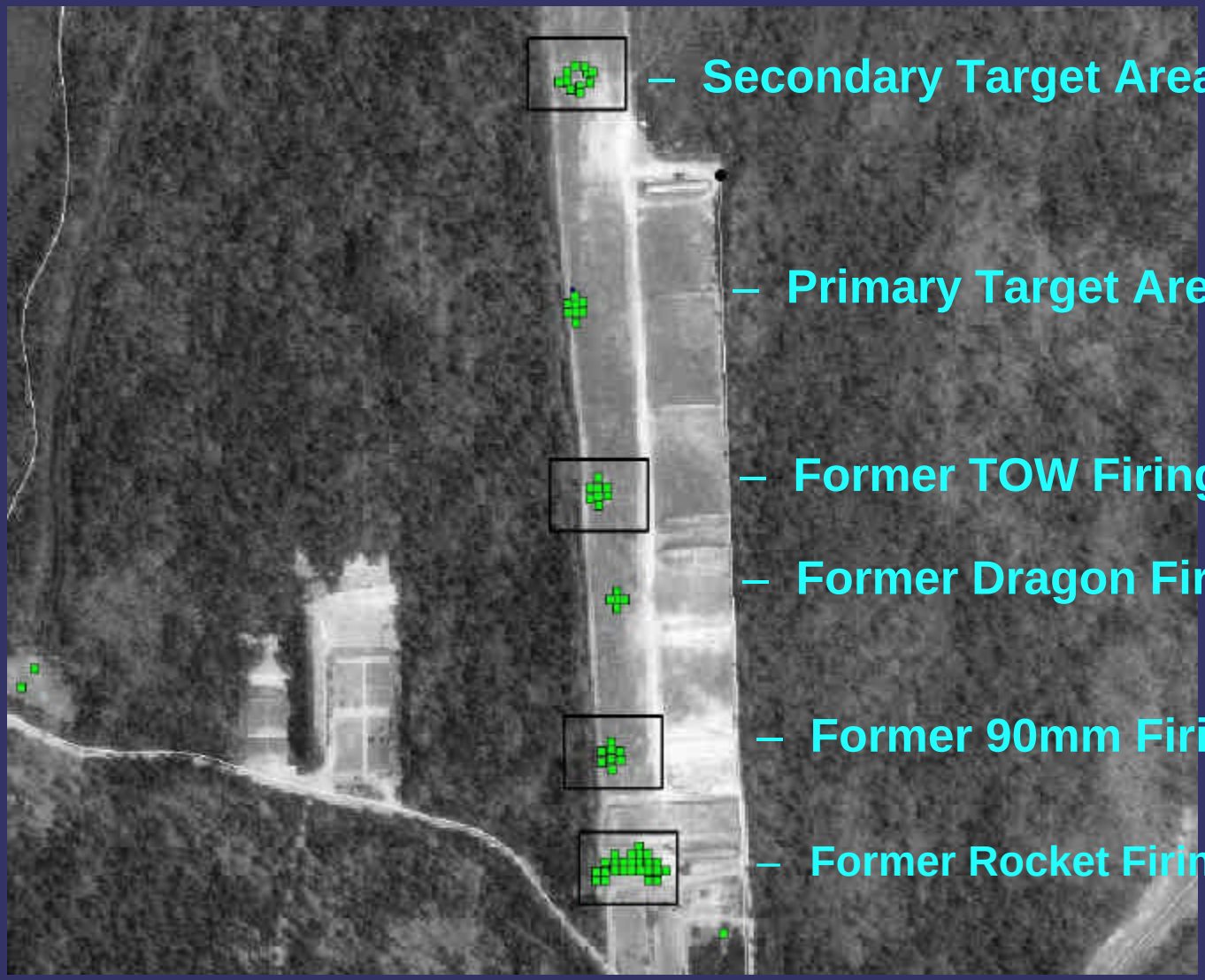
RDX and Perchlorate Groundwater Distribution in the Impact Area



Gun and Mortar Firing Position Findings

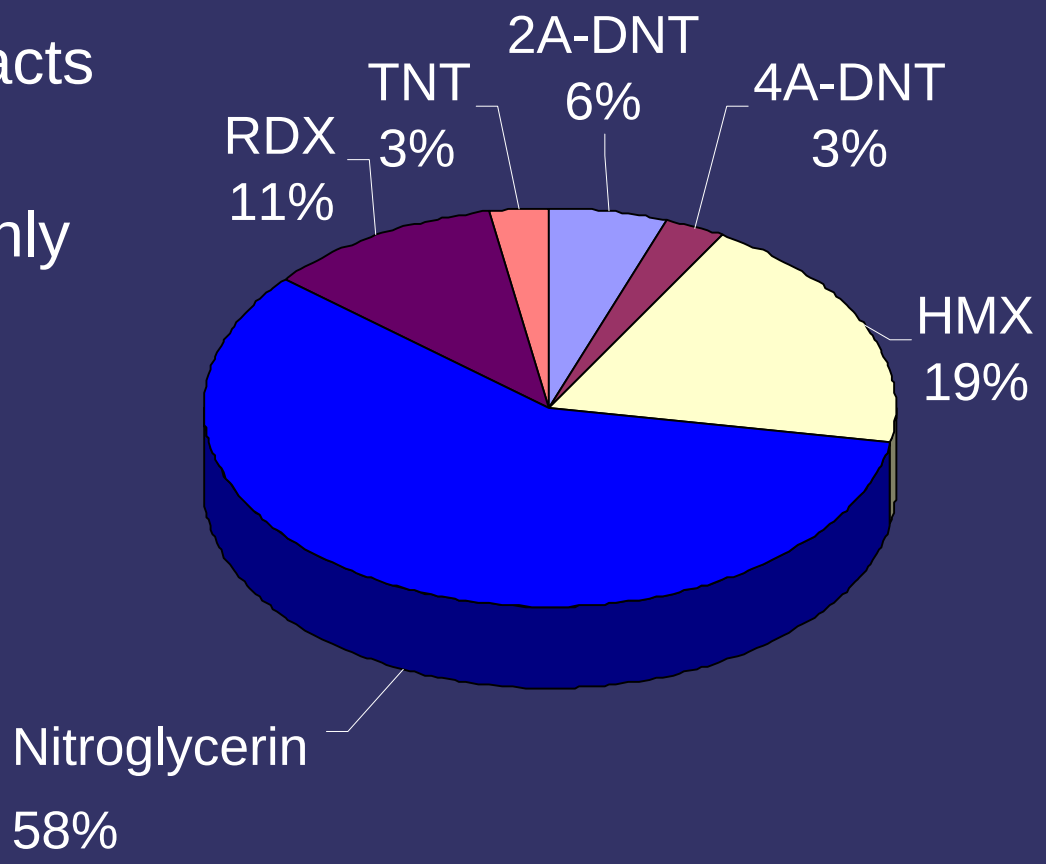
- 37 positions evaluated
- 1,200 soil samples collected
- M1, M2, & M3 propellant used
- 39 soil COPCs identified
  - 2,4-DNT (4%)
  - 2,6-DNT
  - Diethyl phthalate
  - N-nitrosodiphenylamine
  - Lead
- Soil contamination limited to 2 ft
- No groundwater impacts observed

KD Rocket Range



KD Rocket Range Findings

- 300 soil samples collected
- Soil contamination limited to 2 ft
- No groundwater impacts observed
- Nitroglycerin found only at firing points



Demolition Area 1

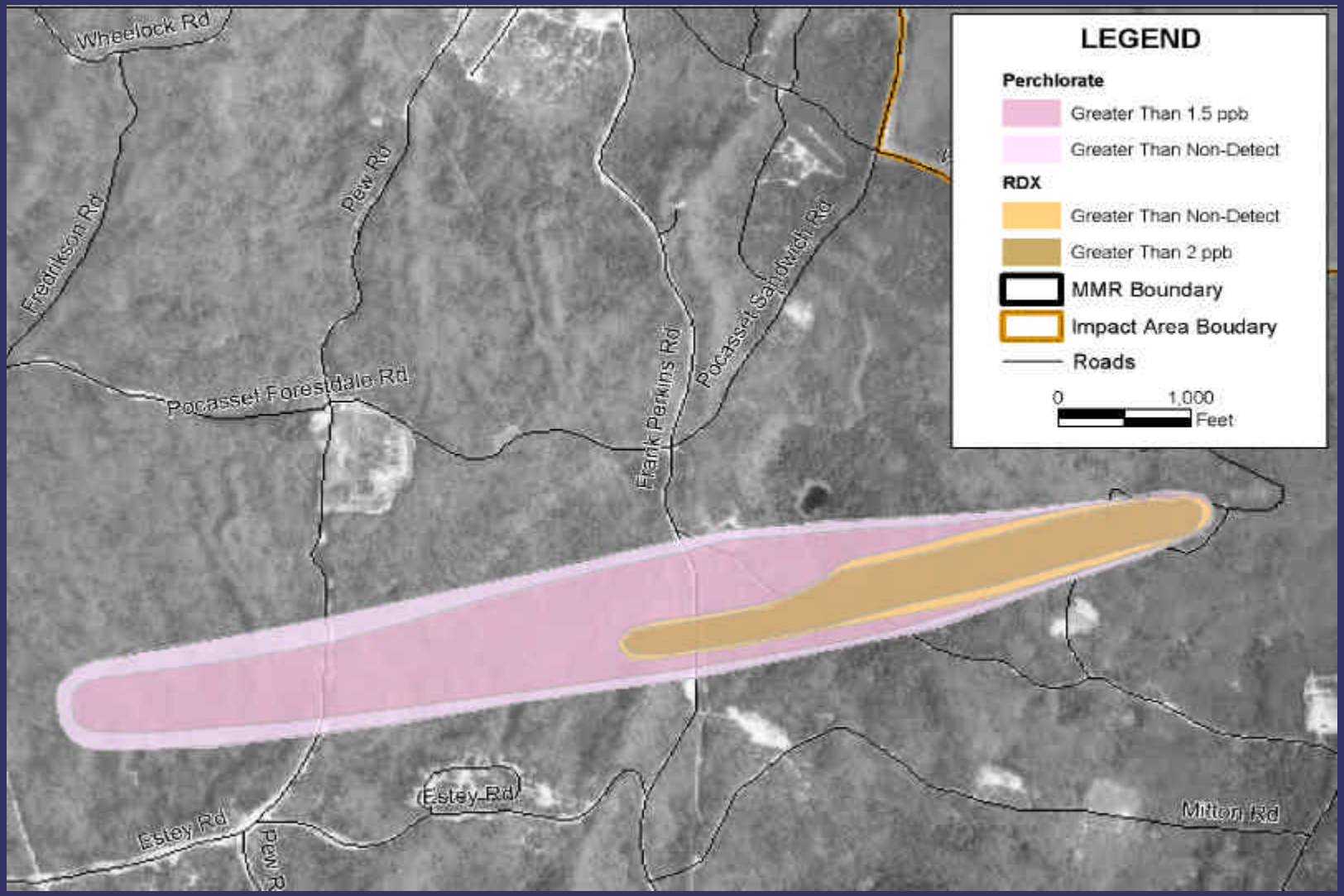
- Site used for OB/OD activities and Engineer and EOD training
- Over 500 soil samples have been collected

- Perchlorate, dyes, and dioxin/furans added to standard analyte list

Demolition Area 1 Findings

- Perchlorate, RDX, HMX, 2A-DNT, 4A-DNT, and TNT routinely detected in soil
- Di-n-butyl phthalate, N-nitrosodiphenylamine antimony, barium, calcium, copper, lead, manganese, silver and zinc exceeds background.
- A dye, perchlorate, and dioxin were detected in soil at low-levels
- Explosives and perchlorate detected in groundwater forming a plume

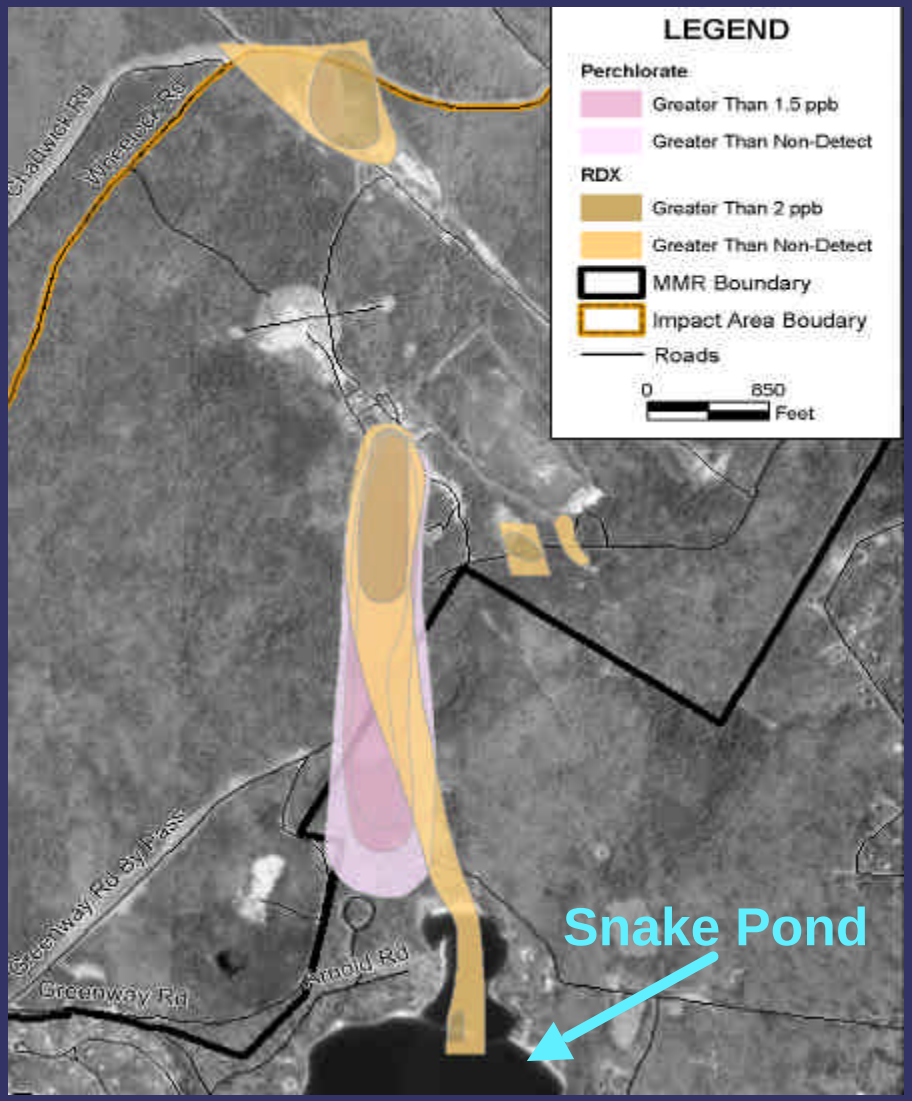
Groundwater Contaminants at Demo 1



J Ranges Findings

- Consists of 4 ranges used by defense contractors for munitions testing
- 800 surface soil samples collected
- Explosives and polychlorinated napthalenes detected in soil
- 61 monitoring wells have been installed with over 800 groundwater samples collected
- RDX, HMX, and perchlorate present in groundwater forming several plumes

J Ranges Groundwater Plumes



Conclusions

- Camp Edwards represents an extreme environment in regards to contaminant mobility
- PEP compounds are present in soil from a variety of activities; firing positions, firing ranges, OB/OD, EOD, weapons testing, and rocket ranges
- Method 8330 may not be sensitive enough for range investigations unless method modifications are considered
- Explosives and perchlorate should be the only analytes of interest for range soils
- Perchlorate, metals, and PCNs may be appropriate if a surface risk pathway exists on ranges
- At gun and mortar firing positions SVOCs should be considered if a surface risk pathway exists on ranges

Conclusions (continued)

- If rocket firing positions are investigated Method 8330 should be modified to improve the sensitivity to NG
- Methods used for ranges would be appropriate at OB/OD sites with possible addition of SVOCs and dioxins
- No evidence warranting the collection of VOCs, SVOCs, herbicides/pesticides, PCBs, dioxins, or evaluating TICs for range soils
- NG and 2,4-DNT not mobile
- Explosives and perchlorate are the only warranted analytes for groundwater
- No other analyte suites (VOCs, SVOCs, pesticides, herbicides, PCBs, metals, PCNs, dioxins, dyes, or TICs) should be evaluated in groundwater