Field Demonstration and Method Validation of NRL Environmental Immunosensors

Center for Bio/Molecular Science and Engineering
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Executive Summary

To meet environmental remediation goals, there is a need for rapid, quantitative detection of hazardous pollutants such as explosives. Biosensors provide a rapid, specific, sensitive, portable, and inexpensive means to fulfill those needs. The Naval Research Laboratory has developed two methods for measuring TNT and RDX. These methods employ either the Analyte 2000 or the FAST 2000 optical instruments, both engineered by Research International (Woodinville WA) in collaboration with NRL. These biosensors, based on fluorescence immunoassay techniques, are interfaced to portable computers for instrument control and data analysis. Both biosensors are portable, and easily set-up within 30 minutes on a small table. The Analyte 2000 is a fiber optic biosensor capable of simultaneously monitoring four optical probes. It is based on a competitive fluoroimmunoassay, in which a fluorescent molecule, similar to the analyte, competes with the analyte for binding sites on antibodies immobilized on the surface of an optical probe. In this format, the fluorescence signal is inversely proportional to the amount of analyte in the sample. Results are determined in 12-17 minutes depending on the analyte. Multiple analyses are performed on the same fiber probe to reducing probe to probe variation issues for quantitation.

The Fast 2000 is a continuous flow immunosensor based on a displacement immunoassay, with the key components being antibodies specific for the analyte immobilized on a membrane support, fluorescent signal molecules similar to the analyte saturated on the immobilized antibodies, and a fluorescent detector. Upon injection of an explosive contaminated sample, fluorescent signal molecules are released into the flow stream and detected by a detector. The FAST 2000 quantitates samples with minimal sample preparation and reagent addition. Analysis is complete within five minutes, with the fluorescent signal being proportional to the analyte concentration in the sample.

To demonstrate these methods, extensive field trials (three for groundwater and one for soil), were conducted at several geochemically diverse sites. The groundwater sites, SUBASE Bangor (Washington), Umatilla Army Depot (Oregon) and NSWC Crane (Indiana), are on the U.S. EPA Superfund list. Additional soil samples from several sites were supplied by T. Jenkins (Cold Regions Research and Engineering Laboratory). Data was used to test detection limits (5-10 ppb in groundwater and 50-100 mg/kg for soil), reproducibility, bias, precision, calibration, waste generation, and matrix effect on detection limits. Cost analysis for the methods was also done. Comprehensive laboratory tests were performed to determine cross-reactivity and false positive/negative rates. In addition to the validation studies, limitations and appropriate scenarios for application of the methods were evaluated.

Overall, results for the biosensors suggest that the instruments are promising field technologies that will require additional development before they are suitable for field use. The instruments were simple to use, required minimal sample preparation, were easily carried to the field and generated minimal waste. Determinations of TNT and RDX levels in spiked water samples were accurate and precise down to 10 μg/L, with acceptable levels of false positive/false negative values. However, significant problems were encountered with respect to accuracy and precision in environmental sample measurements. In general, the biosensors were predictive and gave similar yes/no results

as the direct injection protocol of U.S. EPA SW846 Method 8330 (high performance liquid chromatography) at the field detection limit of 20 µg/L . Site-specific matrix effects produced a large scatter in data points, with a lower level of agreement to HPLC quantitative values for several data sets when compared to the field spike results. Of particular concern was the large number of false positive values for the TNT assay. Further development of the technologies will focus on improved assay performance in environmental matrices, sample preparation for low-end detection, and improved signal processing and instrument calculations to remove user bias.

Table of Contents

List of Tables vii

List of Figures ix

Acronyms xi

1. Introduction 1
    1.1 Background Information 1
    1.2 Official DoD Requirement Statement(s) 2
        1.2.2 How Requirement(s) Were Addressed 2
    1.3 Objectives of the Demonstration 2
    1.4 Regulatory Issues 3
    1.5 Previous Testing of the Technology 3

2. Technology Description 3
    2.1 Description 3
        2.1.1 Fiber Optic Biosensor 3
        2.1.2 Continuous Flow Immunosensor 5
    2.2 Fiber Optic Biosensor and Continuous Flow Immunosensor Comparison 7
    2.3 Strengths, Advantages, and Weaknesses 7
    2.4 Factors Influencing Cost and Performance 9

3. Site/Facility Description 10
    3.1 Background 10
        3.1.1 Naval Submarine Base, Bangor Washington (Groundwater) 10
        3.1.2 U.S. Army Ammunition Depot, Umatilla Oregon (Groundwater and Soil) 10
        3.1.3 Naval Surface Weapons Center, Crane Indiana (Groundwater) 11
    3.2 Site/Facility Characteristics 11
        3.2.1 Naval Submarine Base, Bangor Washington 11
        3.2.2 U.S. Army Ammunition Depot, Umatilla Oregon 12
        3.2.3 Naval Surface Weapons Center, Crane Indiana 12

4. Demonstration Approach 12
    4.1 Performance Objectives 13
    4.2 Physical Setup and Operation 13
        4.2.1 SUBASE Bangor (Groundwater and Umatilla soils) 13
        4.2.2 Umatilla Army Depot (Groundwater) 13
        4.2.3 Naval Surface Weapons Center Crane (Groundwater) 14
    4.3 Sampling Procedures 14
        4.3.1 Groundwater 14
        4.3.2 Soil 15
    4.4 Analytical Procedures 15

4.4.1 Soil Extraction 15
4.4.2 Fiber Optic Biosensor. 15
4.4.3 Continuous Flow Immunosensor 17
4.4.4 SW-846 Method 8330. 18

5. Performance Assessment 18
5.1 Performance Data 18
5.1.1 Laboratory Studies. 19
5.1.2 Relative Percent Difference (RPD). 20
5.1.3 Linear Regression 20
5.1.4 Other Statistical Values 20
5.1.5 Fiber Optic Biosensor 20
5.1.5.1 False positives/False Negatives Spikes 21
5.1.5.2 Cross-Reactivity (water) 21
5.1.5.3 Matrix Effects (Groundwater) 21
5.1.5.4. Field Standards (Groundwater) 22
5.1.5.5 SUBASE Bangor (Groundwater) 22
5.1.5.6 Umatilla Army Depot (Groundwater) 23
5.1.5.7 Naval Surface Weapons Crane (Groundwater) 23
5.1.5.8 Soil Field Samples. 24
5.1.5.9 Summary of results. 25
5.1.6 Continuous Flow Immunosensor 25
5.1.6.1 False Positives/False Negatives Spikes 25
5.1.6.2 Accuracy and Precision (System Flow Buffer) 26
5.1.6.3 Accuracy and Precision (Groundwater Matrix Spikes) 26
5.1.6.4 Cross-Reactivity (Groundwater) 27
5.1.6.5 Field Standards (Groundwater) 28
5.1.6.6 SUBASE Bangor (Groundwater) 28
5.1.6.7 Umatilla Army Depot (Groundwater) 29
5.1.6.8 Naval Surface Weapons Center, Crane (Groundwater) 30
5.1.6.9 Soil Field Samples 31
5.1.6.10 Summary of results. 32
5.2 Data Assessment 32
5.2.1 Groundwater 32
5.2.2 Soil 32
5.3 Technology Comparison 33
5.3.1 Groundwater 33
5.3.2 Soil 33

6. Cost Assessment 33
6.1 Cost Performance 34
6.1.1 Startup Costs 34
6.1.1.1 Fiber Optic Biosensor 34
6.1.1.2 Continuous Flow Immunosensor. 34
6.1.2 Operations and Maintenance 34

6.1.3 Demobilization Costs 35
6.2 Cost Comparisons to Conventional and Other Technologies 35

7. Regulatory Issues 35
7.1 Approach to Regulatory Compliance and Acceptance 35

8. Technology Implementation 36
8.1 DoD Need 36
8.2 Transition 36

9. Lessons Learned 37
9.1 Groundwater 37
9.2 Soil. 38

10. References 39

Appendix A
Points of Contact A-1
Project Managers and Principal Investigators A-1
Other Demonstration Participants A-1
Other Points Of Contact A-3

Appendix B
Data Archiving and Demonstration Plan(s) B-1

Appendix C
U.S. EPA SW846 Method 8330 . . . . . C-1

List of Tables

1. Fiber Optic Biosensor/Continuous Flow Immunosensor Comparison....42
2. Fiber Optic Biosensor False Positives/False Negatives....42
3. Fiber Optic Biosensor Cross-Reactivity of Immobilized anti-RDX and anti-TNT Antibodies 43
4. Matrix Effects on RDX Fiber Optic Biosensor Assay....44
5. Matrix Effects on TNT Fiber Optic Biosensor Assay....44
6. Fiber Optic Biosensor Field Standards at SUBASE Bangor....45
7. Fiber Optic Biosensor RPD Results for Field Samples....46
8. Fiber Optic Biosensor on SUBASE Bangor Samples....46
9. Fiber Optic Biosensor Paired t-Test and F-Test Results for Field Samples....47
10. Fiber Optic Biosensor False Positive/False Negative Results for Field Samples....47
11. Fiber Optic Biosensor on Umatilla Army Depot Samples....48
12. Fiber Optic Biosensor on NSWC Crane Samples....49
13. Fiber Optic Biosensor on Soil Extract Samples....50
14. Fiber Optic Biosensor for Soil Samples....51
15. Fiber Optic Biosensor Statistical Test Summary....52
16. FAST 2000 False Positives/False Negative in Buffer....52
17. FAST 2000 Accuracy and Precision (System Flow Buffer)....52
18. Matrix Effects on RDX FAST 2000 Assay....53
19. Matrix Effects on TNT FAST 2000 Assay....53
20. FAST 2000 Cross-Reactivity of anti-RDX and anti-TNT antibodies....54
21. FAST 2000 Field Standards at SUBASE Bangor....55
22. FAST 2000 RPD Results for Field Samples....55
23. FAST 2000 on SUBASE Bangor Samples....56
24. FAST 2000 t-Test and F-Test Results for Field Samples....57
25. FAST 2000 False Positive/False Negative Results for Field Samples....57
26. FAST 2000 on Umatilla Army Depot Samples....58
27. FAST 2000 on NSWC Crane Samples....59
28. FAST 2000 on Soil Extract Samples....60

29. FAST 2000 for Soil Samples.....61
30. FAST 2000 Statistical Test Summary.....61
31. Technology Comparison of Groundwater Explosive Analysis.....62
32. Technology Comparison of Soil Explosives Analysis.....63
33. Technology Cost Comparison of Groundwater Explosives Analysis.....64
34. Technology Cost Comparison of Soil Explosives Analysis.....65

List of Figures

1. Analyte 2000....66
2. FAST 2000 67
3. Competitive immunoassay in the evanescent wave of a fiber optic probe....68
4. Daughter card from the Analyte 2000....69
5. Capillary flow chambers in series with Analyte 2000....70
6. Competitive immunoassay for TNT....71
7. Continuous flow immunosensor - Displacement format....72
8. Naval Submarine Base Bangor (SUBASE Bangor) - Site Locations....73
9. SUBASE Bangor - Historical Map of Site F....74
10. SUBASE Bangor - Contamination Site F....75
11. SUBASE Bangor - Site A....76
12. U.S. Army Ammunition Depot - Umatilla OR....77
13. Naval Surface Weapons Center - Crane IN....78
14. Method 8330 Validation - NRL vs. QST....79
15. Fiber Optic Biosensor RDX and TNT Standard Curves....80
16. Fiber Optic Biosensor vs. QST HPLC - SUBASE Bangor RDX....81
17. Fiber Optic Biosensor vs. QST HPLC - SUBASE Bangor TNT 82
18. Fiber Optic Biosensor vs. QST HPLC - Umatilla Army Depot RDX 83
19. Fiber Optic Biosensor vs. QST HPLC - Umatilla Army Depot TNT 84
20. Fiber Optic Biosensor vs. QST HPLC - NSWC Crane RDX....85
21. Fiber Optic Biosensor vs. Method 8330 - Soil extracts RDX 86
22. Fiber Optic Biosensor vs. Method 8330 - Soil extracts TNT 87
23. Fiber Optic Biosensor vs. Method 8330 - Soil RDX 88
24. Fiber Optic Biosensor vs. Method 8330 - Soil TNT....89
25. Fiber Optic Biosensor vs Method 8330 - All groundwater sites RDX 90
26. Fiber Optic Biosensor vs Method 8330 - All groundwater sites TNT....91
27. FAST 2000 Test for False Positives....92
28. FAST 2000 Test for False Negatives....93
29. FAST 2000 vs. QST HPLC - Field Standards - SUBASE Bangor RDX 94
30. FAST 2000 vs. QST HPLC - Field Standards - SUBASE Bangor TNT 95
31. FAST 2000 vs. QST HPLC - SUBASE Bangor RDX....96
32. FAST 2000 vs. QST HPLC - SUBASE Bangor TNT 97

33. FAST 2000 vs. QST HPLC - Umatilla Army Depot RDX....98
34. FAST 2000 vs. QST HPLC - Umatilla Army Depot TNT....99
35. FAST 2000 vs. QST HPLC - NSWC Crane RDX....100
36. FAST 2000 vs. QST HPLC - NSWC Crane TNT....101
37. FAST 2000 vs Method 8330 - Soil extracts RDX....102
38. FAST 2000 vs Method 8330 - Soil extracts TNT....103
39. FAST 2000 vs Method 8330 - Soil RDX....104
40. FAST 2000 vs Method 8330 - Soil TNT....105
41. FAST 2000 vs Method 8330 - All groundwater sites RDX....106
42. FAST 2000 vs Method 8330 - All groundwater sites TNT....107

Acronyms

ABG	Ammunition Burning Ground at NSWC
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (a.k.a. Superfund)
DARPA	Defense Advanced Research Program Agency
DNT	Dinitrotoluene
EDA	Ethylenediamine
ESTCP	Environmental Security and Technology Certification Program
GAC	Granulated activated carbon
HMX	1,3,5,7-Tetranitro-1,3,5,7-tetrazacyclooctane
HPLC	High pressure liquid chromatography
MDL	Method Detection Limit
NRL	Naval Research Laboratory
NSWC	Naval Surface Warfare Center
NSWC	U.S. Naval Surface Weapons Center, Crane Indiana a.k.a. NADCrane, NAVSURFWARCEN
ONR	Office of Naval Research
PAU	Peak area unit
PCMCIA	Personal Computer Multiple Computer Interface Accessory
QA/QC	Quality assurance, quality control
RCRA	Resource Conservation and Recovery Act
RDH	RDX hapten
RDX	1,3,5-Trinitro-1,3,5-triazacyclohexane
RI	Research International
RPD	Relative percent difference
RP-HPLC	Reverse phase high pressure liquid chromatography
RQL	Reliable Quantitation Level
SD	Standard deviation
SERDP	Strategic Environmental Research and Development Program
SPE	Solid phase extraction
SUBASE	U.S. Navy Submarine Base, Bangor Washington
TCE	Trichloroethylene
TNB	1,3,5-Trinitrobenzene
TNT	2,4,6-Trinitrotoluene
UMDA	U.S. Army Ammunition Depot, Umatilla Oregon

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1. Introduction

1.1 Background Information

The major components in nearly all military munitions are TNT and/or RDX, compounds which are a potential explosive hazard to remediation workers when present at high concentrations in soil and toxic to humans at lower concentrations. The U.S. EPA has proposed a 'lifetime health advisory' level of 2.0 ng/mL TNT and RDX as the maximum limit for drinking water.[1] The DoD has more than 50 sites listed on the U.S. EPA Superfund list that are contaminated with explosives from munitions manufacture, storage, and demilitarization that do not meet these limits. TNT and RDX are mobile in the soil and, due to this mobility, are a source of groundwater contamination both on and around military sites. Remediation of water and soil at these sites requires rapid, accurate analysis of field samples at the site and in the surrounding area. Each cleanup site will require monitoring for 10-30 years, necessitating analysis of thousands of samples.[1] Currently, samples are collected and sent to a central laboratory for analysis by RP-HPLC according to U.S. EPA SW846 Method 8330, either by direct injection or after preconcentration using an extraction procedure. Turnaround times vary from a week to a month, with laboratory costs per test ranging from $1000 to $250 respectively. Current methods of analysis of both water and soils are insufficient for on-site decision making.

On-site detection systems would reduce costs substantially, provide real-time data, simplify site characterization, and expedite remediation. The estimated cost per test for on-site test analysis would range from $3-$38 per test, far below the $250- $1000 current costs. For site characterization, extra samples could be tested in areas where explosive residues were first detected so that the exact distribution of pollutants could be confirmed. For remediation, rapid on-site analysis could be used to guide earth moving procedures, indicate immediately the need for replacement of pump and treat

granular activated charcoal (GAC) filters, and monitor progress of composting or other remediation operations. Small composting tests indicate that a substantial decrease in contamination is observed in 30 days. Timely determination of those levels would reduce unnecessary composting times. Overall, on-site analysis would eliminate time delays, leading to more effective use of manpower and equipment. Though commercial immunoassay test kits have been introduced to field testing (D-Tech, Ohmicron), they require timed reagent addition, involve multiple steps, and are not easily adapted to online monitoring requirements. Colorimetric methods, also commercially available (EnSys), have these same limitations and require large quantities of solvents and disposable materials. The NRL environmental immunosensors, fiber optic biosensor and continuous flow immunosensor (Figures 1 and 2), are able to analyze a sample on-site in less than 10 min at a cost of $3-4 per test.

1.2 Official DoD Requirement Statement(s)

A 1.1.a Develop Improved Field Analytical Techniques. Priority: M.

N 1.101.k Improved Field Analytical Sensors, Methods, and Protocols to Supplement Traditional Sampling and Laboratory Analysis. Priority: M.

1.2.2 How Requirement(s) Were Addressed. The fiber optic biosensor and the continuous flow immunosensor are analytical instruments that can be employed in the field. They are rapid, sensitive systems capable of monitoring TNT and RDX down to low parts per billion (ppb) without preconcentration. This is an improvement over the current U.S. EPA approved method (SW 846 Method 8330) which is performed in an off-site laboratory via high performance liquid chromatography (HPLC). In the HPLC method, preconcentration of the sample is required for explosive levels below 20 ppb. Demonstration of the sensors on-site for the detection of TNT and RDX addressed the requirement for improved field detection techniques.

1.3 Objectives of the Demonstration

The primary objectives of this project are (a) to demonstrate the efficacy of these immunosensors for on-site characterization of areas contaminated with explosives in both water and soil and (b) to gain validation of both methods by U.S. EPA and/or other regulatory agencies.

To meet these objectives, three field trials for groundwater analysis and one for soil were performed using the two biosensors to perform on-site analysis. The first groundwater test for this project was conducted in June 23-27, 1997 at SUBASE Bangor, Bangor, WA. The second site was Umatilla Army Depot (UMDA) in Hermiston, Oregon August 4-8, 1997. The third site was Naval Surface Weapons Center in Crane, Indiana September 8-12, 1997. The soil field trial was held April 27-May 1, 1998 at Manchester Washington on samples from Umatilla Army Depot. Both sensors were operated on-site by non-NRL employees as well as NRL staff. Splits of the field sample were analyzed by the immunosensors and U.S. EPA SW846 Method 8330. In addition to on-site soil analysis, T. Jenkins CRREL provided ten archived soil samples from various sites in the U.S. Method 8330 analysis was performed on the groundwater samples by QST Environmental Laboratories under contract to H. Craig, U.S. EPA Region 10 while the soil samples were analyzed by GP Laboratories and NRL. The biosensor results for the field samples were evaluated on

accuracy, precision, false positives/negatives rates, predictability, cost, time, and waste generation. Samples from other contaminated sites were also analyzed to study groundwater matrix effects. In addition to the contaminated field samples, appropriate controls, blanks, laboratory spikes and cross-reactants were tested in the laboratory for certification and validation data requirements.

1.4 Regulatory Issues

Congress has enacted several legislations regarding the cleanup and monitoring of compounds that pose a potential risk to humans and the environment. Several examples of those legislations that apply to explosive compounds include the Resource Conservation and Recovery Act (RCRA), the Clean Water Act, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and its amendments (CERCLA, a.k.a. Superfund). The sites employed for these demonstrations are on the Superfund list.

1.5 Previous Testing of the Technology

ESTCP previously funded the non-automated fiber optic biosensor for demonstration of its ability to detect on-site TNT in groundwater. During that project, the fiber optic biosensor was tested at Umatilla Army Depot in Hermiston Oregon and SUBASE Bangor in Bangor Washington. Results of these field demonstrations were encouraging. Full details of the results can be found in the ESTCP final report Fiber Optic Biosensor and well as in two refereed papers.[2-3] Prototypes of the continuous flow immunosensor also participated in those field demonstrations with funding from SERDP. Results for the continuous flow immunosensor can be found in several refereed papers.[4-6] The EPA coordinator Harry Craig has written a report of the field trials and has a proceedings paper describing both sensors.[1]

2. Technology Description

2.1 Description

2.1.1 Fiber Optic Biosensor

The fiber optic biosensor uses molecular recognition and evanescent wave sensing to detect a wide variety of analytes.[27-11] The fiber optic sensor consists of a multichannel 'fluorimeter', a fiber bundle jumper, and disposable fiber optic probes.[12] Properties of optical fibers provide a mechanism for exciting fluorescent molecules that are very close to the fiber core. Light is totally internally reflected within the optical fiber core. An electromagnetic field is generated around the core with power that decreases exponentially with distance from the core. This field is referred to as the evanescent wave (Figure 3). The effective or penetration depth of this field is determined by the wavelength of light and the refractive indices of the fiber core and the surrounding media. In the case of the fiber optic biosensor, the penetration depth is approximately 125 nm. Fluorescent molecules that enter the evanescent wave are excited and emit light at a longer wavelength, i.e., fluorescence. Effectively, these fluorescent molecules are ones that bind to the surface, i.e., antibody-fluorescent antigen complexes. A portion of this fluorescence is captured by the fiber and transmitted to a detector. Molecules outside the

evanescent wave are not detected by the sensor, thereby eliminating wash steps. In this biosensor, the optical fiber probes are tapered to provide maximum excitation and fluorescent emission recovery.

The multichannel "fluorimeter" Analyte 2000, produced by Research International in collaboration with NRL (Figure 1), consists of four integrated circuit 'daughter' cards (Figure 4) that are monitored by a microprocessor-based controller board.[12] On each 'daughter' card is mounted a 5 mW 635 nm diode laser modulated at 135 Hz for synchronous detection. An internal transfer fiber transmits the laser light to the excitation leg of the bundle jumper. A second internal fiber transmits the fluorescent emission from the bundle jumper to a photodiode which is also mounted on the 'daughter' card. Appropriate filters and signal calibration controls are also incorporated on each 'daughter' card. The controller board monitors each card and sends the measured signal from each channel to a laptop computer through an RS-232 communication port. The computer software collects, plots, stores data, and permits user control over several other functions.

The fiber bundle jumper transmits the excitation light from the "fluorimeter" to the fiber optic probe and the returning fluorescent signal to the device. The jumper consists of a fiber in the center to provide excitation and larger surrounding fibers to collect the fluorescence emission from the sensor probe. The fiber optic probe provides the sensing region for the biosensor. Each optical probe is made from 600 μm fused silica multimode fibers with a connector on one end. The end of the probe has the cladding removed to permit attachment of the recognition molecule directly onto the fiber core. This sensing region is tapered to provide efficient fluorescence excitation and signal collection.[13] After the recognition molecule is immobilized, the coated probe is inserted into a sample chamber. This sample chamber may be formed from a 100 μl capillary tube with plastic t-connectors on each end (Figure 5).[8] The capillary chamber system can be injected with syringes or peristaltic pumps for system automation. A semi-automated fluidics system developed at NRL, which employs a mini peristaltic pump, was used for this study.

The disposable fiber optic probes provide the region for specific detection. Antibodies, immobilized on the surface of an optical fiber, provide molecular recognition. Degree of specificity is determined by the choice of the antibody employed. Two types of immunoassays have been used with this sensor. In both scenarios, antibodies are immobilized on the fiber surface. For smaller molecules such as TNT and RDX, a competitive fluoroimmunoassay is performed. In this assay, a fluorescently-labeled antigen analog competes with the antigen for antibody binding sites. A decrease in the maximum fluorescent signal is observed that is proportional to the antigen concentration. For the larger compounds, sandwich immunoassays are performed. The antibody-coated fiber probe is exposed to the antigen containing sample, then to a second antibody that is fluorescently labeled. An increase in the fluorescent signal proportional to the concentration of the antigen is observed. Assays have been developed for small molecules (TNT), proteins (F1 protein of *Yersinia* pestis), toxins (ricin and botulinum), and whole bacterial cells (*Bacillus* anthracis).[2,7-11]

In the assay for the explosive TNT or RDX (purpose of this study), the antibody-coated fibers are first exposed to a solution containing buffer plus a known concentration of a fluorescently-labeled analog of TNT or RDX. After five minutes of exposure to this fluorescent solution, the laser light is turned on for a reading. Only fluorescently-labeled analog bound to the fiber generates a signal. This is the maximum signal generated and is referred to as the reference or 100% signal. To remove the bound analog from the antibody-coated fiber optic probe, a solution of 50% ethanol in buffer is injected over the fiber for 10 minutes and then a fluorescent reading is taken. Next, the fiber is immersed in buffer for 1 minute to prepare it for the next sample. A background reading is taken again. After an assay with the fluorescently-labeled analog alone, an unknown or standard can be assayed. To the unknown or standard sample, fluorescently-labeled analog is added to make the sample contain the same concentration as that used for the 100% signal. An acetone soil extraction is performed to get a liquid sample needed for analysis. The unknown or standard solution with the fluorescent compound is exposed to the fiber for five minutes. The laser light is turned on and the fluorescent signal determined. If TNT or RDX is present, the fluorescent signal for the unknown will be lower than the reference or 100% signal. This decrease in the signal is proportional to the amount of TNT or RDX in the sample and represents competition between the fluorescently-labeled analog and the explosive for the limited number of antibody sites on the fiber probe. The fiber is then regenerated to remove the bound material by exposure to the 50% ethanol solution for 10 minutes followed by one minute with buffer. The fiber is then ready for the next reference sample. The reference sample is run before and after each test sample to monitor continuously for any variation in antibody activity. A representative graph demonstrating multiple assays is shown in Figure 6.

The fiber optic biosensor system is rapid (<17 min), reliable, portable, and highly sensitive (low ppb), and can be used to detect substances in real-world samples such as river water, groundwater and bilge water. We have demonstrated successful analyses in opaque, viscous samples with a portable fiber optic sensor. This portable sensor is also capable of detecting four test samples simultaneously.

2.1.2 Continuous Flow Immunosensor

The Continuous Flow Immunosensor is based on a displacement assay that utilizes antibodies specific for the analyte of interest as a means of detection. The key elements of the sensor are: 1) antibodies specific for the analyte, 2) signal molecules which are similar to the analyte but labeled with a fluorophore (usually a Cy5 dye) so they are highly visible to a fluorescence detector, and 3) a fluorescence detector. For an analysis, the antibodies which specifically recognize the contaminants are immobilized on a solid support and the fluorescently labeled signal molecule is bound to them, creating an antibody/signal molecule complex. The functionalized support is placed in the sensor and connected to a water stream. A sample is then introduced to the system through the injection port. As with the fiber optic biosensor, an acetone soil extraction is performed to obtain a soil sample. If the sample contains the target analyte, a proportional number of labeled signal molecules is displaced from the antibody and detected by the fluorimeter downstream. Figure 7 shows a schematic of the immunosensor operation.

Displacement assays, using the laboratory version of the Continuous Flow Immunosensor, have been developed for a wide range of small molecular weight compounds, including drugs, explosives, and pesticides.[4-6,14-16] Existing assays for a number of environmentally relevant explosives include TNT, RDX and DNT.

The manufacturable, field-portable version of the biosensor, the FAST 2000, has been engineered by Research International (Figure 2). The FAST 2000 is a rapid and convenient system for performing displacement assays with low ppb explosive levels in water and soil. The optically-based signal gathering capabilities are combined with precise fluidics control in a PCMCIA-based PC application. The unit can be easily carried into the field and plugged directly into a portable PC for on-site data acquisition and analysis. Analysis time for each sample is approximately 2 minutes.

The system has been developed as a complete turnkey unit using advanced Windows-based software program to control the system. The hardware provides the necessary fluid storage and flow control. An outboard box provides convenient storage of the various fluids required to perform the assays. The hardware is designed to use a National Instruments data acquisition card (DAQCard - 1200) for gathering data from the FAST 2000 control unit. The software provides a simple menu driven interactive user interface to lead users through the steps required to successfully determine if a trace amount of analyte is present in a given sample. The software also allows the more advanced user complete control of the operational parameters for running nonstandard procedures.

Data analysis is made easy with the use of real time plotting of the data, data logging, and custom calibrations. The Windows-based software allows for both ease of use and complex system manipulation, keeping all skill levels in mind. The assay chemistry for TNT and RDX detection has been developed to be a system that can be successfully used in the field without the need for excessive environmental controls.

The FAST 2000 requires a computer capable of running Windows 95 or Windows 3.1 in enhanced mode. Under Windows 95, the minimum configuration is 12 MB of RAM and a 486/80 MHZ PC, while under Windows 3.1, the minimum configuration is a 486/DX 33 MHZ PC with 12 MB of RAM. In this minimum configuration, the FAST 2000 system should be the only program running. An outboard box, connected to the FAST 2000 unit via color-coded tubing, contains the waste bottle, buffer bag and reference standard bag. Before beginning an assay, flow buffer (10 mM sodium monophosphate, 2.5% ethanol and 0.01% Tween) is pumped into a buffer bag and the system is pressurized with air to control the fluid flow.

The assays are run in disposable coupons using an affinity membrane to perform the displacement assay protocol. The coupon contains discrete flow channels, a membrane and filter pocket in a removable plug, pneumatically controlled valves, and septum seal area used for injecting fluids into the coupon. The coupons are assembled with the functionalized membranes before shipping. Prior to instrument operation, the coupon is inserted into the FAST 2000 control unit, and when the handle is engaged, the coupon septum is automatically pierced. Through the Task Manager in the system software, assays are performed by a

sequence of valve controls which meter the assay fluids through the coupon and into the membrane pocket. The user is instructed when to inject the sample into the coupon through the small septum area on the top of the coupon with the needles of a small volume syringe. The sample volume required to perform an assay to 0.15 mL. The fluids then exit the coupon and travel into the integral fluorimeter in the control unit which detects any fluorescence signal present. Quantitation of the analytes, done by the system software, compares fluorescence intensity to that of a reference standard.

The coupon and membrane can be used for repeated assays. The life of the membrane is dependent upon the number of positive assays that were run. Since only a limited quantity of the label is bound to the antibodies on the membrane, it will eventually become depleted of the label. This may take one to three days, dependent upon usage. If the standard sample cannot be detected, the membrane must be replaced.

2.2 Fiber Optic Biosensor and Continuous Flow Immunosensor Comparison

The fiber optic biosensor and the continuous flow immunosensor are both technologies that rely on antibody-antigen interaction, with fluorescence used for signal transduction. However, they are complementary rather than competing methods, with applications in distinctly different areas. Table 1 summarizes the differences and similarities discussed in previous sections. Specifically, the FOB is more suitable for testing environments requiring remote detection (i.e., soil or groundwater monitoring with a cone penetrometer). In contrast, the continuous flow immunosensor is more appropriate and cost effective in test scenarios that require routine on-site measurements of either discrete samples or intermittent monitoring of process streams (pump-and-treat filters, quarterly tests of monitoring wells). In either case, both sensors are rapid compared to current technologies and are easy to set up and operate in the field. The choice of which sensor to employ must be decided by remediation managers on a case-by-case basis.

2.3 Strengths, Advantages, and Weaknesses

The fiber optic biosensor and the continuous flow immunosensor are rapid analytical tools for the on-site detection and monitoring of compounds. Little sample volume or manipulation is required for groundwater detection. An extraction needs to be performed for soil analysis. The biosensors are completely portable (battery operated and lightweight), which is preferable for on-site analysis. Full set-up (from shipping box to sample analysis) takes approximately 1 hour.

The major strength of the NRL sensors is their adaptability for use in a variety of environments. The biosensors have been tested directly in a variety of environmental media including ground and river water, leachate, and soil extracts that may or may not contain particulates, with some site specific effects on the overall activity of the sensors. Samples can be injected by hand or pump from air samplers that extract vapors into water, or soil extractions. In addition, super sipper systems that rapidly inject samples from hundreds of vials can be employed.

The fiber optic biosensor is capable of analyzing a single sample run either in quadruplicate over four similar fibers or four fibers with different antibodies simultaneously. This advantage

provides the ability to have assay controls performed during sample analysis. In the case of TNT, the fiber probes have been 'regenerated' and reused up to 16 test samples. The continuous flow immunosensor can be used either for continuous monitoring of a water stream, or for testing multiple discrete samples sequentially for an extended period of time per antibody cartridge. The number of samples tested is based in part on the number of positives, since negative samples do not deplete the labeled antigen from the cartridge. For TNT and RDX, more than 50 positives can be analyzed over a single column/cartridge.

The detection limit of the instruments for laboratory samples is already comparable to established, more complicated systems. Using the NRL sensors, TNT spiked into water has been detected at levels of less than 5 parts per billion (equivalent to 5 ng/mL) in the laboratory. This level of sensitivity is well-below that obtained using precipitation, dip stick, most enzyme immunoassays, and fluorescence polarization methods, and is comparable to radioimmunoassays. However, from these studies, it was determined that the limit of detection for field samples is slightly higher (10-20 ppb in ground and 50-100 ppb for soils) than the laboratory spikes. This decrease in sensitivity and associated matrix effects may, at times compromise assay performance.

Antibodies are recognized by biochemists and molecular biologists for their exquisite specificities. Antibody selection is based on affinity and specificity for the compound of interest. Antibodies can be selected such that the specificity is a narrow range for just one compound or wider for a group of similar compounds. Closely related compounds may also react with the antibody but usually with a lower affinity. Molecules such as TNT and RDX are too small to be antigenic so they or a closely related analog is coupled to a larger protein for antibody production. A larger protein cannot be coupled directly to TNT so the compound trinitrobenzene (TNB) was linked to a protein and used as the antigen to elicit antibody production. The TNT antibody used with the fiber optic biosensor, obtained from Strategic Diagnostics, Inc.(Newark, DE), was produced against a TNB conjugate and selected for its affinity for TNT. Therefore, this antibody reacts with both TNT and TNB. The same is true for the 11B3 anti-TNT antibody employed in the continuous flow immunosensor.[14] This poses a problem if one needs know the exact concentration of TNT in the presence of TNB. The result would be an overestimation of TNT in the sample. However, since both TNT and its degradation product TNB are both toxic and explosive, this cross-reactivity is not necessarily a detriment with a screening system as both require cleanup/remediation. The RDX antibody used with both sensors, obtained from Strategic Diagnostics, Inc., has also been selected for its strong affinity and low cross-reactivity with other compounds. The extent of RDX antibody's cross-reactivities is detailed in the company brochure but does include HMX. The amount of antibody cross-reactivity after immobilization in the two biosensors is discussed under data performance.

One problem with any antibody-based assay is that the compound of interest must be known prior to analysis so that the appropriate antibody can be employed. Unlike HPLC which identifies a large number of compounds, an antibody recognizes only a single or limited number of structurally similar compounds. On the other hand, most samples contain both toxic and non-toxic components. In HPLC, both types will be identified. Swamping of the toxic compound signal by that of the non-toxic compounds is possible unless a laborious extraction procedure is

followed. This problem can be eliminated using antibody-based assays because only the toxic compound generates an antibody-mediated signal.

The antibody-antigen reaction is not a covalent one but one of structural complementarity. The binding is comprised of hydrophobic and electrostatic interactions. Since these are not permanent bonds, conditions in real world samples can disrupt those interactions. Examples of such conditions include the presence of cross-reactant compounds, extremes in ionic strength of sample, pH of sample, humic materials, and competitors for the antigen. If it is determined that real world matrix interferes with the antibody-antigen reaction, there are several solutions available including filtering, solid phase extraction and solution buffering.

Antibodies have proven to be very reliable, sensitive and specific for detection for clinical applications. The clinical matrices are quite complex as are the environmental matrices for which these sensors are proposed to utilized. The strengths of antibodies seem to outweigh the weaknesses.

2.4 Factors Influencing Cost and Performance

The NRL immunosensors are designed to be user-friendly for people with medium skill levels. Many of the parameters that may affect cost and performance have been identified. Some of the current high cost associated with the instruments and the antibody-coated substrates are due to the fact that they are prototypes and not in large scale production. The cost should decrease with increased commercialization of the instruments. Another cost is the requirement for sample pre-treatment (other than soil acetone extraction) or concentration, though this is indirectly related to the technology. The biosensors have been designed for a certain level of detection. This does not preclude the use of pre-concentration or filtering methods to improve the limit of detection or to reduce matrix interference. This study did not use any pre-concentration or excessive filtering for any of the samples. By adding in a pre-treatment step, cost will increase due to increase in labor time and the reduction in the number of analyzes that can be achieved per day. Both instruments require minimal labor time for set-up of the instruments. Currently, there is some variability in the length of time needed to wash the FAST 2000 membranes prior to initial sample analysis which is being addressed.

In summary, factors affecting costs include:

- -Cost of manufactured instruments (prototypes vs. production)
- -Disposable components (fiber optic probes, FAST 2000 coupon, membranes)
- -Commercialization of antibody-coated membranes and fluorescent-analog
- -Commercialization of antibody-coated fiber optic probes and fluorescent analog
- -Sample pre-treatment (filtering or pre-concentration), if necessary
- -Washing time for FAST 2000 membranes for initial analysis
- -Number of analyzes per day
- -Maintenance of NRL fluidics (little maintenance is needed for Analyte 2000)
- -Maintenance of FAST 2000
- -Sample Characteristics (i.e., high/low concentration, interferent level)

3. Site/Facility Description

3.1 Background

Site selection was based on several criteria including contamination with explosives, accessability to the site and the groundwater, U.S. EPA interest (i.e., Superfund), availability of non-NRL personnel and a variety in geological parameters. Samples from five sites in the continental United States have been analyzed with the biosensors. Two of the on-site facilities (SUBASE Bangor and Umatilla) are currently undergoing extensive remediation for groundwater contamination with TNT and RDX using pump-and-treat technology. As a result, these sites provided a number of platforms for effective testing of the sensors, including a) direct measurement of contamination levels in monitoring wells, b) analysis of samples in the treatment system (pre- and post-GAC filtration), c) direct comparisons with current field and lab measurements using the ENSYS test kit and SW 846 Method 8330, respectively, and d) experienced Army Corps of Engineers personnel familiar with the site. The EPA Region 10 military site coordinator (two of the sites are in Region 10) provided non-developer personnel to run tests, in compliance with the validation guidelines, as well as assisted in obtaining necessary logistical support.

3.1.1 Naval Submarine Base, Bangor Washington (Groundwater). Naval Submarine Base (SUBASE) Bangor is located northwest of Seattle, Washington and is currently the home port for Trident submarines. From 1942 to 1973, SUBASE Bangor was used as an ammunition depot. Two sites (Site A and Site F) on the base have been inactivated due to explosive contamination. Wastewater from ordnance demilitarization was disposed into an unlined lagoon. This site is referred to as Site F. Currently this site is undergoing cleanup via a pump-and-treat method through granular activated charcoal filters. Sediment that accumulated at Site F was transported to Site A for burning and disposal in a lined area. Water is flushed through the contaminated soil, collected as leachate and processed through a granular activated charcoal (GAC) unit. The four major contaminates identified are TNT, TNB, RDX, and HMX, ranging in concentration from 0-10,000 µg/L.

3.1.2 U.S. Army Ammunition Depot, Umatilla Oregon (Groundwater and Soil). UMDA is located in eastern Oregon and is slated for closure. The base was established as an Army ordnance depot in 1941. From the 1950's until the mid-1960's, UMDA operated an explosive washout facility to remove and recover explosives from munitions. The standard and accepted procedure at that time was to flush and drain the washout system into two unlined infiltration basins or lagoons. A 45-acre plume of RDX in the shallow groundwater aquifer near the lagoons was identified in 1981. Further investigation documented the presence of explosives in both soil and groundwater, ranging in concentration from 0-10,000 µg/L in the groundwater aquifer. These explosives included TNT, TNB, RDX, and HMX. Bioremediation of the soils from the lagoons is currently underway. Treatment of the groundwater consists of pump-and-

treat through granular activated charcoal filters, with re-injection of the polished water back into the aquifer.

3.1.3 Naval Surface Weapons Center, Crane Indiana (Groundwater). In late 1941, Burns City Naval Ammunition Depot (later renamed Naval Ammunition Depot Crane - NAD Crane) was established. The overall mission was to load, prepare, renovate, receive, store and issue ammunition to the fleet. Over the next few years, NAD Crane's role increased to include pyrotechnics production, mine filling, rocket assembly, torpedo storage, ordnance spare parts, and mobile equipment storage. NAD Crane supplied ammunition during the Korean and Vietnam conflicts to the fleet. In 1976, the mission and name were changed. The new Naval Weapons Support Center Crane was to provide support for ships equipment, shipboard weapon systems, and assigned ordnance items as well as provide support for the Crane Army Ammunition Activity which includes production and renovation of ammunition, storage, demilitarization and disposal of conventional ammunition. In 1992, the site was designated NAVSURFWARCENDIV.

Contamination at Crane, located at three sites: a) Ammunition Burning Ground (ABG) b) Rockeye and c) Rifle Range, is primarily due to the demilitarization and disposal of ammunition and pyrotechnics. Contamination of the groundwater with TNT and RDX exists along with high levels of trichloroethylene (TCE). The method for disposal is based on the physical and chemical characteristics of the munition with double open burning or flashing being the most common. Since the 1940's, ABG has been used extensively for destruction of explosive contaminated material. Between 1956 and 1960, 15,000 pounds/day of smokeless powder and 48,000 pounds/day of high explosives were burned. Initially, solid explosive residues were spread out on burning pads or in flash pits and ignited. Today, clay-lined steel pans are employed. For the liquid explosive contaminated material three surface ponds were employed to remove the liquid from combustible sludge. In 1982, the ponds were modified to include a liner and leachate collection system. Currently, sludge burn pads are used and the ponds closed. Leachate and runoff were initially stored in two underground tanks. Now pink water is stored in two aboveground tanks and the underground tanks are closed. Demilitarization continues with more stringent requirements to prevent soil and water contamination.

3.2 Site/Facility Characteristics

3.2.1 Naval Submarine Base, Bangor Washington. SUBASE Bangor, northwest of Seattle Washington, is located in a region with wet climates. The hydrology of the soils is fluvial/glacial deposition and contains high levels of organic compounds. The groundwater from the contaminated region is pumped to a facility containing several GAC units. Approximately 600 gallons of water per minute is treated with this system. The groundwater is known to be high in organic material and highly turbid.

Figures 8-11 contain the maps of SUBASE Bangor and the contaminated sites that were used for this field trial. Figure 8 is the entire base showing site locations for restoration. Sites A

and F are highlighted. Site F was used for demilitarization and is the area where the unlined lagoons contained the wastewater. Figure 9 shows the historical features of Site F. The groundwater from this area is undergoing remediation through GAC units. Figure 10 shows the extent of contamination and cleanup for Site F. The water treatment facility is identified on this figure. Groundwater from the monitoring wells and before/after the GAC units was analyzed. Site A is being used for cleanup of contaminated soils. The soil is placed in a lined basin and the leachate is collected and remediated through GAC units. Figure 11 gives a schematic of this site. The water coming into and out of the GAC in Site F was tested with the biosensors.

3.2.2 U.S. Army Ammunition Depot, Umatilla Oregon.
UMDA is located due east of Portland, Oregon and near the Columbia River in an arid region with no surface water. The primary geology is aluvium on top of basalt, with approximately 100 feet to groundwater. The groundwater flow is northeast to southeast, depending upon the irrigation pumping season. The net flow to the southeast has led to the spread of explosive contamination. The groundwater from the contaminated region is pumped to a facility containing several GAC units. Approximately 600 gallons of water per minute is treated with this system. Figure 12 provides a map of UMDA and the contaminated sites that were used for this field trial. The locations for restoration are shown and each groundwater monitoring well is identified by number. The site of the former munitions cleanout plant, now demolished, is marked "A". The extent of contamination (approximately 45 acres) is shown by the concentric circles.

3.2.3 Naval Surface Weapons Center, Crane Indiana. NAVSURFWARCENDIV is located in the eastern Illinois Basin. Crane consists of undulating terrain with many small drainageways. Four types of soil are identified at Crane including Wellston-Gilpin, Wellston-Berks-Gilpin, Wellston-Berks-Ebal and Wakeland-Wilbur-Haymond. These soils are primarily silt loams with 0.6 to 2.0 in/hr permeabilities. The bedrock at Crane is lower Pennsylvanian and upper Mississippian age sandstones, limestones and shales. Surface drainage from the facility flows to the south, eventually emptying into the east fork of the White River.

ABG is approximately 20 acres near the east center boundary of NAVSURFWARCENDIV. (Figure 13) It lies in Little Sulphur Creek Valley. Surface drainage flows into and from the ABG via Little Sulphur Creek with the flow varying considerably with the seasons. Downstream from the center of ABG, surface flow ceases during the dry months as the water is captured by vertical infiltration into the sandstone and limestone aquifer underlying the area. Within ABG, there are designated areas for different methods of demilitarization including burn pads, burn pans, pink water tanks, incendiary cages and a primer pit. All current devices employed are equipped with run-on and run-off controls in the form of lids for pans or drains with sumps. Previous methods of demilitarization contributed to the soil and groundwater contamination.

4. Demonstration Approach

4.1 Performance Objectives

The objectives of the field trials were the demonstration of the biosensors being operated on-site by non-NRL personnel as well as NRL staff and the generation of analytical data appropriate for sensor validation and certification by a regulatory agency such as the U.S. EPA or Cal EPA. A minimum of four instruments of each biosensor type was employed for each field trial. At least two of the sensors were operated by non-NRL personnel (a U.S. EPA chemist and/or contractor).

A specific goal for the NRL environmental immunosensors was to achieve 1-5 ppb sensitivity for TNT and RDX in environmental groundwater samples and 50-100 ppb in soil samples. Specificity of the sensors was provided by the antibodies immobilized on solid matrices within the biosensors. The immunosensors should be specific for TNT and RDX with minimum cross-reactivities. It should be noted that cross-reactivity with TNB and HMX are expected with the antibodies employed. Accuracy and precision were evaluated using linear regression and relative percent differences (RPD). It has been noted in several papers that ± 50% RPD is routinely used as the control limit. [18,19] Our goal for the linear regressions was a coefficient of determination (r^2) greater than 0.70 and a significantlly different from zero (assessed by t-test). A student's paired t-test (a test of accuracy) and the Fisher F-test (a test of variance) were performed on all field trial data values. In each case, the goal was to obtain values that indicate no significant difference between the immunosensors and Method 8330. The field data was also evaluated for false positive/false negative rates with the goal of having <10% false positive and 0% false negative. In addition to sensitivity and specificity, other advantages of the sensors including low generation of waste, short analysis times, limited sample preparation, low cost per analysis, and little or no matrix effects were validated.

4.2 Physical Setup and Operation

4.2.1 SUBASE Bangor (Groundwater and Umatilla soils). At this site, the biosensors were set up in one room in a one story office/conference building attached to the Manchester EPA laboratories in Manchester, WA. The building housed two offices (unoccupied at the time) and two conference rooms. Both the flow biosensor and the fiber optic biosensor were deployed and operated in the larger conference room at the front of the building. The building was temperature controlled and electricity was available. The building had a single sink, but no refrigerator. Samples were stored in a walk-in refrigerator in the main EPA laboratory building and carried to the conference building in coolers as needed. All preparation of the samples was performed in the room with the instrumentation. All materials necessary for the analysis of groundwater were carried with us on-site. Setup of the four flow immunosensors took approximately 30 minutes. The antibody-coated membranes need to washed prior to initial sample analysis to obtain a sample baseline. The four fiber optic biosensors were operational in less than one hour. The EPA laboratories' water deionizer supplied water as was needed.

4.2.2 Umatilla Army Depot (Groundwater). At the UMDA field test site, the biosensors were operated in one room in a one story office/conference building located inside the military installation. The building housed two offices (1 occupied at the time), one utility room (refrigerator) and one conference room. Both the flow biosensor and the fiber optic biosensor were deployed and operated in the conference room toward the rear of the building. The building was temperature controlled and electricity was available. The utility room contained a refrigerator for storage of samples, a sink, and table for sample preparation. Samples were stored in the refrigerator until diluted for immunosensor analysis. All preparation of the samples was performed in the room with the instrumentation. All materials necessary for the analysis of groundwater were carried with us on-site. Setup of the four flow biosensors took approximately 30 minutes. The antibody-coated membranes need to washed prior to initial sample analysis to obtain a sample baseline. The four fiber optic biosensors were operational in less than one hour. Distilled water was obtained for sample dilution as was needed.

4.2.3 Naval Surface Weapons Center Crane (Groundwater). At this location, the biosensors were set up in two rooms in a two-story building. The building housed a library in the basement and the upper floor was undergoing renovation. A finished conference room was employed for four semi-automated fiber optic biosensors. Four Continuous Flow Immunosensors were setup in a large unfinished area. The building was temperature controlled and electricity was available. A small sink and refrigerator were available for preparing and storing samples. Everything needed to perform groundwater analysis was brought with us. Setup of four FAST 2000 instruments took approximately 30 minutes. The antibody-coated membranes need to washed prior to initial sample analysis to obtain a sample baseline. The four fiber optic biosensors were operational in less than one hour. As with the other sites, distilled water was purchased from a local grocery store.

4.3 Sampling Procedures.

4.3.1 Groundwater. Groundwater from monitoring and extraction wells in contaminated areas were collected by on-site personnel or EPA Region's contractor for analysis. In addition, spring water was also collected at the Crane site. Groundwater from the monitoring wells and before and after the GAC units were analyzed at all three sites. Samples were initially collected into 20L EPA-approved cleaned containers and sealed until on-site analysis or shipment to laboratories for analysis. Individual groundwater samples were collected directly from the extraction wells. In addition, groundwater samples were collected from the combined flow from the extraction wells at sampling ports before and after initial particulate filters and upstream of the granular activated carbon (GAC) unit at SUBASE Bangor. After the samples were collected, they were stored in the dark and kept cool (<10ºC). Aliquots or splits from the large sample container were used for laboratory and field analysis. These aliquots (one liter for each laboratory and 40 mLs for on-site analysis by the biosensors) were stored in EPA-approved cleaned amber bottles in the dark and cool (4ºC). Due to rapid TNT degradation in groundwater, analysis for TNT was performed within one month of

collection. The contract laboratories were monitored by Harry Craig of U.S. EPA Region 10 (QST, Gainesville FL) and P. Gauger of Geo-Centers, Inc. (GP Laboratories).

4.3.2 Soil. Soils from Umatilla Army Depot were provided by H. Craig (U.S. EPA) and Gannett Fleming staff. Additional soil samples were provided by T. Jenkins (CRREL). The additional soil samples were from Ft. Ord, CA (1), Hawthorne Army Ammunition Plant, Hawthorne, NV (3), Raritan Arsenal, NJ (1), and Nebraska Ordance Plant, Mead, NE (4). They were archived samples that were dry, well homogenized, and fully characterized.

4.4 Analytical Procedures.

4.4.1 Soil Extraction. An acetone extraction was performed on all soil samples using the method developed by Jenkins et. al.[20] For the on-site field trial, 20 gm of soil was mixed with 100 mL acetone. The sample was shaken for three minutes and then filtered. The acetone extract was measured. The extract was stored in amber containers at 4ºC until analysis. Since there was less than 5 gms of the archived soils, the procedure was modified to 2 gm of soil and 10 mL acetone.

4.4.2 Fiber Optic Biosensor. Detection of TNT and RDX was achieved by performing competitive fluorescence immunoassays on the surface of an antibody-coated fiber probe.[2,9] The procedure for making the antibody-coated optical probes has been described in the literature.[17] Briefly, a 10-cm long, 600 µm optical fiber probe, with a bayonet connector on one end, has cladding removed from the last 7 cm to expose the core. The probe is tapered in hydrofluoric acid to obtain the optimal geometry for excitation and emission collection. A thiol-terminal silane is attached to the core surface, followed by a heterobifunctional crosslinker. After attachment of the crosslinker, a succinimide residue binds primary amines on the antibody. The antibody-coated fibers can be stored for more than 1 year before use. The preferred method for storage is lyophilized or in buffer at 4ºC, but can be stored for extended periods at 25ºC.

In a competitive fluoroimmunoassay like the one for TNT and RDX, fluorescent compounds compete with the unlabeled compound in the sample for the limited number of antibody binding sites. The maximum fluorescent signal occurs when there is only the fluorescently-labeled compound present. Fluorescently-labeled TNB (Cy5-EDA-TNB) was used as the competitor in this TNT assay and fluorescently-labeled RDX hapten (Cy5-EDA-RDH) for RDX.[17] As the unlabeled compound increases, a proportional decrease in the fluorescent signal is observed. Using a standard curve generated by evaluating known concentrations of unlabeled compound on the biosensor, unknowns can be assayed and the results compared to the standard curve to determine the concentrations in the test sample.

In the TNT assays run during the field trials, all test solutions, reference solutions and controls contained buffer with the following components: 7.5 µg/L Cy5-EDA-TNB in 1x PBS pH 7.4, 5% acetone, 2 mg/mL bovine serum albumin and 0.1% Tween 20. A 10x stock solution of this

buffer was used to make all test solutions. After a background reading from PBS buffer, a solution containing only the Cy5-EDA-TNB (reference solution) was exposed to an antibody-coated optical fiber probe for five minutes. Upon laser excitation of the fiber probe, a specific signal that corresponded to the maximum (100%) or reference signal was generated. This reference signal is defined as the signal change associated with the labeled TNB alone. The fiber probe was washed with 50% ethanol in buffer for five minute to remove the Cy5-EDA-TNB. In the case of explosives, the explosive and the labeled analog are more soluble in the ethanol solution than the buffer. This fact along with the moderate affinity of the antibody permit removal of the material bound to the fiber probe. Next, the probe was re-equilibrated with the PBS buffer solution for two minutes to prepare it for the next sample. At the end of a minute, another background reading is taken.

An unknown or standard is then assayed in a protocol identical to the reference solution. To the unknown or standard, fluorescently-labeled TNB is added to make the sample contain the same concentration as that used for the 100% signal (7.5 µg/L Cy5-EDA-TNB). For water studies, the groundwater replaces deionized water in preparation of the sample. For soils, the acetone extract is employed to achieve the 5% acetone component of the sample, thereby creating a 1:20 dilution. Additional dilutions of the acetone extract may be required to obtain a reading that falls on the standard curve. The fluorescent signal for the test sample will be lower than the reference signal if TNT is present. After the test sample, the fiber probe was regenerated and re-equilibrated with PBS buffer. The protocol for analysis was a reference assay (Cy5-EDA-TNB only), regeneration of the fiber, test sample assay, regeneration, and then another reference assay. If multiple test samples were being assayed consecutively, only a single reference assay is run between test assays. Figure 6 graphically demonstrates this protocol with TNT spiked samples.

The RDX competitive immunoassays followed the same procedure with the following exceptions. First, Cy5-EDA-RDH is employed in place of Cy5-EDA-TNB but at the same concentration. The second exception is the length of time for regeneration. The fiber optic probe is exposed to the 50% ethanol solution for ten minutes instead of the five minutes needed for TNT. This is due to the relative affinity of the anti-RDX antibody compared to the anti-TNT antibody.

Inhibition of the reference signal was observed when TNT or RDX was present in the test sample. The percent inhibition observed was proportional to the explosive concentration in the sample. The reference signal value was determined both before and after the test sample assay in order to normalize for the gradual decrease in the antibody activity. The following equation was used to determine the percent inhibition of the 100% signal value by TNT or RDX.

$$\%\ Inhibition = \left[1 - \frac{Test\ signal}{\left(\frac{Reference_{pre} + Reference_{post}}{2}\right)} \right] * 100$$

By employing the standard curve, the unknown samples could be converted from percent inhibition to µg/L (ppb). The % inhibition and concentration values were determined for each analysis and there was a minimum of seven fiber probes analyzes per test sample.

4.4.3 Continuous Flow Immunosensor. The continuous flow immunosensor is based on a displacement immunoassay in which the explosive molecules in the sample selectively "displace" a fluorescently labeled signal molecule from an immobilized antibody. This sensor has been described extensively in the literature based on work with the laboratory version[4]. Procedures used in the field trials with the new FAST 2000 instrument were modified from previously published work to reflect differences from the laboratory sensor operation. Briefly, all assay parameters and commands are controlled using a PCMCIA-based PC software program arranged by function. The 11B3 TNT and Strategic Diagnostics RDX monoclonal antibodies were immobilized onto porous membrane supports and saturated with the fluorescent analog using the detailed protocols outlined in the Demonstration Plans. The membrane was inserted into a disposable coupon, the coupon was placed in the FAST 2000, and the buffer flow was started by a computer command. Once the fluorescence background signal due to unbound CY5 had stabilized (generally 15-20 minutes), the biosensor was ready for sample injection.

For groundwater samples, a small amount of concentrated flow buffer is added prior to injection to buffer the sample. The acetone soil extracts are first dried down, then brought up in flow buffer before injection. Samples of 150 ul were injected using a 1cc tuberculin syringe in the following order:

Standard Injection (1000 ppb - 100 ppb)
Sample Injection #1
Sample Injection #2
Sample Injection #3
Standard Injection (close to range of the sample)
Sample Injection #4
Sample Injection #5
Standard Injection (close to range of the sample)
Sample Injection #6
Sample Injection #7
Standard Injection (close to range of the sample)

This injection protocol proved to be close to ideal when dealing with the displacement assay, where fluorescence peak area decreases both with subsequent samples and with time. By comparing standard injections at the beginning of the sample run with standard injections in the middle and end of the run, we were able to monitor membrane behavior and change the membrane before the accuracy of the analyses was compromised. Also, standards could be selected that closely matched the concentration of the sample. This calibration method improves as working experience with the instrument increases, but even the non-developer users at the field trials very quickly understood how the instrument was behaving and could select standards that closely matched the samples.

For all samples, the computer calculated a Peak Area (integral) that corresponded to the beginning and end of the peak, as defined by the operator. To calculate a sample concentration, the peak area value for each sample was compared to the calibration standards injected before the sample. In most cases, all that was needed was to derive the average area under the peak for all standards of the same concentration. Ideally, the standards concentrations were close in value to signals obtained from the samples being analyzed. This value was then used to derive a concentration/unit signal value (ng/mL/Peak Area Unit [PAU]). The averaged value was applied to each PA from each sample injection to acquire a concentration for that injection of the sample. The concentrations were averaged and the Standard Deviation (SD) was calculated. In some cases, outlying values were rejected using the Q-Test with a 95% confidence rejection criterion.

4.4.4 SW-846 Method 8330. The EPA-approved method for explosive analysis in groundwater is SW-846 Method 8330. This method employs high performance liquid chromatography (HPLC) and a UV detector to determine explosive concentrations. A copy of SW-846 Method 8330 is located in Appendix C. For low concentration water samples (< 20 µg/L), a salting-out extraction is performed, whereas higher concentration water samples are injected directly. All analysis by QST and GP Laboratories on the test water sample splits and standards employed the salting-out extraction step prior to analysis. In addition to the contract laboratories, NRL performed direct injection analyses of all samples. For soil extracts, the acetone extract (10-100 µl) is dried down. Next, 1-2 mls of 50/50 methanol/water is added and this is used for direct injection. The columns for HPLC analysis are a C-18 reverse phase followed by a CN reverse phase column. The mobile phase is 50/50 (v/v) methanol/sample or methanol/water. The absorbance is monitored at 254 nm. The explosive concentrations for Method 8330 are based on a single analysis, unlike the multiple analyzes performed by both biosensors. Since Method 8330 is the "standard", HPLC results from QST and NRL were evaluated to assess the accuracy and precision (Figure 14).

5. Performance Assessment

5.1 Performance Data

There is not one clear-cut way to analyze the correctness of the results of the various assays for the detection of TNT and RDX. Several statistical methods were employed to evaluate the data from the field trials. One method compared the relative percent difference (RPD) between baseline concentration (Method 8330) and the result of the field screening method. At the lower concentrations, minor differences will show up as large RPD's. The second method used linear regression curves of the field screening results versus Method 8330 concentrations. With this method, variations in the higher concentrations have a large effect on the regression line. Examination of both the RPD and linear regression data gives a better overall picture of each assay. The bias and precision of each method was also evaluated for groundwater samples. Spikes of soil samples were not performed due to concern over accurate representation of spiked soil to weather-conditioned soil in regard to extraction efficiency and matrix effects. In addition

to the statistical analysis, other factors were examined including false positives/negatives, analysis time, cross-reactants, analysis cost, sample size, use of solvents, and operator skill requirements.

As mentioned earlier (2.1.2), the biosensor technologies are based on different principles and should be considered complimentary and not necessarily competitors. Consequently, the analysis of the fiber optic biosensor and the continuous flow immunosensor will be discussed separately. Field demonstration data for both sensors will be compared to Method 8330 for TNT and RDX. Other factors used to evaluate the biosensors will also be examined.

5.1.1 Laboratory Studies. The false positive/false negative rates were determined in water spikes as suggested by U.S. EPA Office of Solid Waste. Distilled water was spiked with either TNT or RDX at 0.5X and 2X the detection limit and analyzed. The goal is to obtain no response at the 0.5X level and 100% response at the 2X level. A false positive is a sample that gives a positive response below the stated detection limit while a false negative is one which does not generate a response above the detection limit. In addition to the spiked samples, the false positive/false negative rates were determined for the field groundwater and soil samples.

Antibody cross-reactivity with compounds similar in structure were determined. The response of the antibodies to secondary targets is not equivalent or constant over concentration ranges for the secondary analyte. In a competitive immunoassay, an analyte (primary or secondary) causes a decrease in signal. The amount of cross-reactivity compound has with the antibody is reported as the concentration that causes a 50% decrease in signal or the IC_{50}. In a displacement assay, cross-reactivity is reported as the concentration of the secondary analyte needed to achieve a set response. This concentration is compared to the concentration of the primary analyte to achieve that same response.

Bias, precision, method detection limit and reliable quantitation limits were determined in groundwater only. Method bias (accuracy) is determined with the following equation:

$$bias = \left(\frac{\overline{X}}{X}\right) * 100\%$$

where $\overline{X}$ is the mean value for seven or more replicate determinations and X is the spiked or characterized concentration. To determine the precision of the biosensor, the standard deviation and the mean are employed as follows:

$$precision = \left(\frac{s}{\overline{X}}\right) * 100\%$$

The U.S. EPA also requires the Method Detection Limit (MDL) and Reliable Quantitation Limit (RQL).[21] The MDL is calculated based on the low matrix spike standard deviation from the seven replicates:

$$MDL = 3.143\ \sigma$$

The RDL is defined as four times the MDL.

5.1.2 Relative Percent Difference (RPD). The RPD values between Method 8330 concentrations and the field screening results were calculated with the following equation

$$RPD = \left(\frac{(D_1 - D_2)}{\left(\frac{D_1 + D_2}{2}\right)} \right) * 100\%$$

where D_1 = Field Screening concentration and D_2 = Method 8330 concentrations. The smaller the RPD value, the closer are the concentrations of the two methods and the more accurate the field screening method. A positive RPD indicates that the field screening method gave higher concentrations than Method 8330 results. The reverse is true for a negative RPD. A value of ±50% RPD is acceptable.[18,19]

5.1.3 Linear Regression. Linear regression plots were constructed to evaluate the accuracy of the field screening methods. The results from each method were plotted verses the Method 8330 results for each sample. A best-fit line was calculated for each assay method at each field test site. Under ideal conditions, true accuracy would have a slope = 1.0, y-intercept = zero, and a coefficient of determination (r^2) = 1.0. A slope greater than 1.0 indicates that the field screening methods generally give higher concentrations than Method 8330, and the reverse is true for slopes less than 1.0. The r^2 indicates the amount of scatter in the data, with 1.0 indicating no scatter.

5.1.4 Other Statistical Values. Other statistics used in the evaluation of the field data are the paired student's t-test and F-test on the raw data and t-test on the slope from linear regression analyses at 95% confidence levels. The paired t-test indicates whether or not the immunosensor method predicted the same analyte concentrations as the HPLC method, i.e. it is a test of accuracy. If the immunosensor is generating accurate numbers, the result of the paired t-test will be that of no significant difference between the methods. The F-test assesses the variance of the data generated by the methods. In most cases, an accurate method will predict analyte concentrations that span the same range as those from the HPLC and there will be no significant difference between the variances. The t-tests on the slope from regression analyses determine whether or not these values differ significantly from zero. The ideal case would be a slope of one.

From these properties, the following set of criteria was employed to assess the predictive capability of the immunosensor method for a given analyte at a particular site:

1. The paired t-test result from the raw data must not be significant.
2. There F-test result from the raw data must not be significant.
3. The slope must be positive and significantly different from zero.

Therefore, a method must satisfy all three criteria to be deemed predictive.

5.1.5 Fiber Optic Biosensor

Raw data from the field demonstrations and the laboratory analysis are located in Appendix B. Since the geochemical conditions at each site are different, the analysis of the data is discussed separately for each location. All inhibition data were compared to standard curves to determine the concentration of the specific explosive. The standard curves used for quantitation are shown in Figure 15.

5.1.5.1 False positives/False Negatives Spikes. Following U.S. EPA protocols for false positive/negatives, buffer was spiked at 2X and 0.5X the MDL concentration. The MDL for the fiber optic biosensor for both RDX and TNT is 5 ppb, therefore the concentrations of the spikes tested were 2.5 and 10 ppb. The goal of any field analysis is to identify all samples containing RDX or TNT greater than the stated detection limit (i.e., no false negatives). At the higher concentration (10 ppb), there were no false negatives in either the RDX or TNT spiked samples (Table 2). Samples which do not contain explosives should also be accurately identified. With the lower concentration (2.5 ppb), there were 42% and 62% positives for RDX and TNT, respectively. The high level of positives at 2.5 ug/L can be partially explained by the standard curve and variability. The standard curves for RDX and TNT are asymmetric sigmoids which are linear in the middle range and gradually level off at the lower and upper ends of detection. This makes it difficult to establish a precise limit of detection. If the cut-off for detection was exactly 5 ug/L, none of the 2.5 ug/L samples would have been positive. The variability between analyses can also affect the number of positives. With mass production of the antibody-coated fiber optic probes, there should be less variability due to improved QA/QC, therefore the MDL could be lowered to reduce the false positives without increasing the false negatives.

5.1.5.2 Cross-Reactivity (water). Both the limits of detection and the concentration at which 50% inhibition of the maximum signal (IC_{50}) occurred were determined for TNT and RDX (Table 3). Values greater than 1000 µg/L indicate no detectable inhibition. For the anti-TNT antibody from Strategic Diagnostics, only 1,3,5 trinitrobenzene (TNB) showed any appreciable level of cross-reactivity with detection at 10 µg/L and the IC_{50} at 50 µg/L (Table 3). Other compounds were detected with this antibody but did not achieve 50% inhibition of the signal for concentrations less than 1000 µg/L. This cross-reactivity to TNB is expected as the antibody was raised against a TNB conjugate. TNT could not be used because it is not immunogenic. There were no significant cross-reactants with the anti-RDX antibody at the IC_{50} level. Only HMX had any significant limit of detection with the anti-RDX antibody.

5.1.5.3 Matrix Effects (Groundwater). The effect of different matrices on the explosive assays were examined by spiking each matrix with a high and low concentration of explosives. The results of this study are shown in Tables 4 and 5. The bias is the indication of how accurate the assay was (i.e., the similarity of the measured concentration to the spiked concentration). In all cases the higher concentration was more accurate or had a higher bias than the lower concentration. It should be noted that the % inhibition values were used to determine the bias and precision. The standard deviation from the % inhibition values was then converted to ppb to calculate the MDL and RQL values. The reason for this is the high TNT concentration is not on the linear portion of the standard curve. The inhibition values

are at the level where dilutions should be performed to quantitate the sample. Very small changes have dramatic changes in the concentration values, which make the standard deviations very large. The TNT assay appears to have better values for the bias than the RDX assay. The precision varied in both assays but at the higher concentrations were less than 15%.

5.1.5.4. Field Standards (Groundwater). Explosive standards were prepared by R. Araki of U.S. EPA Region 10 Manchester Laboratory for analysis during the initial field demonstration on SUBASE Bangor samples. The concentrations of TNT and RDX ranged from 1-5000 ppb (µg/L). Table 6 shows the results from the field analysis by the fiber optic biosensor and the Method 8330 laboratory results. The 1 ppb sample is below the detection limit of the biosensor. At the 10 ppb level, the biosensor was able to detect both RDX and TNT. It is noted that the concentrations determined by the fiber optic biosensor are lower than those obtained by Method 8330 direct injection. By employing an extraction to preconcentrate prior to Method 8330, the HPLC can detect lower levels. The higher concentrations of 1000 and 5000 ppb were above the percent inhibition levels that can be confidently used for accurate measurements. No dilutions were performed on the higher concentration samples to bring them down onto the curve. Table 6 gives the RPD's for the field standards with the averages being 37 and -13 for RDX and TNT respectively (Table 7). At lower detection levels, the RPD's are higher than the acceptable criteria of ±50[18,19] but as stated earlier, small variations at the lower concentrations greatly affect the RPD values.

5.1.5.5 SUBASE Bangor (Groundwater). The first field demonstration was performed on monitoring well and GAC effluent samples at SUBASE Bangor. During this demonstration, personnel from the U.S. EPA Region 10 and their contractors were trained to use the Analyte 2000 and the NRL fluidics unit. A summary of the results and the comparison to the independent QST laboratory's Method 8330 are shown in Table 8. Due to variations in fiber probe response and instrument noise (determined from blank samples), a conservative detection limit of 5 ppb was calculated. Some fiber optic samples on Table 8 have concentration values listed lower than 5 ppb rather than below the detection limit (BDL) to give the full range of information on the sensor. The RPD's for RDX ranged from -71 to160 with an average of 19 (Table 7). This average RPD value indicates that the fiber is slightly overestimating the RDX concentrations but is clearly within acceptable range. The samples with higher RPD's also were samples that had large standard deviations for the replicates. For TNT, the RPD's ranged from -40 to 198 with an average of 65 (Table 7). The positive RPD value indicates an overestimation of TNT concentration but the larger RPD's values are mostly associated with EW4, which has a value of 13 ppb. As with the RDX analysis, the higher RPD samples have the larger standard deviations for the % inhibition values.

Another way to analyze the fiber optic biosensor data is to perform a linear regression on the data versus Method 8330. In this method, variations at the higher concentrations greatly affect the regression values for the slope. The linear regressions for RDX and TNT on SUBASE Bangor samples are shown in Figures 16 and 17. The samples used for the regression analysis were ones in which both the fiber optic biosensor and Method 8330 gave numerical results. The mean and standard deviation from seven or more analyses of each

sample are shown. As mentioned above, perfect agreement is indicated by slope = 1.0 with a $r^2 = 1$. Slopes less than 1.0 indicate an underestimation of the explosive concentration. For RDX, the slope was 0.61 (significant from 0) with $r^2 = 0.67$. As shown in Figure 16, there are several points with large standard deviations. The TNT regression line (Figure 17) has a slope of 0.15 (not significant from 0) and a $r^2 = 0.50$. It should be noted that there are only four points on the TNT curve.

A student's t-test and the Fisher's F-test was performed on the data with positive values in Table 8. The results are shown in Table 9. The fiber optic biosensor values for RDX passed both the t-test and the F-test in that neither was significant. The TNT values passed the t-test but were significant for the F-test ($p<0.05$). It should be noted that the TNT analysis was on four samples with low levels of TNT and large standard deviations. This low number of degrees of freedom resulted in the strange outcome of the t- and F-test. Usually, a data set that passes the t-test will also pass the F-test, i.e. an accurate data set spans the same range as its reference. There were no false negatives for either RDX or TNT. The RDX assay had two false positives while TNT had four (Table 10).

5.1.5.6 Umatilla Army Depot (Groundwater). The second demonstration was on monitoring well and GAC effluent samples from Umatilla Army Depot. In the period between the two field trials, there was a major change in NRL personnel operating the fiber optic biosensors. The U.S. EPA personnel and contractors remained the same. The summary of the data can be seen in Table 11. Twenty-one samples were analyzed at Umatilla. Most of the samples (17) required dilution to permit quantitation of either TNT, RDX or both. Dilutions at 1:10, 1:50 or 1:100 in water were performed on samples with % inhibitions greater than 70 and the diluted sample re-tested. The fiber optic biosensor and HPLC values of the diluted sample are given in Table 11 and used for all calculations. The RPD's for the Umatilla samples can be found in Table 11. The RPD range for RDX is -67 to 188 and -69 to 200 for TNT (Table 7). The average RPD's are 18 and 78 for RDX and TNT, respectively. The average RDX RPD easily falls into the acceptable range of ± 50.

The linear regression's for the Umatilla samples are shown in Figures 18 and 19. The slope for the RDX regression is 0.51 with a correlation coefficient of 0.40. Two samples (EW-4 and 4-24) seem to be associated with high levels of variation. These samples appear to have a significant effect on the coefficient of determination. The equation for the TNT linear regression is $y = 0.31x + 32.04$ with a $r^2 = 0.25$. The t-test on the slope indicates that it is not significantly different from zero.

Statistical analysis of the Umatilla with a t-test and the F-test indicated that the fiber optic biosensor generated results for RDX and TNT that were not significantly different from Method 8330 (Table 9). As with Bangor, there were no false negatives for either RDX or TNT (Table 10). There were two false positives for RDX and eight for TNT. In several of the false positives, the cross-reactant TNB was present.

5.1.5.7 Naval Surface Weapons Crane (Groundwater). The third field demonstration took place in September at the Naval Surface Weapons Center in Crane Indiana. At this site, there

were problems with the assays, later identified in the laboratory as problems with the antibody-coated probes. Due to rapid degradation of TNT, we were unable to repeat the TNT analysis on the Crane samples in the laboratory. We were able to perform RDX analyses on the Crane samples back at NRL and the summary of the data is shown in Table 12. Only one sample required dilution. The RPD's ranged from -124 to -52 with an average of -92 (Table 7). This is out of the acceptable range and indicates underestimation of the concentration. This site has very different geochemistry from the other demonstration sites with acidic conditions and significant levels of trichloroethane. The RDX regression line y = 0.42x - 2.44 with a r^2 =0.84, indicating an underestimation of the concentration (Figure 20). The slope passed the t-test which denotes that the slope is significantly different from zero.

The RDX data set from Crane did not pass either the student t-test ($p<0.001$) or the F-test($p<0.05$) (Table 9). There were 2 false negatives but no false positives at Crane (Table 10).

5.1.5.8 Soil Field Samples. Ten archived, characterized soil samples (TJ00x) from several locations in the United States were provided by T. Jenkins of CRREL. In addition, H. Craig of U.S. EPA Region 10 provided us with five soil samples (Gxx-xx-A) from Umatilla Army Depot, Hermiston OR. A summary of the soil extract results from the fiber optic biosensor and Method 8330 are shown in Table 13. It should be noted that a 1:20 dilution is always performed to get the proper acetone concentration in the test sample that is applied to the fiber optic biosensor. Because of this dilution, the MDL prior to dilution for a sample is 100 µg/L. Many of the samples required additional dilution to obtain quantitative values from the standard curve. Sample TJ005 extract, which was bright yellow, seemed to cause some problem with the fiber optic biosensor in that it gave values higher than the HPLC value, especially in the TNT assay. As it turns out, this sample contained high levels of picric acid which in a basic form in yellow. The RPD values for RDX ranged from -193 to 94 with the average being -7 (Table 7). Ten samples had RPD's less than ± 50. Only one sample (TJ005) seem to give an artificially high value which may be due to picric acid. The TNT assay did not perform as well as the RDX assay. The TNT RPD values ranged from -134 to 195 with an average of -38 (Table 7). Two of the samples gave RPD values less than ± 50 with five others in the ± 50-100 range.

Another approach for data analysis is to perform a linear regression on the fiber optic results versus Method 8330. In this method, variations at the higher concentrations greatly affect the regression values for the slope. The linear regressions for RDX and TNT are shown in Figures 21 and 22. The mean and standard deviation from seven or more analyses of each sample are shown. For RDX, the slope was 1.13 with an r^2 = 0.87 while the TNT assay gave values of slope =0.88 and r^2 = 0.92. Both slopes passed the t-test as being significantly different from zero.

The RDX and TNT passed both the student t-test and the F-test by being not significantly different from Method 8330 (Table 9). There was two false negatives and one false positive for RDX while there were no false negatives and two false positives for TNT (Table 10).

For the T. Jenkins samples, we were supplied with the archived mg/kg values. In the CRREL Special Report 96-10, the authors reported each site has its own extraction efficiency but all were greater than or equal to 70% with the three minute acetone extraction method.[20] Therefore, the µg/L concentration values were converted to mg/kg employing the assumption of 70% extraction efficiency . The results are shown in Table 14. Six of the eight RDX RPD values were ≤50% . The RPDs ranged from -85 to 156 with an average of 10. Again, the TNT results were not as clean. The TNT RPD values ranged from -154 to 197 (for TJ005) and an average of 10. Only one of seven TNT RPD's fall in the acceptable range. Figures 23 and 24 show the linear regression of the calculated mg/kg FOB values for the samples supplied by T. Jenkins. The slope for the RDX assay is 0.95 with an r^2 of 0.99. The slope for TNT is 0.13 with an r^2 of 0.18. Since the extraction efficiency is not know for each sample, not further statistical analysis was performed on this data set.

5.1.5.9 Summary of results. When the groundwater from all the sites is combined, the average RPD was -8 for RDX and 74 for TNT (Table 7). This suggests that in general the RDX assay is accurate. The RPD value for TNT is out of the acceptable range and indicates overestimation of the concentration. This may be due in part to cross-reactivity to TNB. When a linear regression in performed on the combined data set, the line for RDX is $y = 0.61x + 11.05$ with an $r^2 = 0.65$ (Figure 25). The slope is significantly different from zero but the coefficient of determination is lower than desired. For TNT, the slope of the regression line is 0.37 with an $r^2 = 0.28$ (Figure 26). A student's t-test and a F-test was performed on the combined data sets. Both the RDX and the TNT assay, showed no significant difference in either test (Table 9). In the combined data sets, there were two false negatives(9%) and four false positives (4%) for RDX while there were no false negatives and 12 false positives for TNT (Table 10).

As stated in Section 5.1.5.4, each assay must pass three criteria to be considered predictive. The three criteria are no significance for the student t-test and F-test and significant difference from zero for the linear regression slope. A summary of those results are shown in Table 15. For RDX, overall groundwater, Bangor groundwater, Umatilla groundwater, and soil passed all three criteria, therefore they were predictive. The RDX assay at Crane failed the t-test and F-test. The TNT assay passed the three criteria for overall groundwater and soil and are considered predictive for those tests. The TNT assay failed the F-test and the slope test on the four positive samples at Bangor. Only the slope test for TNT was failed at Umatilla. No TNT samples were analyzed at Crane. From these tests, it appears the fiber optic biosensor can be predictive for RDX and TNT but there can be matrix interferences that would need to be addressed.

5.1.6 Continuous Flow Immunosensor

5.1.6.1 False Positives/False Negatives Spikes. Experiments were conducted with the FAST 2000 to determine the false positive/ false negative percent for TNT and RDX Explosive samples were prepared in the system flow buffer and injected into the FAST 2000. Fluorescence dose responses were recorded from the immunosensor and calculated. The definition of a "false negative" is a negative response for a sample that contains 2 times the

stated detection level of the target analyte. A "false positive" is a positive response for a sample that contains analyte at one-half the detection level. The minimal detection limit with the FAST 2000 in the system flow buffer is 10 ng/mL. The false positive (FP) / false negative (FN) experiments involved 20 -30 replicate injections of TNT or RDX at concentrations at 5 ng/mL (FP) and 20 ng/mL (FN) into the FAST 2000 immunosensor (Figures 27 and 28). The dotted line indicates the positive/negative cutoff line. Results showed 0% false positives and 0% false negatives. (Table 16)

5.1.6.2 Accuracy and Precision (System Flow Buffer). Two other performance criteria are accuracy and precision. Accuracy is an indication of how closely the average value of the FAST 2000 immunosensor matches with the HPLC confirmatory method (SW846-Method 8330). Precision is an indication of how close the replicate injections into the FAST 2000 are to each other. Listed in Table 17 are results from the accuracy and precision experiments in which RDX and TNT samples in buffer (5 and 50 times the detection limit) were injected into the FAST 2000. Results indicate a high degree of accuracy between RDX and TNT with values that range from 93% - 99%. The precision of the sensor is also indicated with percentages that are as low as 6% up to 15%.

5.1.6.3 Accuracy and Precision (Groundwater Matrix Spikes). The groundwater spiked matrices give an indication of the environmental interferents that could pose problems for immunoassays. To determine the effect of groundwater matrixes on the analysis of TNT and RDX by FAST 2000 immunosensor, a series of experiments was performed. The first set of experiments required supplementing 3 different groundwater matrices (SUBASE Bangor, Umatilla Army Depot and Volunteer Army Ammunition Plant) with TNT and RDX at concentrations 5X and 50X the minimal detection limit. Each groundwater matrix selected contained little to no explosive content. Analysis by the FAST 2000 involved 7 injections of each spiked groundwater matrix onto the respective antibody/ fluorescence antigen membrane complex. The fluorescence displacement area was recorded and translated into accuracy (%) and precision (%). Results indicated in Tables 18 and 19 show a wide percentage fluctuations for the matrix spikes in comparison to the system flow buffer data. TNT accuracy results ranged from 68% to as high as 653%. This high value (653%) can be attributed to an interferent in the groundwater matrix that caused non-specific displacement of the fluorescence analog. This dramatic increase in fluorescence caused the data to be skewed on the higher end. Of the other matrix spikes, all were relatively accurate (within a factor of 2) in the measurement of TNT. Precision values were as low as 10% to as high as 86%. RDX accuracy measurements were not skewed as much as TNT. Using criteria, RPD accuracy ranged from 20% to as high a 96%. Precision results ranged from 9% to 59%. Data calculations also reveal that the FAST 2000 immunosensor was less affected by the matrix interferent at the higher concentrations than at the low end. Overall, the FAST 2000 was able to detect TNT and RDX with reasonable accuracy but did encounter matrix associated problems at each location. Elemental analyses of groundwater samples taken at one site (Volunteer Army Ammunition Plant) showed enormously high concentrations of sulfate, magnesium, carbon and alkalinity. These results suggest that the FAST 2000 can provide a qualitative indication of explosive contaminants but like most other immunoassay techniques can encounter problems associated with the natural environment in quantitative

determinations. Efforts to remove the environmental interferent by solid phase extraction are being investigated.

5.1.6.4 Cross-Reactivity (Groundwater). Another performance criterion for the FAST 2000 immunosensor is its ability to select and measure the unlabeled RDX or TNT molecule among other explosive compounds. To demonstrate the RDX immunosensors selectivity, a series of standard solutions containing various explosive compounds at 1000 ng/mL was injected into the immunosensor. As a calibrant, unlabeled RDX was also injected at the same concentration. After each injection of explosive samples, fluorescence integrated area from the displaced fluorescent RDX analog was recorded and compared to the fluorescence integrated area of the RDX standard (used as 100% value). Similar experiments were performed to determine TNT antibody cross-reactivity using 250 ng/mL as the explosive concentration. Exhibited in Table 20 are the percent cross-reactivity results of each explosive compound compared to unlabeled RDX and TNT measured by the FAST 2000 immunosensor.

Results exhibited minimal cross-reactivity of other explosive compounds in the FAST 2000 immunosensor. Percent cross-reactivity values ranged from as low as 0.9% (Tetryl) to 4.8% (HMX). The average percent cross-reactivity was approximately 2% for all compounds tested. One of the highest cross-reactivity values obtained was with HMX at 4.8%. It is reasonable to assume that the HMX molecule would exhibit high cross-reactivity results in the RDX immunoassay because of similar structural characteristics. Molecules such as TNT and its breakdown products, 2-amino-4,6-DNT, TNB and nitrobenzene show less cross-reactivity than HMX. This is expected because explosives similar in structure to TNT possess a planar conformation and not the chair conformation exhibited in RDX. Increases in percent cross-reactivity, evident with nitrotoluene (NT) and trinitrobenzene (TNB), may result from resonance and electrical field effects from the electronegative charge distribution from nitro groups oriented on the benzene ring. These series of tests for cross-reactivity in the RDX FAST 2000 immunosensor demonstrate that other explosive compounds such TNT and its breakdown products exhibit minimal non-specific fluorescence response. However, that fraction of cross-reactivity is minimal and is most likely to occur due to like characteristics of all explosive compounds. These results confirm the high selectivity for RDX in the FAST 2000 immunosensor and its ability to screen out interferents that generate erroneous signal responses.

TNT cross-reactivity experiments performed with the FAST 2000 immunosensor involved injection of a series of standard solutions containing various explosive compounds at 250 ng/mL similar to that of the RDX immunoassay. As a calibrant, unlabeled TNT was also injected at the same concentration. Results shown in Table 20 show a 600% increase in cross-reactivity to trinitrobenzene (TNB). This is to be expected given the 11B3 anti-TNT antibody was raised against a TNB hapten complex. High cross-reactivity results of this nature can be positive given that many of the breakdown products of TNT are TNB and/or amino-DNT. Molecules such as TNB and its breakdown products, 2-amino-4,6-DNT, Tetryl and nitrobenzene are more cross-reactive than HMX or RDX because of their similar structural characteristics. Explosives similar in structure to TNT possess a planar conformation and not the chair conformation exhibited in RDX which allow better recognition of the molecule to the anti-TNT antibody.

5.1.6.5 Field Standards (Groundwater). The initial field demonstration conducted at SUBASE Bangor involved preparation and analysis of explosive standards (TNT and RDX). The explosive standards prepared at SUBASE Bangor served as calibrants while analyzing groundwater samples. Each explosive standard was analyzed by the FAST 2000 immunosensor in a series of 7 injections (0.150 mL). A fluorescence peak area from the FAST 2000 immunosensor was recorded for each injection. The explosives concentrations for each injection were calculated by comparing fluorescence peak areas of standards to samples, as described in Sec. 4.4.2. As seen in Table 21, RDX standards analyzed by the FAST 2000 were consistent with the calculated value measured by QST Environmental Lab (e.g. FLS-8; 113 vs. 97). Standard deviations ranged from as low as 8% to as high as 31%. However, the highest standard deviation was only evident at the lowest concentration of 1.0 ug/L, where slight changes can skew standard deviation values. Calculated concentrations of TNT for the explosive standards (FLS-1 thru FLS-5) were also close to the expected values, determined by QST Laboratory. However, standard deviations were higher than expected, ranging from 16% to as high as 114% (FLS-4). A possible factor for the increased standard deviations is the low binding affinity of the anti-TNT antibody (11B3). Low affinity of the antibody to the explosive molecule, TNT, can result in fluorescence peak area differences seen even with multiple injections of the same standard solution.

Statistical calculations of the field data were performed as a measure of performance for the FAST 2000 immunosensor in the analysis of explosives in groundwater. One such analysis performed was relative percent differences (RPD). In general, low RPD values (near zero) indicate the closeness of the two analytical methods (FAST 2000 immunosensor verses HPLC). Calculated RPD's for the RDX and TNT field standards (Table 12) range from -30% to 15% and -24% to 61% (Table 22). From the RPD calculations only 1 sample was higher than ± 50 (FLS 2). The average RPD value of -11% and 10% for RDX and TNT is a good indication that the FAST 2000 was quite accurate in the determination of the explosive standards. However, a value as high as 50% seen in a standard could suggest a number of factors could be influencing the assay. Such factors could include fluorescence depletion on the membrane causing less displacement of fluorescence analog or variance in flow rates from instrument to instrument. Fluorescence depletion leading to decreased displacement efficiency will result in an underestimation of explosive standards and higher RPDs.

Linear regression analysis was also performed on the field standards. As mentioned earlier, the goal is to have a slope = 1.0 with a $r^2 = 1.0$. The RDX standards yielded a regression line of $y = 0.76x + 6.02$ with a $r^2 = 1.00$ (Figure 29). The line for TNT was $y = 0.77x + 58.17$ with an $r^2 = 0.997$ (Figure 30).

5.1.6.6 SUBASE Bangor (Groundwater). At SUBASE Bangor, 13 groundwater samples were analyzed by the FAST 2000 for RDX and TNT content. Calculated concentrations of RDX determined by the FAST 2000 immunosensor from samples, listed in Table 23, were within a factor of 2 of the value determined by QST Laboratory. Although, some groundwater samples (e.g., EW-8) analyzed for RDX by the FAST 2000 immunosensor were very accurate, most of the samples analyzed were lower in RDX concentration when compared to QST Laboratory.

Analyses of TNT content between the FAST 2000 and QST Laboratory were different. TNT concentration values listed in Table 23 revealed most of the samples were below the detection limit of the FAST 2000, but did illicit a positive response (e.g., EW-9). Although the anti-TNT antibody (11B3) is specific for TNT it does exhibit minimal cross-reactivity to other compounds, which could result in an inaccurate response. Another possible explanation for the difference between the FAST 2000 immunosensor results and the HPLC analysis is the incorporation of an extraction method. A salting-out extraction method performed by QST Laboratory was used to obtain sufficient quantities of TNT for SW-846 Method 8330 analysis. This extraction method may decrease the actual concentration of the sample below the detectable limit of the HPLC. The result is a negative response when explosive material in trace quantities may be present. As a result of the TNT data, further experiments were conducted to improve assay performance.

RPD values were calculated for 13 groundwater samples containing TNT and RDX (Table 23). From these results, calculated RPD's were much higher than what is normally accepted. The average RPD for RDX and TNT were -41 and 118 with the values ranging from -146 to 60 and -44 to 199 (Table 22). RDX RPD values showed that seven out of the eleven samples with numerical values gave negative RPD values. Of those negative samples, three were above the -100% threshold (EW-3, EW-4 and INF-1) revealing a lowered estimation of RDX concentration by the FAST 2000 immunosensor compared to the certified laboratory method (SW846-Method 8330). From the remaining four positive RPD values, only one (BET-1) was above the +100% threshold.

Another method for analyzing the field data is linear regression. Figures 31 and 32 show the plots for RDX and TNT at SUBASE Bangor, respectively. The regression line for RDX is $y = 0.67x - 3.07$ with a $r^2 = 0.48$. TNT gave a line of $y = 1.58x - 1.54$ and a r^2 of 0.96. In RDX, the slope suggests an underestimation of the explosive while the reverse is true to TNT. Both the RDX and TNT assays passed the slope t-test by demonstrating slopes significantly different from zero.

Statistical analysis of the RDX and TNT data sets with the student's paired t-test and the Fisher test, gave results that indicated that the FAST 2000 data was not significantly different from Method 8330 (Table 24). Table 25 shows that there were no false negatives in either the RDX or TNT assay . There were two false positives for RDX and eight for TNT.

5.1.6.7 Umatilla Army Depot (Groundwater). Using lessons learned from SUBASE Bangor, the second series of field tests at Umatilla Army Depot showed significant improvements in the estimation of RDX and TNT by the FAST 2000 immunosensor. The values listed in Table 26 for RDX concentrations determined by the FAST 2000 were in close proximity to that of QST laboratory. Two samples (4-114 and EW-1) were considerably off the value obtained by QST Laboratory. RDX concentrations measured by the FAST 2000 in some groundwater samples were very accurate (e.g. EW-3, EW-4 and Combo 2). Determination of TNT concentration also improved on groundwater samples measured by the FAST 2000. Groundwater samples measured by the FAST 2000 containing mid to high concentrations of TNT (e.g. Combo-2, 9, and 4-112) were accurately measured compared to those containing lower TNT concentrations

(4-113 and 4-114). This response could be due to a groundwater matrix interferant that can complex with the explosive material, preventing recognition by antibody binding sites, causing no displacement of the fluorescent antigen.

Calculated RPD values (Table 26) show good correlation between the HPLC method performed by QST Laboratory and the FAST 2000 immunosensor. The average RPD for RDX and TNT were -39 and -15 with ranges of -165 to 87 and -185 to 197 respectively (Table 22). Of the 21 groundwater samples analyze for RDX, seven of the fourteen with numerical values above the detection limit were inside the acceptable ± 50% range. Only two samples (4-102 and EW-1) were above the -100% threshold. There were eight out of 21 groundwater samples analyzed for TNT by the FAST 2000 immunosensor that were above the MDL and three of those samples were inside the acceptable ± 50 % range. Two of those nine samples gave values above the +100% threshold.

Linear regression plots for RDX and TNT at Umatilla Army Depot also indicated improvements in slope and r^2 for both analyzes (Figures 33 and 34). For RDX, the regression line was $y = 0.73x - 41.59$ while the line for TNT was $y = 0.70x - 4.70$. The coefficient of determinations (r^2) were 0.81 and 0.84, respectively. Both assays passed the slope t-test for being significantly different from zero. Even though there was improvement, the immunosensor still biased low on the explosive concentrations.

The RDX assay at Umatilla did not pass the t-test ($p<0.01$) but was found to be not significantly different with the F-test (Table 24). The TNT passed both statistical tests. There were higher levels of false negatives for both RDX and TNT, than had been previously observed (Table 25). There were five false negatives and no false positives for RDX, while there four false negatives and four false positives for TNT.

5.1.6.8 Naval Surface Weapons Center, Crane (Groundwater). RDX and TNT analysis of 15 groundwater samples by the FAST 2000 at the Naval Surface weapons Center provided the most accurate and precise analysis of all the field demonstrations (Table 27). The "Spring" sample by Method 8330 gave a result that was right at or below the MDL set for the FAST 2000. It was observed, particularly at the NSWC Crane, that the groundwater matrixes can have a pronounced effect on the results when the explosive concentration is right at the detection limit of the instrument. Efforts to improve the TNT immunoassay were rewarded with most groundwater samples estimated by QST Laboratory being correctly estimated by the FAST 2000. Most of the groundwater samples were low in TNT concentration or below the detectable limit of the FAST 2000. The mean RDX RPD value for concentrations other than BDL was -11% (Table 22). The mean TNT RPD value of 83 was based on the only two values that were above the detection limit, and it should not be considered a good indicator.

Linear regression plots for RDX and TNT at NSWC Crane show r^2's of 0.58 and 1.00, respectively (Figures 35 and 36). The coefficient of determination for the TNT regression plot is ideal because of the number of data points (2). This is a result of most samples being below the detection limit (BDL) which gave no numerical value. The slopes for the regression lines were 0.74 and -1.56 for RDX and TNT, respectively. The slope for RDX is again less than one,

indicating the sensor is consistent in underestimating the explosive concentration. The slope for RDX is significantly different from zero, thereby passing the slope t-test. It should be noted that the slopes for Umatilla, Crane and the field standards range were 0.73, 0.73, and 0.76 for RDX. The same slope range is seen with TNT at Umatilla and the field standards (0.77 and 0.72). If this is a consistent trend, a correction factor could be employed to yield results very close to Method 8330.

At Crane, the RDX assay passed both the student t-test and the Fisher test (Table 24). The results for the TNT assay (both tests were not significant) are suspect since the analysis was performed on two positive samples. There was a single false negative each for RDX and TNT at Crane (Table 25). As for the false positives, there was one for the RDX assay and two for the TNT assay.

5.1.6.9 Soil Field Samples. The same samples as those described for the fiber optic biosensor were also analyzed by the continuous flow immunosensor. It is important to keep in mind, that after the acetone extraction, 1.5 mL of the sample was dried down in a test tube with nitrogen and rehydrated with flow buffer for analysis. Table 28 shows the results from the continuous flow immunosensor and Method 8330. As with the fiber optic biosensor, sample TJ005 caused some problems in the analysis for both the TNT and RDX assays. The RPD values for RDX ranged from - 195 to 122 with an average of -16 (Table 22). Eight of the fourteen values were less than ± 50. The TNT RPD values ranged from -39 to 199 with the average value of 86. Four of the samples were in the acceptable (± 50) RPD range. Several of the samples contained levels of TNB equivalent to or greater to those of TNT. As mentioned earlier, the 11B3 antibody is highly cross reactive to TNB which may explain the high values for the FAST 2000 TNT assay. The linear regression analysis of the soil extracts are shown in Figure 37 and 38. With the RDX analysis, TJ008 which is very high in HMX as well as TJ005 cause the linear regression to give a slope and r^2 (0.82 and 0.68). The equation for the TNT regression is $y = 0.91x + 164613.40$ with an $r^2 = 0.44$. The slope values passed the t-test for being significantly different from zero.

Table 24 shows the values for the student's paired t-test and the Fisher test. Both RDX and TNT demonstrated no significant difference from Method 8330 and therefore both tests were passed. No false negatives were found with the RDX soil assay but there was one false positive. The TNT soil assay also found no false negatives but did have three false positives (Table 25). In one sample (TJ009) there was significant quantities of TNB in the absence of TNT. This would cause a response in the system, thereby generating a false positive. Cross-reactivity of HMX might also be responsible for the TNT false positive for TJ008 as there is limited cross-reactivity with the 11B3 antibody for HMX.

As with the fiber optic biosensor, the values for the soil extracts was converted to mg/kg soil using a 70% extraction efficiency. The results are shown in Table 29. The RDX RPD's ranged from -161 to 100 with an average of -15 while the TNT RPD's ranged from -37 to 199 with an average of 90. Six out of nine of the RDX positive values and four of eight are in the acceptable RPD range. The linear regression analysis can also be observed with the mg/kg values for the samples from T. Jenkins in Figures 39 and 40. The slope for RDX is 0.95 and the r^2 value is

0.94. The TNT assay gave a slope of 0.70 with an r^2 of 0.08. No further statistical analysis was performed on this converted data.

5.1.6.10 Summary of results. The average RPD was -31 for RDX and 20 for TNT for the combined groundwater data set (Table 22). This suggests that in general the RDX and TNT assays are accurate. When a linear regression in performed on the combined data set, the line for RDX is $y = 0.68x + 7.72$ with an $r^2 = 0.68$ (Figure 41). The slope is significantly different from zero but the coefficient of determination is slightly lower than desired. For TNT, the slope of the regression line is 0.96 with an $r^2 = 0.73$ (Figure 42). This meets the goals established initially for the coefficient of determination value and is close to ideal for the slope. A student's t-test and a F-test was performed on the combined data sets. The RDX assay passed the Fisher test with no significance but failed the t-test ($p<0.005$)(Table 24). The TNT assay showed no significant difference in either test. In the combined data sets, there were three false negatives(6%) and six false positives (13%) for RDX while there were five (11%) false negatives and 14 false positives (30%) for TNT (Table 25).

As stated earlier, each assay must pass three criteria to be considered predictive. The three criteria are no significance for the student t-test and F-test and significant difference from zero for the linear regression slope. A summary of those results are shown in Table 30. For RDX, Bangor groundwater, Crane groundwater, and soil passed all three criteria, therefore they were predictive. The RDX assay for overall groundwater and Umatilla groundwater failed the t-tests. The TNT assay passed the three criteria for overall groundwater, Bangor groundwater, Umatilla groundwater, and soil ,therefore, they are considered predictive for those tests. The TNT assay failed the slope test on the two positive samples at Crane. From these tests, it appears the continuous flow immunosensor can be predictive for RDX and TNT but there can be matrix interferences that would need to be addressed.

5.2 Data Assessment

5.2.1 Groundwater. Since evaluation of the biosensors depends on the result of Method 8330, steps were taken to have useable data. In addition to the main contract lab (QST), NRL performed in-house HPLC analysis of all samples. Selected samples from Umatilla, Crane, Volunteer, and Louisiana were also analyzed by a second laboratory (GP Laboratories). Figure 14 shows the correlation of NRL's HPLC results versus QST. As can be seen, the correlations are excellent giving us confidence in the Method 8330 results used for comparative analysis.

Some problems have been identified with the fiber optic biosensors during the field trials. These problems appear to be associated with the fiber optic probe preparation. One problem dealt with antibody immobilization that affected the quantity of the antibody immobilized on the surface. The other problem was the fiber optic probes were not tapered down to the appropriate diameter required for maximum excitation and fluorescent collection. These problems were due in part to improper training of new personnel. These issues have been addressed. There are still some problems with variability of fiber probes that should be improved when the probes are mass produced.

5.2.2 Soil. The results from acetone extracts of the soil samples were compared for the immunosensors and Method 8330 to eliminate the variations in extraction efficiency due to the source of the soil.[20] We used the field acetone extraction method but other extraction methods could be employed. The fiber optic biosensor used the acetone extract directly but the continuous flow method required drying down the acetone extract and redissolving in flow buffer. It is not clear if this concentrates other compounds which could be interfere with the assay. Matrix effects should not be an issue unless the interferent is co-extracted.

5.3 Technology Comparison

5.3.1 Groundwater. There are several commercially available immunoassay test kits and a colorimetric test kit for the explosives TNT and RDX. In 1997, Craig et al compared several of these field methods [1]. Currently, the U.S. EPA is putting together a report on field methods for explosives in groundwater[19]. From these documents, a chart comparing the different technologies was developed (Table 31). Table 31 indicates that the biosensors are in the range of the other methods for detection with the exception of the RaPID Assay and the salting-out procedure for Method 8330. The salting-out extraction takes several hours to perform where as the biosensors do not employ an extraction/concentration step. Usually the direct injection procedure with Method 8330 is used when the suspected explosive concentration is above 20 µg/L which is higher than the detection limit of the biosensors. The RaPID system is only useful and cost-effective if batches of 10-40 samples are being analyzed simultaneously. The on-site method currently being used at several Superfund sites is the EnSys RIS system. The biosensors have several advantages over this method including analysis time, a substantial reduction in solvent, solid, and chemical waste generated, and data integration capabilities. Currently, the biosensor devices are commercially available but the antibody-coated matrices (fiber or membrane) are not. Research International is pursing partnerships with other companies to make those items commercially available.

5.3.2 Soil. As with groundwater, there are several commercially available test kits for the detection of TNT and RDX in soils. Crockett et. al. compared several of these analytical methods and described them in a 1998 CRREL Special Report.[22] From this document, a chart comparing the different technologies with the NRL immunosensors was developed (Table 32). All the methods require some sort of soil extraction prior to analysis. Of the methods listed on Table 32, only one, the RaPID assay, does not use acetone as the extraction solvent. Of the assays using acetone, most use a 5:1 (V:W) solvent to soil ratio for extraction. The continuous flow immunosensor and the Ohmicron RaPID assay give the lowest limits of detection of the test kits. The fiber optic biosensor in is the range of the other methods, if not slightly lower MDL. The current on-site soil method being used at several Superfund sites is the EnSys RIS system. As with the groundwater comparisons, the NRL biosensors have several advantages over most of these methods including sample analysis time, and reduction in waste. As stated earlier, the instruments are commercially available but not the antibody-coated matrices.

6. Cost Assessment

6.1 Cost Performance

6.1.1 Startup Costs.

6.1.1.1 Fiber Optic Biosensor. Currently, the fiber optic device is commercially available (~$18K) but the antibody-coated optical probes are not. NRL developed a semi-automated microfluidics unit for the addition of samples and reagents which is not commercially available but made from commercially available parts. The estimated cost of this unit is $8K. A computer (i.e., portable or laptop) is needed to operate the current fiber optic device via an RS232 port. In addition to the device and probes, there are some initial supplies (~$800) that are suggested but not required including adjustable pipettors and graduated cylinders. As the system becomes fully automated, the need for the pipettors will be eliminated. At the present time, a person with laboratory training is needed to operate the sensor but with automation this requirement will be diminished as will the labor costs. Little, if any, cost is associated with site preparation and permits other than obtaining the water samples. The fiber optic biosensor can be battery operated or run off a line source (110V). It is recommended that the current biosensor be operated out of direct sunlight. Refrigeration of the stock solutions is the optimum storage condition but is not required. Stock solutions can be lyophilized for long term storage (± 1 yr) and rehydrated when needed with short term storage up to 1 month without refrigeration. The physical requirements pose minimal additional costs to the startup. Antibody-coated fibers may be stored more than 1 year lyophilized at ≤ 25ºC or in buffer at 4ºC.

6.1.1.2 Continuous Flow Immunosensor. The FAST 2000 was designed to be a field portable, single-channel instrument that uses a displacement immunoassay for detection of analytes. Currently, ten instruments have been produced by the manufacturer, Research International, at a cost of approximately $21,000/per instrument. The cost reflects the "custom" engineering of each instrument to date-- such factors as machining of individual parts, etc. Fluidics and hardware to maintain precise flow control during each analysis, software development costs are also involved.

Assay times are generally 2-4 minutes, allowing approximately 40-50 analyses per day. Set up and shut down can be completed in 15-20 minutes. Additional supplies required to run the instrument include the disposable coupons ($49/each) which are individually assembled and the antibody coated membranes/fluorescent analogs, prepared at NRL. RI is currently discussing several options for full-scale commercialization of the instrument, which would include injection molded coupons (reducing the cost to pennies per coupon), and membrane preparation by a company that currently sells immunoassay kits and produces TNT/RDX antibodies.

6.1.2 Operations and Maintenance. The consumables (buffers, pipet tips, syringes) for the fiber optic biosensor are estimated to be $110/wk and are included in the $3-5/sample cost. Additional costs for acetone soil extractions are estimated at $1 - $1.50 per sample. Minimal training is

required to operate the fiber optic biosensor. It can be run continuously or intermittently to allow for spot monitoring. For most groundwater monitoring during cleanup, intermittent (daily, weekly) monitoring is performed. The fiber optic sensor can be setup and assays run within an hour. Minimal waste is generated by the operation of the biosensor. Little maintenance of the Analyte 2000 has been required during the last four years of operation at NRL.

General operation of the FAST 2000 requires consumables similar to those needed for the Analyte 2000 (buffers, pipet tips, syringes, sample tubes), with an estimated cost of $3-5 per sample. Training of operators with technical backgrounds (engineers, environmental project managers) can be done in several hours. As discussed in the manual provided with the FAST 2000, maintenance of the fluidics in the instrument is essential to continued optimal performance. A shutdown routine is part of the software and provides an easy means of cleaning the instrument effectively after each use. More complete maintenance of the instrument to replace tubing or service the internal pump would require return of the instrument to the manufacturer, RI.

6.1.3 Demobilization Costs. There are no costs associated with the demobilization of these biosensors.

6.2 Cost Comparisons to Conventional and Other Technologies

Tables 33 and 34 give a comparison of cost for the commercially available methods for explosive analysis in groundwater and soil, respectively. The initial set-up costs for the biosensors are high compared to the other technologies but the ongoing cost per sample is very low compared to the other methods. For a typical long-term groundwater remediation program, 50 to 150 samples will be tested per year (excluding quality assurance samples and individual extraction wells) for 10 to 30 years. Craig et al. estimated that after 500 samples, money is being saved by employing the biosensors versus the currently employed EnSys RIS method[1]. Both the EnSys RIS method and the NRL immunosensors currently require operation by personnel with some laboratory experience or with field analytical methods (Tables 31 and 32). The FAST 2000 is being automated so personnel with low skill level will be able to operate the instrument, thereby reducing labor costs.

7. Regulatory Issues

7.1 Approach to Regulatory Compliance and Acceptance

All field demonstrations were planned and executed with the assistance of Harry Craig, U.S. EPA Region 10. The three field sites are currently undergoing remediation and therefore, have well-established plans for handling samples generated on base during the test period. At each site, the regulatory personnel were informed of the field demonstration. At two of the trials, Roy Araki, a chemist from U.S. EPA Region 10's Manchester Laboratory, assisted with the immunosensor analysis. In addition to the personnel directly involved with the field trials, Barry Lesnick of the U.S. EPA Office of Solid Waste was consulted to make sure all necessary information was being collected for submission for method approval.

Based on data contained in this final report, methods were drafted on both the fiber optic biosensor and the continuous flow immunosensor for groundwater and submitted to U.S. EPA Office of Solid Waste. Soil methods are in preparation. The working group under the direction of Barry Lesnick has given their authorization to continue with the method approval process. These methods are not designed to replace HPLC analysis but are to be used in conjunction with Method 8330. Confirmatory testing with Method 8330 would be performed on a minimum of 10% of the samples analyzed by the biosensors.

8. Technology Implementation

8.1 DoD Need

The average cost for a single sample analysis is $250 for SW 846 Method 8330. It is estimated that monitoring of groundwater at a single site during remediation is $35,000 per year and the length of time for monitoring will be a minimum of 20 years.[1,19] This cost does not take into account lost work time waiting for the results of the analysis. On-site analysis will greatly reduce the overall cost of monitoring. There are 20 Superfund sites and many other sites contaminated with explosives that will require monitoring for an extended period of time.

8.2 Transition

The groundwater field trial results have been incorporated into a submission to the U.S. EPA with the goal of obtaining an immunoassay method number under OSW 846 within the next six months for both sensors. NRL was responsible for submitting the OSW paperwork to the US. EPA. To guide our efforts, we have had ongoing conversations with Barry Lesnick at the U.S. EPA. Barry Lesnick and the technical working group have examined the validation data submissions and given positive comments.

Research International has also licensed key patents related to the fiber optic biosensor. Current focus of this technology has been on the development of a fully automated system for the U.S. Marines and Special Forces for the detection of biological warfare agents (BW) (proteins, toxins, bacteria, etc.). DARPA and ONR have jointly funded a Phase II SBIR to produce inexpensive, manufacturable fiber optic probes for the biosensor. SERDP has funded a project for the proof of principle for deployment of the fiber optic biosensor into a cone penetrometer for detection of explosives. In addition to the BW and explosive applications, collaborations with NSWC Carderock and Tulane University are adapting the Analyte 2000 for the detection of polyaromatic hydrocarbons and heavy metals, respectively. Assays for the rapid detection of sepsis markers with the Analyte 2000 are being pursued in a collaboration with WRAIR and AGEN Biomedical, LTD. The market for a fast, sensitive sepsis test includes not only medical diagnostics and casualty care but also food processing and beverage production.

The FAST 2000 has been commercialized by Research International. The company has licensed the NRL patent for the technology, has sold several instruments to the U.S. EPA, and is actively

pursuing marketing partners and possible market niches. RI is working with NRL to solve the problems identified with instrument reliability. To overcome problems with matrix effects at the low ends of detection, the U.S. EPA is providing additional samples for screening. These field samples will be prepared as before, with simple buffer addition, and will also be pre-treated using a solid phase extraction protocol.

The most effective pathway for transferring this technology is through the current FAST 2000 manufacturer, Research International. The company has built 10 instruments, has actively exhibited the instrument at major trade shows, has indicated its commitment to commercializing the technology by signing a licensing agreement with NRL and is actively holding talks with several larger companies that would serve as marketing/development partners.
The manufacturer has been involved with technical assistance and instrument maintenance throughout this process. The company has made modifications as required to improve field trial performance.

9. Lessons Learned

9.1 Groundwater.
Several lessons were learned regarding the fiber optic biosensor during these field trials. The main lesson was the need to make sure the QA/QC procedures for the preparation of the antibody-coated fiber optic probes are clearly stated and emphasized to all. This is especially true with new personnel. Another point that needed to be addressed was determining when the fiber optic probe was no longer useable for data analysis. Several times at the first field demonstration, analyses of samples were performed on fiber probes that were no longer functioning optimally. Also from these trials it was noticed that possible instrument problems that may occur, both the symptom and possible cause, should be written out for the operator. This is important as several of the Analyte 2000s, which have been use heavily for 3-4 years, are now hitting their lifetime. Variability in laser power is one problem in the older, heavily utilized instruments. Overall, the Analyte 2000 is a durable instrument but all things have a limited lifetime. Fluidics problems such as clogging, leaks, etc., are something that any instrument working with real world samples will have to address. The symptoms, possible causes, and solutions need to be stressed to the operator so time, reagents, and samples are not wasted.

In addition to issues with the instruments, matrix effects were observed with the fiber optic biosensor. The importance of filtering the samples was clearly demonstrated in the field, as the presence of particulates and/or cloudiness was observed in many samples. The standard curves which are used for quantitation are created from explosive spikes into distilled water. Under ideal conditions, which should reduce or eliminate matrix effects, the standard curves should be created with explosive spikes into blank water from the test site.

For the flow immunosensor, early results with the FAST 2000 varied widely, most probably due to the nature of the dose/response curve of the analysis. At the conclusion of field trial 1 (SUBASE Bangor), an improvement was implemented in the immunoassay protocol, i.e., the insertion of more internal standards during the 7 injections of each groundwater sample to achieve a closer approximation of the unknown concentration. This modification to protocols and recognition of constant fluorescence depletion of the membrane with time proved important for later accuracy and precision measurements by the FAST 2000 immunosensor. In addition, some technical expertise with other EPA methods would, in our opinion, be necessary to understand and fully use the instrument as is. This is primarily due to the complex nature of the response of the instrument to the analyte over the time of the instrument usage.

Additional lessons were learned from the studies on matrix interferences. As seen in the results, we found that differing hydro-chemistries affected final determinations of TNT/RDX at each site. In the flow immunosensor protocol, samples are generally tested without dilutions, extractions or selective prefiltration. In fact, even after general filtering to remove particulates, the results for several samples varied widely. Matrix effects are a major concern, since especially high salt concentrations or other compounds may interfere with antibody selectivity and binding or quenching fluorescence. In a few sample matrices, a slight change occurred in the background signal just before the sample signal was observed on the continuous flow sensor. This change was usually observed as a decrease in the background signal but, in a few cases, the signal intensity showed a slight increase or spike above the background value. This may be due in part to the use of highly purified water in preparing the standards. In any event, in no case did we observe the matrix to hide the signal of even the lowest standards tested.

To correct for the majority of matrix effects, we recommend preparing and analyzing field standards in a blank water sample acquired from each remediation site prior to running actual samples. Matrix effects may still be present but will essentially be normalized after all the calculations have been performed. To run matrix spikes, “blank” groundwater from the remediation site (defined as having TNT and RDX concentrations below the MDL of Method 8330) is spiked with TNT/RDX concentrations 5 and 50 times the MDL of the FAST 2000 (i.e., 10 ng/mL). Replicates of these matrix spikes (50 and 500 ng/mL final concentration) are then tested in the FAST 2000 and compared to standards of identical concentrations. These changes have been incorporated into the SOP’s.

It became clear with both systems that further studies into sample preparation to prevent matrix effects would greatly improve the accuracy and precision of the sensors. Solid phase extraction (SPE) is the preferred method used to reduce matrix contaminants which affect the assays and to improve detection limits by preconcentrating the sample. In limited laboratory tests performed using SPE samples, we found it to be an effective way to improve overall assay reliability. SPE is also recommended for those sites where samples are at the lower end of the method detection limit.

9.2 Soil.

The analysis of soil samples for TNT and RDX, requires an extraction of the explosive material from the soil. For this study, we utilized a field method of extraction developed by Tom Jenkins

(CRREL) that can be performed in less than five minutes. The method dictates that 20g of soil be mixed with 100 mLs of acetone, in a certified clean vial, and shaken for 3 minutes. The mixture then sits for a short period of time to allow the particulates to fall out of suspension. The fiber optic biosensor uses the acetone extract directly, replacing the 5% acetone in the sample fluorescent solution, thereby performing a 1:20 dilution. This raises the limit of detection by 20. In the continuous flow immunosensor method, sample preparation involves placing 2 mLs of the extraction supernatant into a test tube and removing the acetone using an argon stream. The remaining material is then brought up in 2 mLs of the assay buffer. Direct injection of the prepared sample and subsequent analysis allow for semi-quantitative analysis of the soil.

In similar lessons learned with groundwater, we found that the highly heterogeneous nature of soils can lead to a high degree of variability in the amount of explosives material found in the extract. Also, by using a strongly polar solvent, like acetone, to perform an extraction, a wide variety of other materials will be contained in the sample that may cause anomalies during analysis. The nature of these matrix-related effects are not specifically known, but they do appear to be ubiquitous in soils collected from many different sites. In several cases, the HPLC analysis showed high levels of cross-reacting species, further emphasizing the importance of a complete site characterization prior to implementing any routine monitoring program. As with the groundwater, these effects can be mitigated by further treatment of the acetone extract using SPE protocols. The additional work required to perform the SPE adds significantly to the time and cost of sample preparation. However, samples prepared using SPE provide improved accuracy and precision of the assay.

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Appendix A
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Appendix B
Data Archiving and Demonstration Plan(s)

This section includes the summary of all analyzes, including QST's results, performed during the demonstration and validation of the NRL Environmental Immunosensors. The actual raw data is archived at NRL in the Center for Bio/Molecular Science and Engineering (CBMSE). The data along with the demonstration plans are stored as hard copies and in electronic formats. Copies of the demonstration plans or the raw data are available from Lisa Shriver-Lake or Anne Kusterbeck at CBMSE. The address, phone, and email information can be found in Appendix A.

Appendix C
U.S. EPA SW846 Method 8330

Table 1: Fiber Optic Biosensor/Continuous Flow Immunosensor Comparison	
FOB Competition Immunoassay 4 simultaneous assays 8-16 min/assay Cone penetrometer monitoring	**CFI** Displacement Immunoassay Sequential assays 2 min/assay Intermittent on-line monitoring
Rapid Simple set-up Field portable Field tested TNT and RDX assay	

Table 2: Fiber Optic Biosensor False Positives/False Negative		
Sample	**TNT** MDL= (5 ppb)	**RDX** MDL= (5 ppb)
10 ppb RDX (20 replicates)	----	0% false negative
2.5 ppb RDX (20 replicates)	----	42% false positive
10 ppb TNT (20 replicates)	0% false negative	----
2.5 ppb TNT (20 replicates)	62% false positive	----

Table 3: Fiber Optic Biosensor Cross-Reactivity of Immobilized Anti-RDX and Anti-TNT Antibodies

Sample	50% Inhibition (IC_{50}) µg/L		Limit of Detection µg/L	
	RDX	TNT	RDX	TNT
RDX	33	> 1000	5	> 1000
HMX	> 1000	> 1000	100	> 1000
TNT	> 1000	46	> 1000	5
1,3,5-Trinitrobenzene	> 1000	500	1000	10
2-Amino-4,6-Dinitrotoluene	> 1000	1500	> 1000	50
2,4-Dinitrotoluene	> 1000	> 1500	> 1000	50-100
Tetryl	> 1000	> 1500	1000	150
1,3-Dinitroglycerin	> 1000	> 1000	1000	250
1,2-Dinitroglycerin	> 1000	> 1000	> 1000	350
4-Amino-2,6-Dinitrotoluene	> 1000	> 1500	1000	500
Dinitroethylene glycol	> 1000	> 1000	1000	500
1,3- Dinitrobenzene	> 1000	> 1500	1000	750
Trinitroglycerin	> 1000	> 1000	1000	> 1000
2,6-Dinitrotoluene	> 1000	> 1500	> 1000	1500
Nitrobenzene	> 1000	> 1500	> 1000	> 1500
2-Nitrotoluene	> 1000	> 1500	> 1000	> 1500
3-Nitrotoluene	> 1000	> 1500	> 1000	> 1500
4-Nitrotoluene	> 1000	> 1500	> 1000	> 1500

Limit of Detection: lowest concentration to give more than 9% inhibition of the reference signal

IC_{50}: concentration that gives 50% inhibition of the reference signal

Table 4: Matrix Effects on TNT Fiber Optic Biosensor Assay				
Spike	**Bias**	**Precision**	**MDL (ppb)**	**RQL**
Umatilla Army Depot				
25 ppb TNT	77	12	4	16
250 ppb TNT	115	7	9	36
SUBASE Bangor				
25 ppb TNT	54	31	10	40
250 ppb TNT	77	12	11	44
LAAP				
25 ppb TNT	76	8	2	8
250 ppb TNT	97	8	9	36
Distilled Water				
25 ppb TNT	50	22	6	24
250 ppb TNT	91	11	12	48

Table 5: Matrix Effects on RDX Fiber Optic Biosensor Assay				
Spike	**Bias**	**Precision**	**MDL (ppb)**	**RQL (ppb)**
Umatilla Army Depot				
20 ppb RDX	38	41	10	40
75 ppb RDX	50	7	8	32
Crane NSWC				
20 ppb RDX	9	92	2	8
75 ppb RDX	87	10	9	36
LAAP				
20 ppb RDX	60	41	14	56
75 ppb RDX	83	6	3	12
Distilled Water				
20 ppb RDX	59	38	13	52
75 ppb RDX	90	9	8	32

Table 6: Fiber Optic Biosensor Field Standards at SUBASE Bangor						
Sample	**RDX**			**TNT**		
	NRL Analyte 2000	**QST Method 8330**	**RPD**	**NRL Analyte 2000**	**QST Method 8330**	**RPD**
FLS-1 (1 ppb TNT)	----	----	-----	2 ± 4	1	66
FLS-2 (10 ppb TNT)	----	----	-----	8 ± 4	10	-22
FLS-3 (100 ppb TNT)	----	----	----	38 ± 19	91	-82
FLS-4 (1000 ppb TNT)	----	----	-----	>200	960	
FLS-5 (5000 ppb TNT)	----	----	----	>200	5230	
FLS-6 (1 ppb RDX)	3 ± 7	1	93	-----	----	----
FLS-7 (10 ppb RDX)	11 ± 4	9	20	----	-----	----
FLS-8 (100 ppb RDX)	95 ± 41	97	-2	-----	----	----
FLS-9 (1000 ppb RDX)	>100	1110		----	----	----
FLS-10 (5000 ppb RDX)	>100	5220		----	----	----

Table 7: Fiber Optic Biosensor RPD Results for Field Samples				
Site	**RDX**		**TNT**	
	Avg RPD	**RPD Range**	**Avg RPD**	**RPD Range**
Standard Spikes	37	-2 to 93	-13	-82 to 66
SUBASE Bangor	19	-71 to 160	65	-40 to 198
Umatilla Army Depot	18	-67 to 188	78	-69 to 200
NSWC Crane	-92	-124 to -52		
Total Groundwater	-8	-124 to 188	74	-69 to 200
Soil	-7	-193 to 94	-38	-134 to 195

Table 8: Fiber Optic Biosensor on SUBASE Bangor Samples						
Sample	**RDX (ppb)**			**TNT (ppb)**		
	NRL Analyte 2000	**QST Method 8330**	**RPD**	**NRL Analyte 2000**	**QST Method 8330**	**RPD**
INF1[+]	29 ± 11	43	-39	BDL	2	
INF2	>200	455		BDL	2	
EW2	169 ± 185	356	-71	16 ± 11	24	-40
EW3[+*]	33 ± 6	50	-41	16 ± 19	5	105
EW4[+]	27 ± 13	3	160	13 ± 11	0.1	198
EW5[+]	15 ± 2	19	-24	BDL	0.1	
EW6[+]	40 ± 7	42	-5	BDL	BDL	
EW7[+*]	106 ± 113	74	36	19 ± 10	20	-5
EW8	404 ± 453	562	-33	7 ± 14	BDL	
EW9[+]	10 ± 10	4	97	10 ± 13	BDL	
EW10[+]	299 ± 265	92	106	BDL	BDL	

[+] Dilution performed to determine RDX values

[*] Dilution performed to determine TNT values

BDL - Below detection limit

Table 9: Fiber Optic Biosensor Paired t-test and F-test Results for Field Samples				
Site	RDX		TNT	
	Paired t-test (df)	F-test(df)	t-value (df)	F-test(df)
SUBASE Bangor	0.33 (9)	1.82 (9)	-0.75 (3)	22.13 (3)
Umatilla Army Depot	-0.19 (18)	1.52 (18)	-1.24 (9)	2.65 (9)
NSWC Crane	5.41 (8)	4.85 (8)	—	---
Total Groundwater	1.61 (37)	1.79 (37)	-1.37 (13)	2.09 (13)
Soil	-0.51 (11)	1.48 (11)	1.49 (11)	1.20 (11)

Table 10: Fiber Optic Biosensor False Positive/False Negative Results For Field Samples				
Site	**RDX**		**TNT**	
	FP	**FN**	**FP**	**FN**
SUBASE Bangor	2/11 (18 %)	0/11 (0 %)	4/11 (36 %)	0/11 (0 %)
Umatilla Army Depot	2/21 (10 %)	0/21 (0 %)	8/21 (38 %)	0/21 (0 %)
NSWC Crane	0/14 (0 %)	2/14 (14 %)	---	---
Total Groundwater	4/46 (9 %)	2/46 (4 %)	12/32 (38 %)	0/32 (0 %)
Soil	1/15 (7%)	2/15 (13%)	2/15 (13%)	0/15 (0%)

Table 11: Fiber Optic Biosensor on Umatilla Army Depot Samples						
Sample	**RDX (ppb)**			**TNT (ppb)**		
	NRL's Analyte 2000	**QST Method 8330**	**RPD**	**NRL's Analyte 2000**	**QST Method 8330**	**RPD**
WO22*	14 ± 15	14	0	12 ± 13	0.02	200
EW-1+	14 ± 4	9	43	>100	126	
WO-24+	9 ± 5	9	0	19 ± 11	BDL	
EW-4+	92 ± 94	20	129	BDL	0.45	
4-114	8 ± 9	16	-67	58 ± 43	94	-47
4-7+	15 ± 4	13	14	12 ± 12	BDL	
SB-3	9 ± 10	14	-43	BDL	BDL	
4-24	77 ± 18	39	66	BDL	BDL	
4-112*	21 ± 6	15	33	37 ± 9	16	79
4-102+*	31 ± 7	40	-25	18 ± 4	37	-69
EW-3+*	BDL	2		17 ± 16	8	72
4-117+	22 ± 11	21	5	59 ± 74	BDL	
4-3+	17 ± 4	13	27	BDL	0.1	
4-111+	BDL	BDL		76 ± 20	94	-21
4-25	27 ± 9	21	25	9 ± 8	BDL	
WO-21+	28 ± 6	39	-33	BDL	BDL	
009+*	9 ± 6	4	77	28 ± 11	23	18
4-113*	9 ± 14	9	0	BDL	1	
Combine 1+*	60 ± 12	118	-65	37 ± 26	3	172
Combine 2+*	72 ± 37	109	-41	67 ± 19	3	185
4-114D+*	11 ± 11	0.3	188	56 ± 15	2	187

+ Dilution performed to determine RDX values

* Dilution performed to determine TNT values

BDL - Below detection limit

Table 12: Fiber Optic Biosensor on NSWC Crane Samples			
Sample	**RDX (ppb)**		
	NRL Analyte 2000	**QST Method 8330**	**RPD**
Spring	36 ± 19	119	-107
03C03P2*	40 ± 9	68	-52
03C04	BDL	BDL	
10C55P2	12 ± 9	51	-124
10C55	84 ± 44	184	-75
10C57	BDL	BDL	
03C08AP2	57 ± 32	126	-75
03C10	50 ± 25	121	-83
03-34	BDL	41	
10-07	13 ± 6	29	-76
10-08	BDL	24	
10-17	9 ± 11	35	-118
10C37	BDL	BDL	
03C09P2	44 ± 9	146	-107

* Dilution performed to determine RDX values

BDL -Below Detection Limit

Table 13: Fiber Optic Biosensor on Soil Extract Samples						
Sample	**RDX (µg/L)**			**TNT (µg/L)**		
	NRL Analyte 2000	**Method 8330**	**RPD**	**NRL Analyte 2000**	**Method 8330**	**RPD**
TJ001	1100 ± 110	BDL		BDL	BDL	
TJ002	430 ± 74	352	20	350 ± 180	551	-44
TJ003	BDL	209		851000± 295000	915965	-7
TJ004	BDL	407		41800 ± 6600	49054	-16
TJ005	860 ± 70	50456	-193	102000 ± 11000	1205	195
TJ006	176000 ± 53100	147985	17	29400 ± 4500	82118	-95
TJ007	7200 ± 2900	8633	-18	98600 ± 16800	251548	-87
TJ008	116000 ± 10200	138500	-18	920 ± 60	BDL	
TJ009	550 ± 40	526	4	140 ± 30	BDL	
TJ010	2300 ± 400	2818	-20	3300 ± 270	434	154
G51-L1-A	2100 ± 100	2203	-5	900 ± 170	2660	-99
G16-L2-A	17500 ± 3300	14850	16	3300 ± 1400	12797	-118
G55-X-A	196000 ± 25000	135885	36	45800 ± 28600	231011	-134
G18-L3-A	8200 ± 2200	10259	-22	1100 ± 660	3698	-108
G18-L1-A	53900 ± 2100	19492	94	8400 ± 1990	23482	-95

BDL - Below detection limit

Table 14: Fiber Optic Biosensor on Soil Samples						
Sample	**RDX (mg/kg)**			**TNT (mg/kg)**		
	NRL Analyte 2000	**Method 8330***	**RPD**	**NRL Analyte 2000**	**Method 8330***	**RPD**
TJ001	8 ± 1	1	156	BDL	BDL	
TJ002	3 ± 1	3	0	3± 1	4	-29
TJ003	BDL	4.4		6085 ± 2109	>750	
TJ004	BDL	BDL		299 ± 47	2318	-154
TJ005	6 ± 1	4	40	729 ± 79	6	197
TJ006	1258 ± 380	1247	1	210 ± 32	375	-56
TJ007	51 ± 21	127	-85	705 ± 120	1914	-92
TJ008	828 ± 73	986	-17	7 ± 0.4	4	33
TJ009	4 ± 0.3	4	0	1.0 ± 0.2	BDL	
TJ010	16 ± 3	19	-17	24 ± 2	2	169

*Values from T. Jenkins, CRREL

BDL - Below detection limit

Table 15: Fiber Optic Biosensor Statistical Tests Summary								
	RDX				TNT			
Site	**t-Test**	**F-Test**	**Slope test**	**Predictive**	**t-Test**	**F-Test**	**Slope test**	**Predictive**
Groundwater (all)	Y	Y	Y	Y	Y	Y	Y	Y
Bangor	Y	Y	Y	Y	Y	N	N	N
Umatilla	Y	Y	Y	Y	Y	Y	N	N
Crane	N	N	Y	N	--	--	--	--
Soil	Y	Y	Y	Y	Y	Y	Y	Y

Table 16: FAST 2000 False Positives/False Negative in Buffer		
Sample	**TNT** MDL=10ng/mL	**RDX** MDL= 10ng/mL
5ng/mL TNT (20 replicates)	0% positive	----
20ng/mL TNT (20 replicates)	0% negative	----
5ng/mL RDX (30 replicates)	----	0% negative
20ng/mL RDX (30 replicates)	----	0% positive

Table 17: FAST 2000 Accuracy and Precision (System Flow Buffer)		
Sample	**TNT/RDX** MDL=10ng/mL	
	Bias	Precision
50ng/mL TNT (9 replicates)	99	7
500ng/mL TNT (7 replicates)	93	14
50ng/mL RDX (7 replicates)	98	15
500ng/mL RDX (7 replicates)	99	6

Table 18: Matrix Effects on RDX FAST 2000 Assay				
Spike	**Bias**	**Precision**	**MDL (ppb)**	**RQL (ppb)**
Umatilla Army Depot				
50 ppb RDX	20	37	7	28
500 ppb RDX	62	11	107	427
Bangor SUBBASE				
50 ppb RDX	55	9	7.5	30
500 ppb RDX	96	3	53	214
Volunteer, TN				
50 ppb RDX	N/D	N/D	N/D	N/D
500 ppb RDX	29	59	268	1074

Table 19: Matrix Effects on TNT FAST 2000 Assay				
Spike	**Bias**	**Precision**	**MDL (ppb)**	**RQL (ppb)**
Umatilla Army Depot				
50 ppb TNT	130	10	20	80
500 ppb TNT	97	86	409	1634
Bangor SUBBASE				
50 ppb TNT	212	26	85	340
500 ppb TNT	68	63	211	842
Volunteer, TN				
50 ppb TNT	653	41	475	1898
500 ppb TNT	142	15	324	1295

Table 20: FAST 2000 Cross-reactivity of anti-RDX and anti-TNT Antibodies		
Sample	**Anti-RDX Ab Cross-reactivity (%)**	**Anti-TNT Ab (11B3) Cross-reactivity (%)**
RDX	100	1
2,4,6-Trinitrotoluene (TNT)	1.8	100
HMX	4.8	5
2-Nitrotoluene (NT)	1.9	9
3-Nitrotoluene	2.6	ND
4-Nitrotoluene	3.0	ND
Nitrobenzene (NB)	1.9	16
1,3-Dinitrobenzene (DNB)	2.8	ND
1,3,5- Trinitrobenzene (TNB)	3.8	600
Tetryl	0.95	38
2,4-Dinitrotoluene (DNT)	3.1	20
2,6-Dinitrotoluene	1.1	4
Trinitroglycerin	1.4	ND
2-Amino-4,6-DNT	1.3	21
4-Amino-2,6-DNT	1.8	1
1,2-Dinitroglycerin	1.8	ND
1,3-Dinitroglycerin	1.3	ND
Dinitro Ethylene Glycol	1.9	ND

ND - not determined

Table 21: FAST 2000 Field Standards at SUBASE Bangor						
Sample	**RDX**			**TNT**		
	NRL FAST 2000	**QST Method 8330**	**RPD**	**NRL FAST 2000**	**QST Method 8330**	**RPD**
FLS-1	----	----	----	1 ± 0.1	1	0
FLS-2	----	----	----	15 ± 25	8	61
FLS-3	----	----	----	105 ± 53	91	14
FLS-4	----	----	----	965 ± 1102	960	1
FLS-5	----	----	----	4097 ± 1718	5230	-24
FLS-6	1 ± 0.3	1	0	----	----	----
FLS-7	8 ± 2	9	-12	----	----	----
FLS-8	113 ± 8	97	15	----	----	----
FLS-9	822 ± 77	1110	-30	----	----	----
FLS-10	3980 ± 390	5220	-27	----	----	----

Table 22:FAST 2000 RPD Results for Field Samples				
Site	**RDX**		**TNT**	
	Avg RPD	**RPD Range**	**Avg RPD**	**RPD Range**
Standards	-11	-30 to 15	10	-24 to 61
SUBASE Bangor	-41	-146 to 60	118	-44 to 199
Umatilla Army Depot	-39	-165 to 87	-15	-185 to 197
NSWC Crane	-11	-168 to 107	83	-24 to 189
Total Groundwater	-31	-168 to 107	20	-185 to 197
Soil	-16	-195 to 122	86	-39 to 199

Table 23: FAST 2000 on SUBASE Bangor Samples						
Sample	**RDX**			**TNT**		
	NRL FAST 2000	**QST Method 8330**	**RPD**	**NRL FAST 2000**	**QST Method 8330**	**RPD**
EW-2	124 ± 9	356	-97	49 ± 9	24	68
EW-3	77 ± 8	496	-146	168 ± 36	263	-44
EW-4	64 ± 29	261	-121	57 ± 20	0.1	199
EW-5	345 ± 55	186	60	13 ± 6	0.1	197
EW-6	315 ± 204	419	-28	45 ± 18	BDL	
EW-7	68 ± 10	147	-74	1608 ± 304	977	49
EW-8	579 ± 100	562	3	79 ± 15	0.1	199
EW-9	799 ± 383	700	13	690 ± 428	BDL	
EW-10	478 ± 112	922	-63	39 ± 22	BDL	
INF 1	114 ± 41	429	-116	16 ± 3	2	158
BET 1	26 ± 16	7	115	BDL	BDL	
BET 2	10 ± 3	BDL		BDL	BDL	
EFF	BDL	BDL		91±12	BDL	

BDL - Below detection limit

Table 24: FAST 2000 t-Test and F-Test Results for Field Samples				
Site	**RDX**		**TNT**	
	t-test (df)	**F-Test (df)**	**t-test (df)**	**F-Test (df)**
SUBASE Bangor	2.22 (10)	1.05 (10)	-1.14 (6)	2.59 (6)
Umatilla Army Depot	3.26 (13)	1.51 (13)	1.78 (7)	1.70 (7)
NSWC Crane	-0.18 (10)	1.06 (10)	-0.82 (1)	2.44 (1)
Total Groundwater	3.27 (35)	1.49 (35)	-0.04 (18)	1.27(16)
Soil	0.18 (13)	1.04 (13)	-1.94 (11)	1.91(11)

Table 25: FAST 2000 False Positive/False Negative Results for Field Samples				
Site	**RDX**		**TNT**	
	FP	**FN**	**FP**	**FN**
SUBASE Bangor	2/13 (15 %)	0/13 (0 %)	8/13 (62 %)	0/13 (0 %)
Umatilla Army Depot	0/20 (0 %)	5/20 (25 %)	4/20 (20 %)	4/20 (20 %)
NSWC Crane	1/15 (7 %)	1/15 (7 %)	2/14 (14 %)	1/14 (7 %)
Total Groundwater	3/48 (6 %)	6/48 (13 %)	14/47 (30 %)	5/47 (11 %)
Soil	1/15 (7%)	0/15 (0%)	3/15 (20%)	0/15 (0%)

Table 26: FAST 2000 on Umatilla Army Depot Samples						
Sample	**RDX**			**TNT**		
	NRL FAST 2000	**QST Method 8330**	**RPD**	**NRL FAST 2000**	**QST Method 8330**	**RPD**
4_3	59 ± 2	133	-37	BDL	0.1	
4_7	88 ± 31	132	-40	33 ± 19	BDL	
4_24	53 ± 18	39	30	BDL	BDL	
4_25	BDL	21		32 ± 6	BDL	
4_102	121 ± 24	402	-107	14 ± 3	367	-185
4_111	BDL	19		BDL	94	
4_112	39 ± 26	15	87	191 ± 18	164	15
4_113	BDL	9		BDL	63	
4_114	BDL	16		BDL	94	
4_114D	BDL	16		56 ± 11	94	-51
4_117	165 ± 53	209	-24	BDL	BDL	
9	77 ± 7	189	-84	958 ± 354	1160	-19
SB-3	BDL	14		48 ± 18	BDL	
WO-21	163 ± 14	389	-82	BDL	BDL	
WO-22	NA	14		NA	0.2	
WO-24	233 ± 22	470	-67	BDL	BDL	
EW-1	43 ± 28	450	-165	BDL	126	
EW-3	149 ± 51	112	28	457	846	-60
EW-4	902 ± 53	1020	-12	56 ± 30	0.4	197
Comb-1	607 ± 106	1180	-64	73 ± 28	138	-53
Comb-2	990 ± 101	1090	-10	190 ± 30	133	35

BDL- Below detection limit

NA - Not analyzed

Table 27: FAST 2000 on NSWC Crane Samples						
Sample	**RDX**			**TNT**		
	NRL FAST 2000	**QST Method 8330**	**RPD**	**NRL FAST 2000**	**QST Method 8330**	**RPD**
Spring	174 ± 78	119	38	115 ± 16	3	189
03C03	504 ± 35	678	-29	BDL	4	
03C04	BDL	BDL		BDL	BDL	
03C08	11 ± 5	126	-168	14 ± 9	BDL	
03C09P2	483 ± 62	146	107	BDL	BDL	
03C10	104 ± 41	121	-15	BDL	BDL	
03C12	17 ± 7	26	-40	BDL	BDL	
03_34	23 ± 10	41	-56	BDL	BDL	
10-07	54 ± 6	29	62	BDL	1	
10-08	BDL	24		BDL	1	
10-17	32 ± 16	35	-10	BDL	22	
10C37	BDL	BDL		BDL	BDL	
10C55	184 ± 56	184	0	40 ± 12	51	-24
10C55R	47 ± 18	51	-9	NA	BDL	
10C57R	66 ± 33	BDL		BDL	BDL	

BDL - Below detection limit

NA - Not analyzed

Table 28: FAST 2000 on Soil Extract Samples						
Sample	**RDX (µg/L)**			**TNT (µg/L)**		
	NRL FAST 2000	**Method 8330**	**RPD**	**NRL FAST 2000**	**Method 8330**	**RPD**
TJ001	400 ± 64	BDL		20 ± 6	BDL	
TJ002	530 ± 51	352	40	370 ± 110	551	-39
TJ003	60 ± 10	209	-109	1027000 ± 204000	915965	11
TJ004	40 ± 7	407	-167	482200 ± 117000	49054	163
TJ005	600 ± 120	50456	-195	342000 ± 115600	1205	199
TJ006	193400 ± 36100	147985	27	963000 ± 313000	82118	169
TJ007	8560 ± 920	8633	-1	183200 ± 48000	251548	-31
TJ008	92900 ± 6500	138500	-39	7300 ± 1020	BDL	
TJ009	370 ± 40	526	-36	14200 ± 1000	BDL	
TJ010	3470 ± 520	2818	21	87100 ± 25600	434	198
G51-L1-A	3550 ± 290	2203	47	5530 ± 1350	2660	70
G16-L2-A	36800 ± 3500	14850	85	27200 ± 16000	12797	72
G55-X-A	74400 ± 13000	135885	-58	219400 ± 67000	231011	-5
G18-L3-A	14355 ± 1440	10259	33	27900 ± 3300	3698	153
G18-L1-A	80500 ± 11400	19492	122	50600 ± 6300	23482	73

BDL -Below Detection Limit

Table 29: FAST 2000 for Soil Samples						
Sample	**RDX (mg/kg)**			**TNT (mg/kg)**		
	NRL Analyte 2000	**Method 8330***	**RPD**	**NRL Analyte 2000**	**Method 8330***	**RPD**
TJ001	3 ± 1	1	100	0.1 ± 0.04	0.1	0
TJ002	4 ± 0.4	3	29	3 ± 1	4	-29
TJ003	0.4 ± 0.1	4.4	-161	7343 ± 1459	>750	
TJ004	0.3 ± 0.1	BDL		3448 ± 837	2318	39
TJ005	4 ± 1	4	0	2445 ± 827	6	199
TJ006	1383 ± 258	1247	10	6885 ± 2238	375	179
TJ007	61 ± 7	127	-70	1310 ± 343	1914	-37
TJ008	663 ± 93	986	-39	52 ± 7	4	171
TJ009	3 ± 0.3	4	-29	102 ± 7	BDL	
TJ010	25 ± 4	19	27	623 ± 183	2.0	199

*Values from T. Jenkins, CRREL

BDL - Below detection limit

Table 30: FAST 2000 Statistical Tests Summary								
	RDX				**TNT**			
Site	**t-Test**	**F-Test**	**Slope test**	**Predictive**	**t-Test**	**F-Test**	**Slope test**	**Predictive**
Groundwater (all)	N	Y	Y	N	Y	Y	Y	Y
Bangor	Y	Y	Y	Y	Y	Y	Y	Y
Umatilla	N	Y	Y	N	Y	Y	Y	Y
Crane	Y	Y	Y	Y	Y	Y	N	N
Soil	Y	Y	Y	Y	Y	Y	Y	Y

Table 31: Technology Comparison of Groundwater Explosive Analysis							
Method/Kit	**Method Types and Analytes**	**Detection Range and Range Factor**	**Type of Results**	**Sample/Batch**	**Water Sample Size**	**Analysis Time**	**Skill Level**
Continuous Flow Immunosensor	**Immunosensor** **TNT, RDX, PETN**	**10-1000 ug/L**	**Quantitative**	**Sequential**	**150 uL /sample per injection.**	**3-4 min sample, plus 3-4 min internal standard** **1 min peak analysis per sample**	**Medium/low**
Fiber Optic Biosensor	**Immunosensor** **TNT** **RDX**	**TNT:10-150 ug/L** **RDX:10-100 ug/L**	**Quantitative**	**Single up to a batch of 4**	**1.7 mL for 4 fiber analysis with fluidics unit**	**TNT: 8 min per quadruplicate sample or batch of 4** **RDX: 16 min per quadruplicate sample or batch of 4** **Double times to run reference analysis**	**Medium**
CRREL	**Colorimetric Ammonium Picrate/Picric Acid**	**AP/PA: 3.6 to 200ug/L (56X)**	**Quantitative**	**AP/PA: Single or batched**	**2L**	**20 minutes to hours to filter, faster per sample if batched; 20 minutes/sample to analyze**	**Medium /high**
EnSys RIS	**Colorimetric TNT, RDX and HMX Proposed Method 8510**	**TNT: 1 to 30 ug/L (30X)** **RDX: 5 to 150 (30X)**	**Quantitative**	**Single**	**2 L**	**20 minutes to a few hours for filtering** **TNT: 35 min/10 samples** **RDX: 50 min/sample**	**Medium**
D-TECH	**Immunoassay - ELISA** **TNT** **RDX**	**TNT and RDX: 5 to 45 ug/L (9X) with DETECHTOR** **TNT and RDX: 5 to 60 ug/L (12X)**	**Semiquanti-tative (concentra-tion range)**	**8 (single or batch)?**	**1 mL**	**40 minutes for 8 samples for TNT and RDX** **10 to 15 minutes for single sample**	**Low**
Ohmicron RaPID Assay	**Immunoassay - ELISA** **Magnetic particle/tube kit TNT**	**TNT: 0.07 to 5 ug/L (71 X)**	**Quantitative**	**10 to 40 (batch only)**	**100 uL**	**70 minutes for 10 samples**	**High, initial training recommended**
Method 8330	**High Performance Liquid Chromatography**	**Direct injection:** **RDX : 14 ug/L** **TNT : 7 ug/L** **Salting out and extraction:** **RDX: 0.84 ug/L** **TNT: 0.11 ug/L**	**Quantitative**	**Single**	**100 uL**	**20 min/sample** **If <20 ug/L need salting - out extraction ~2-3 hours/sample**	**high**

Table 32: Technology Comparison of Soil Explosive Analysis								
Method / kit	**Method type/ analytes**	**Detection range**	**Type of result**	**Samples/ batch**	**Sampl e size**	**Sample preparation time**	**Sample analysis time**	**Skill level required**
Fiber Optic Biosensor	**Immunoassay TNT, RDX**	**TNT: 0.7-21 mg/kg RDX: 0.7-14 mg/kg**	**quantitative**	**1-4**	**5 g**	**3 min shaking in 25 mL acetone, settle**	**TNT: 8 min per quadruplicate sample or batch of 4 RDX: 16 min per quadruplicate sample or batch of 4 Double times to run reference analysis**	**Medium**
Continuous Flow Immunosensor	**Immunoassay TNT, RDX**	**0.05 - 5 mg/kg**	**quantitative**	**1**	**5 g**	**3 min shaking in 25 mL acetone, settle**	**3-4 min sample, plus 3-4 min internal standard 1 min peak analysis per sample**	**Medium/ low**
CRREL	**Colorimetric TNT,RDX, 2,4DNT, ammonium picrate, picric acid**	**TNT: 1-22 mg/kg RDX: 1-20 mg/kg**	**quantitative**	**TNT: batch or single RDX: 6-7**	**20 g**	**3 min shaking in 100 mL acetone, filter**	**5 min/ sample**	**Medium**
Ensys RISc	**Colorimetric TNT,RDX**	**TNT, RDX: 1-30 mg/kg**	**quantitative**	**single**	**10 g**	**3 min shaking in 50 mL acetone, 5 min to settle, filter**	**40 min per 10 samples**	**TNT: low RDX: Medium**
Dtech	**Immunoassay TNT,RDX**	**TNT:0.5-5.0 mg/kg**	**semi-quantitative (concentrati on range)**	**4 single or batch**	**3 ml ~4.5g**	**3 min shaking in 6.5 mL acetone, 1-10 min to settle**	**30 min per 1-4 samples**	**Low**
Idetek Quantix	**Immunoassay TNT**	**TNT; 0.25-100 mg/kg**	**quantitative**	**20-40 batch only**	**~4.2 g**	**3 min shaking in 21 mL acetone, settle**	**2.5-3.5 hours for 20-40 samples**	**Medium-High**
EnviroGard	**Immunoassay TNT,RDX**	**Plate: TNT, RDX 1-100 mg/kg Tube: TNT, RDX 0.2-15 mg/kg**	**Plate: quantitative Tube: semi-quantitative**	**Plate: 8 per batch Tube: 14 per batch**	**2 g**	**Air dry soil, 2 min shaking in 8 mL acetone, filter**	**Plate: 90 min for 8 samples Tube: 30 min for 14 samples**	**Plate: Medium-High Tube: Medium**
Ohmicron RaPID Assay	**Immunoassay TNT,RDX**	**TNT: 0.07-5 mg/kg**	**quantitative**	**5-51 batch only**	**10 g**	**1 min shaking in 20 mL methanol, 5 min to settle, filter**	**1 hour for 20 extractions; 45 minutes for analysis (51 samples)**	**Medium-High**

Table 33: Technology Cost Comparison of Groundwater Explosive Analysis			
Method/Kit	**On-Going Cost**	**Start-Up Costs**	**Training**
Fiber Optic Biosensor	**$3-5/sample**	**Analyte 2000 $18K Fluidics unit - ~$8K**	**None**
Continuous Flow Immunosensor	**$50 per coupon ~20-30 analysis per coupon or ~$3-5/sample**	**FAST 2000 $21K unit cost.**	**None**
CRREL	**$15/sample**	**$1500 for Hach spectrometer**	**None**
EnSys RIS	**$21/sample for TNT $25/sample for RDX $175/day or $450/week, $800/month for lab station**	**$1950 lab station cost**	**Training available. Applicable video on CRREL soil method available only**
D TECH	**$32.50/sample for TNT or RDX $300 for DTECHTOR (optional)**		**2 to 4 hours free on-site training**
Ohmicron Rapid Assay	**$13 to $20/sample, $175/day,$450/week or $800 for first month, $400 each additional month (rental)**	**$4000 for equipment**	**4 hours free on-site training**
Method 8330	**$200 - $1,000/sample depending on turnaround time**	**n/a**	**n/a**

Table 34: Technology Cost Comparison of Soil Explosive Analysis			
Method / Kit	**On-Going Costs**	**Start-Up Costs**	**Training**
Fiber Optic Biosensor	**$4-6.50/sample (includes extraction)**	**Analyte 2000 - $18K Fluidics Unit - ~$8K**	**None**
Continuous Flow Immunosensor	**$50 per coupon ~20-30 analysis per coupon or$4-6.50/sample (includes extraction)**	**FAST 2000 - $21K**	**None**
CRREL	**$15/sample**	**$1500 for Hach spectrophometer**	**Free video**
Ensys RISc	**TNT: $21/sample RDX: $25/sample**	**$1950 for lab station**	**Available- free**
Dtech	**$30/sample**	**$300 DTECHTOR (optional)**	**2-4 hrs free training**
Idetek Quantix	**$21/sample**	**$5880 for lab station**	**1day free training**
EnviroGard	**Plate: $17/sample Tube: $20/sample**	**Plate: $4129 for equip and small supplies Tube: $2409 for equip. and small supplies**	**Available- free**
Ohmicron RaPID Assay	**$13-20/sample**	**$5500 for equip. purchase or rental for$800 1st month and $400 monthly thereafter**	**4 hrs free training**

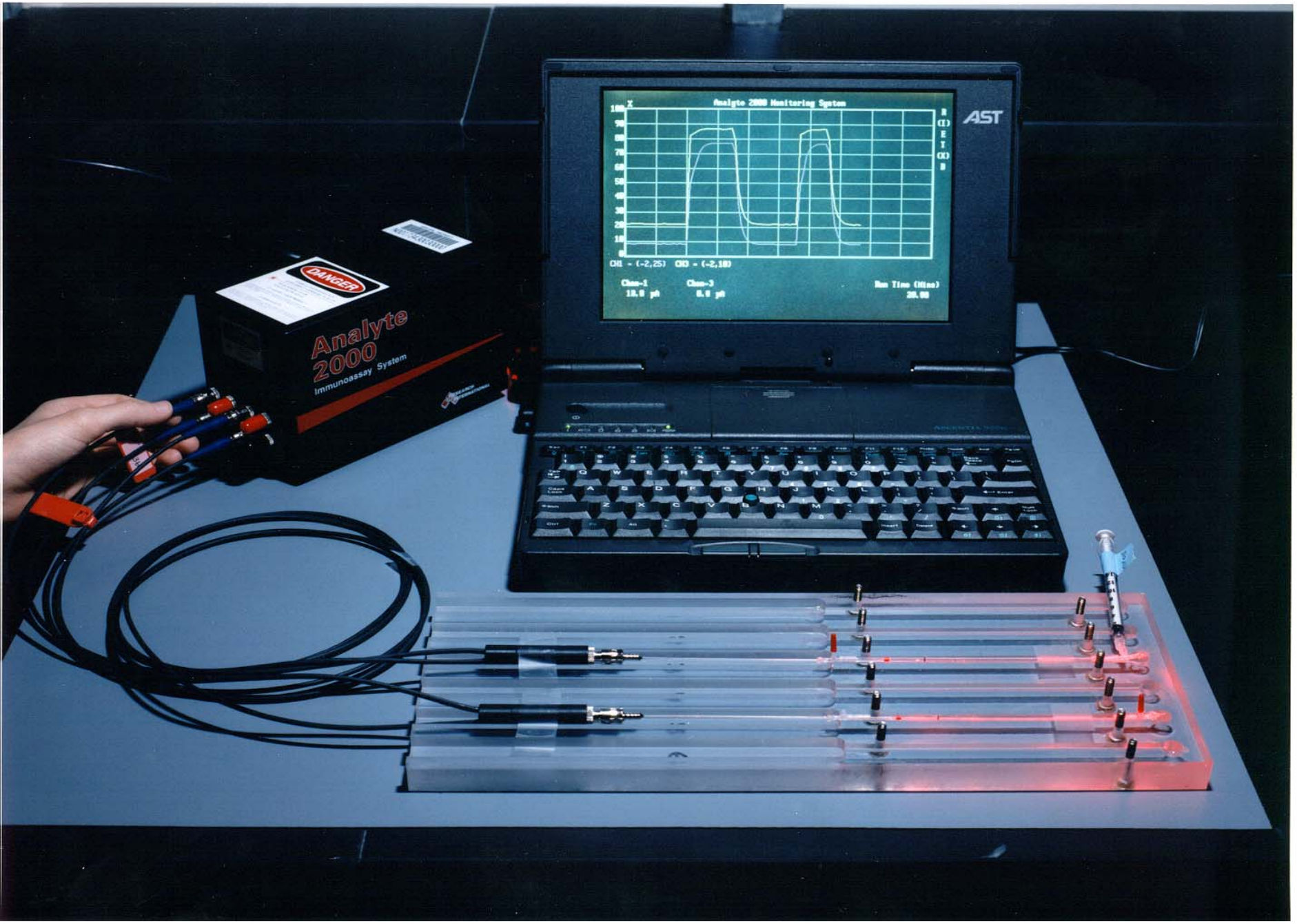

DANGER
Analyte
2000
Immunoassay System
Analyte 2000 Monitoring System
AST

Figure 1

Figure 2

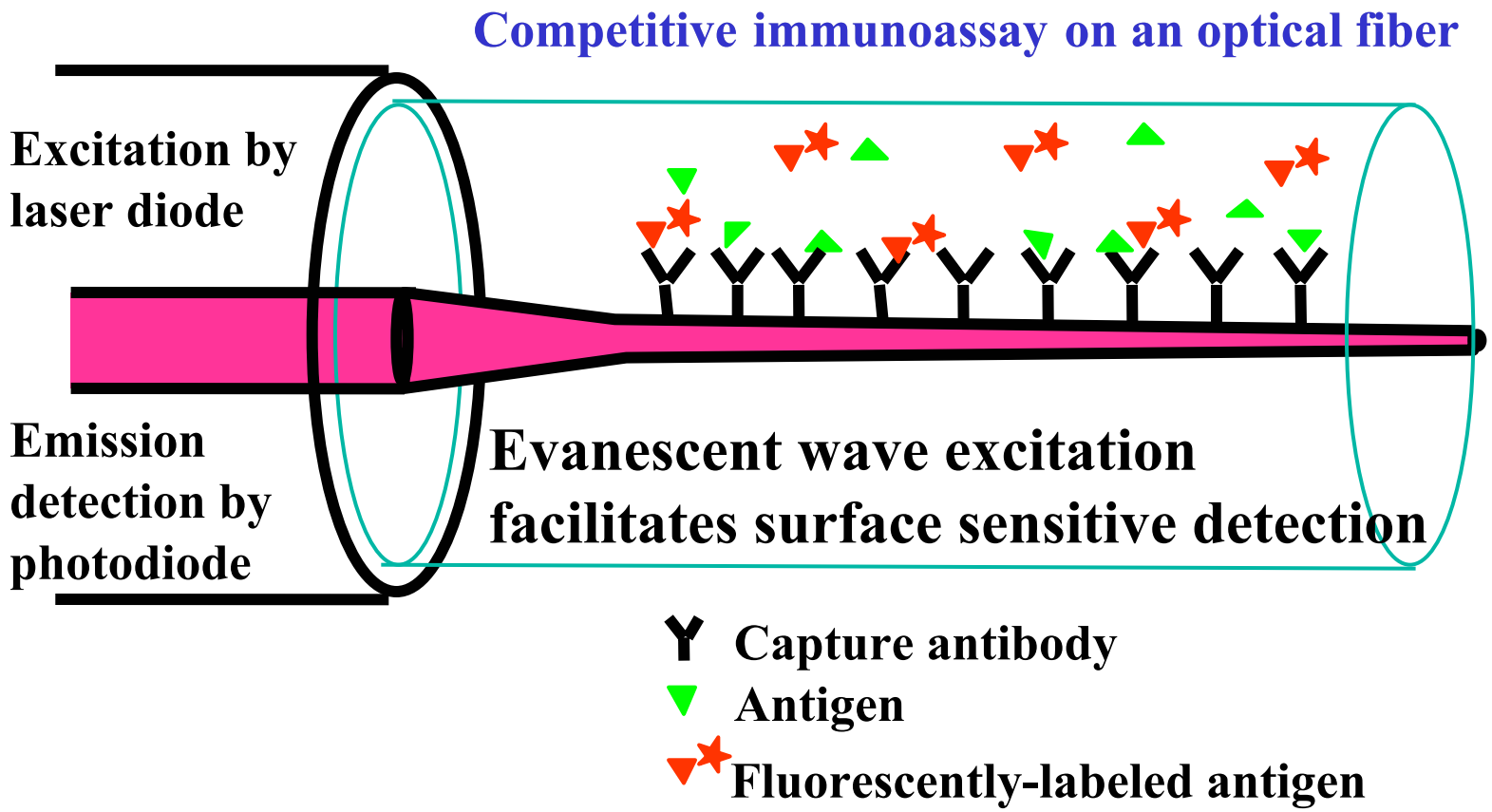

Competitive immunoassay on an optical fiber
Excitation by laser diode
Emission detection by photodiode
Evanescent wave excitation facilitates surface sensitive detection
Capture antibody
Antigen
Fluorescently-labeled antigen

Figure 3

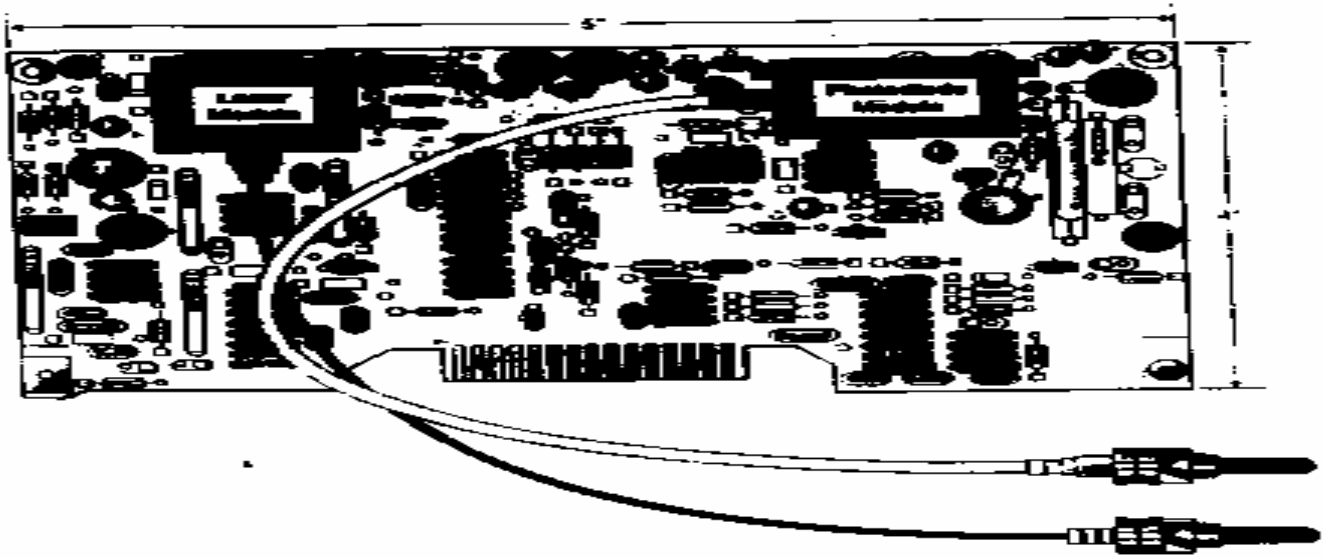


Figure 4: Daughter card from the Analyte 2000.

Figure 4

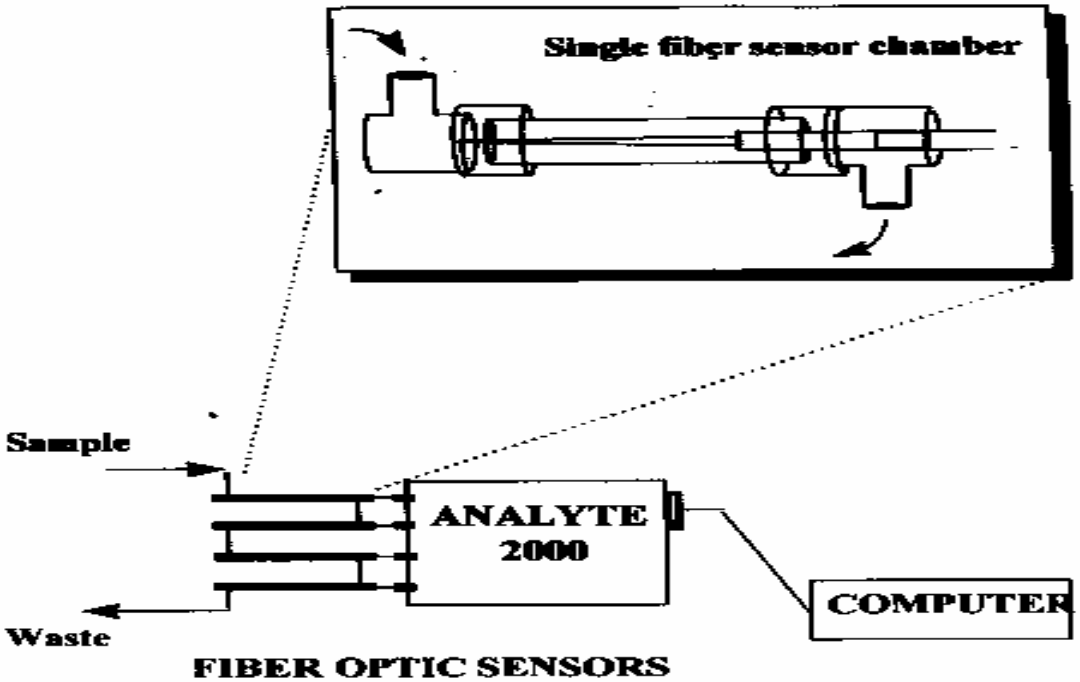


Figure 5: Capillary flow chambers in series with the Analyte 2000

Figure 5

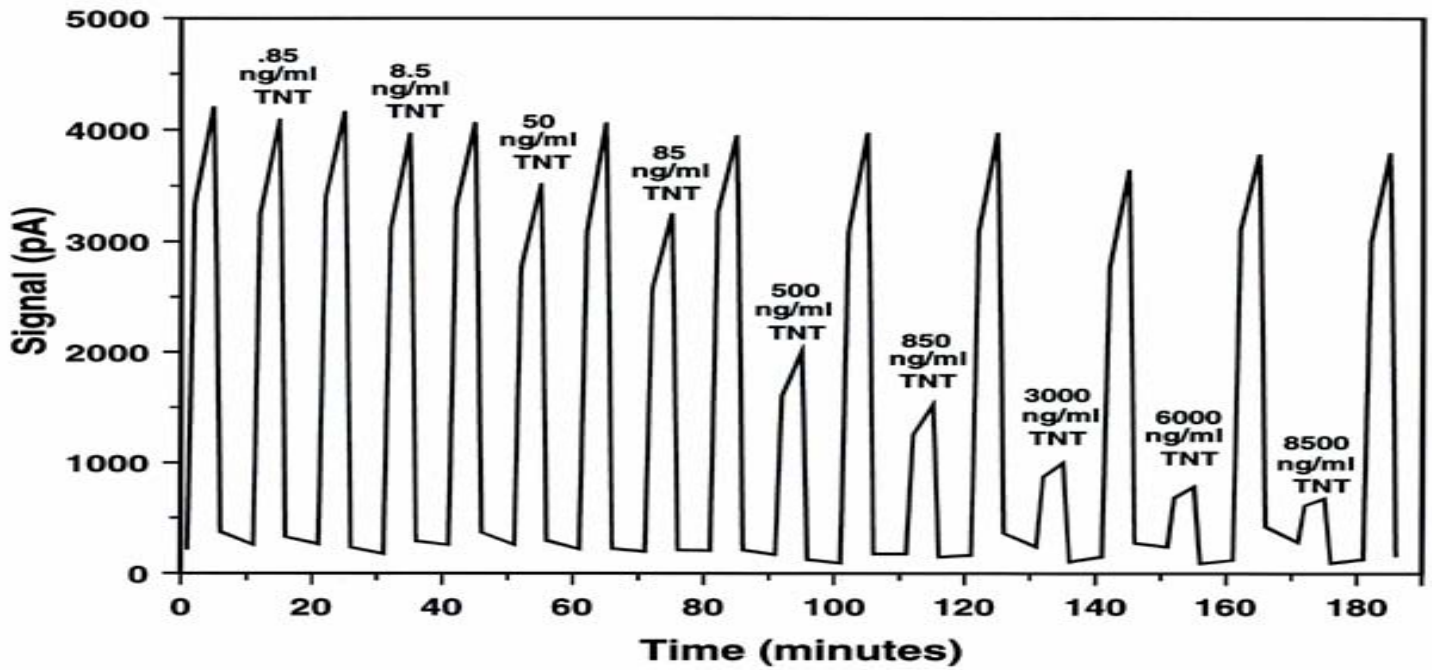

5000
4000
3000
2000
1000
0
Signal (pA)
.85 ng/ml TNT
8.5 ng/ml TNT
50 ng/ml TNT
85 ng/ml TNT
500 ng/ml TNT
850 ng/ml TNT
3000 ng/ml TNT
6000 ng/ml TNT
8500 ng/ml TNT
0
20
40
60
80
100
120
140
160
180
Time (minutes)

Figure 6

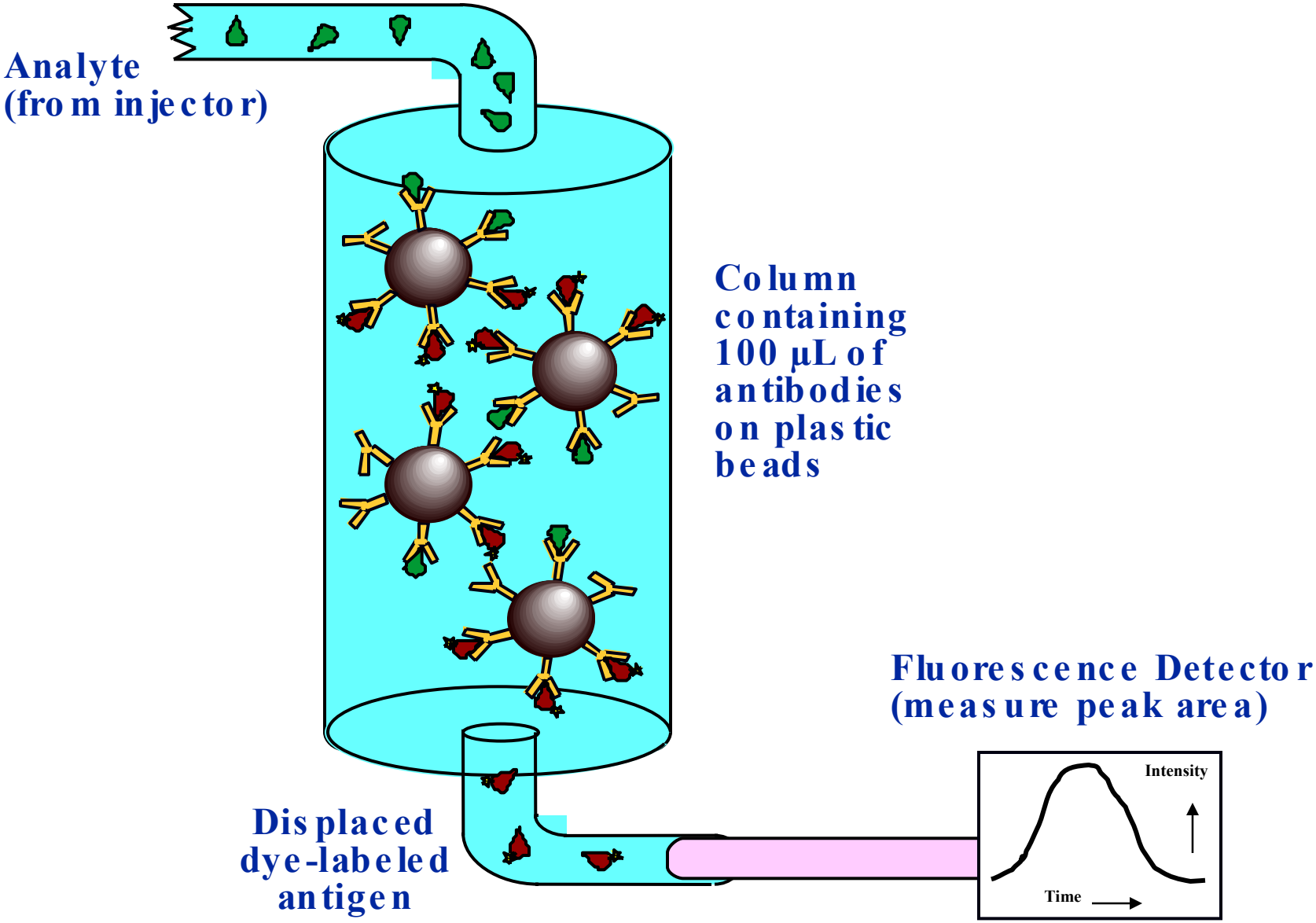
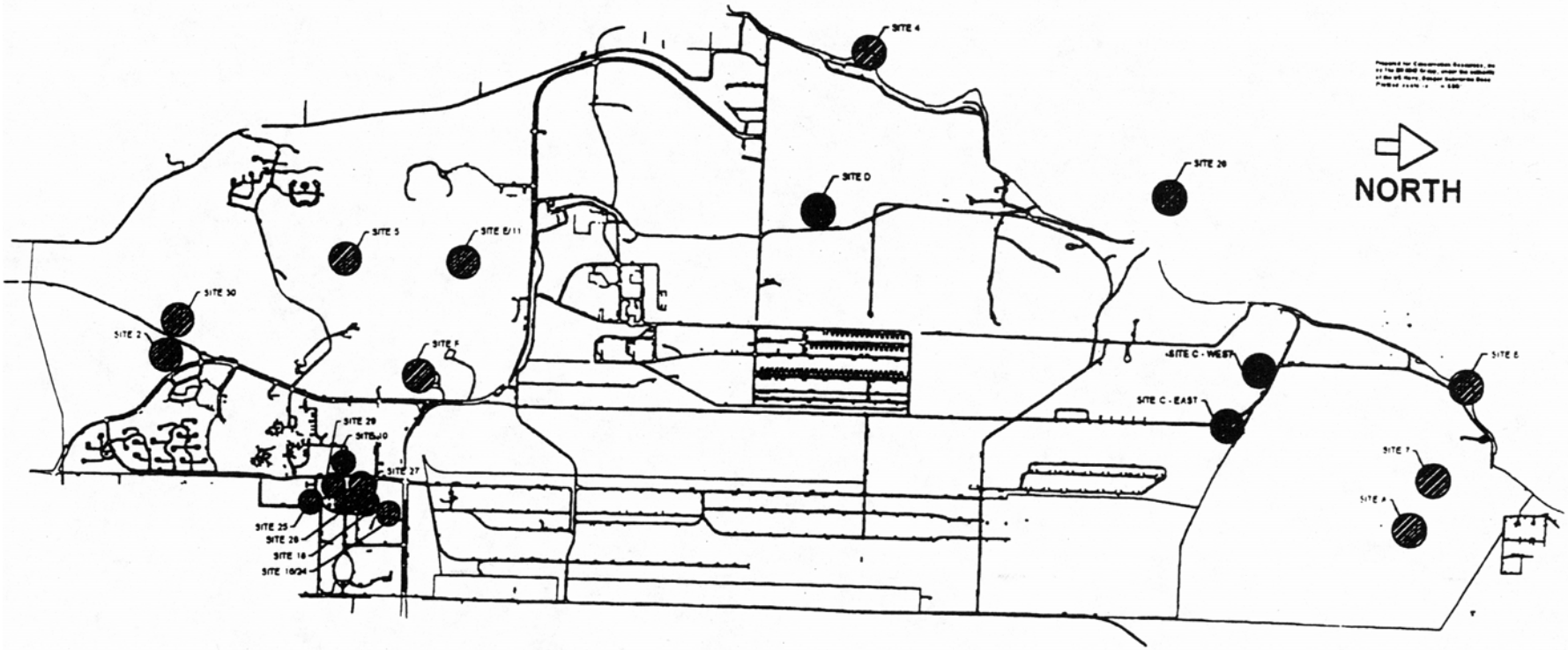

Analyte
(from injector)
Column
containing
100 µL of
antibodies
on plastic
beads
Fluorescence Detector
(measure peak area)
Intensity
Time
Displaced
dye-labeled
antigen

Figure 7

Naval Submarine Base Bangor
Installation Restoration Program
Site Locations



OPERABLE UNIT 1
Site A Bangor Ordnance Disposal Site

OPERABLE UNIT 2
Site F Former Wastewater Lagoon

OPERABLE UNIT 3
Site 16 Storage Area
Site 24 Former Incinerator Site
Site 25 Former Treatment Plant Outfall

OPERABLE UNIT 4
Site C - West Bldg 7700 Fill Area
Site C - East Ordnance Wastewater Disposal Area

OPERABLE UNIT 5
Site 5 Former Metallurgy Lab Rubble

OPERABLE UNIT 6
Site D Munitions Burn Area

OPERABLE UNIT 7
Site 8 Floral Point
Site E Old Acid Pit
Site 2 Classification Yard
Site 4 Carlson Spit
Site 7 Paint Can Site
Site 10 Pesticide Storage Quonset Hut
Site 11 Pesticide Drum Disposal Area
Site 18 PCB Spill Site
Site 26 Hood Canal Sediments
Site 30 Railroad Tracks

OPERABLE UNIT 8
Public Works Industrial Area Including:
Site 27 Bldg 1014 Steam Cleaning Pit
Site 28 Bldg 1032 Drainage Ditch
Site 29 Former Pesticide Rinsate Area

Figure 8

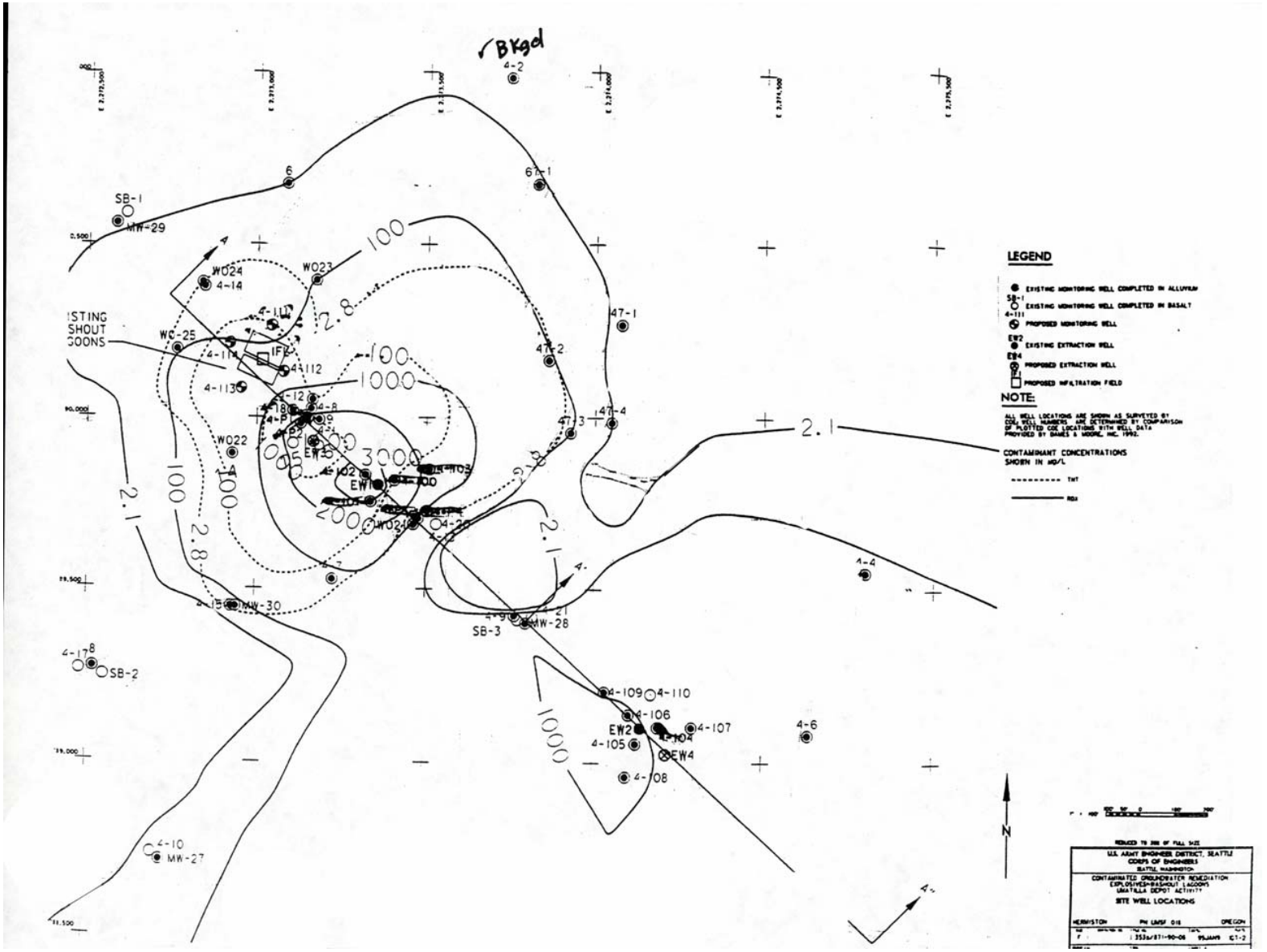

BKgd
LEGEND
EXISTING MONITORING WELL COMPLETED IN ALLUVIUM
EXISTING MONITORING WELL COMPLETED IN BASALT
PROPOSED MONITORING WELL
EXISTING EXTRACTION WELL
PROPOSED EXTRACTION WELL
PROPOSED INFILTRATION FIELD
NOTE:
CONTAMINANT CONCENTRATIONS SHOWN IN UG/L
N
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON
CONTAMINATED GROUNDWATER REMEDIATION
EXPLOSIVES BLOWOUT LAGOON
UMATILLA DEPOT ACTIVITY
SITE WELL LOCATIONS
HERMISTON
OREGON

Figure 12

Method 8330 RDX Regression Plot

SUBASE Bangor Samples

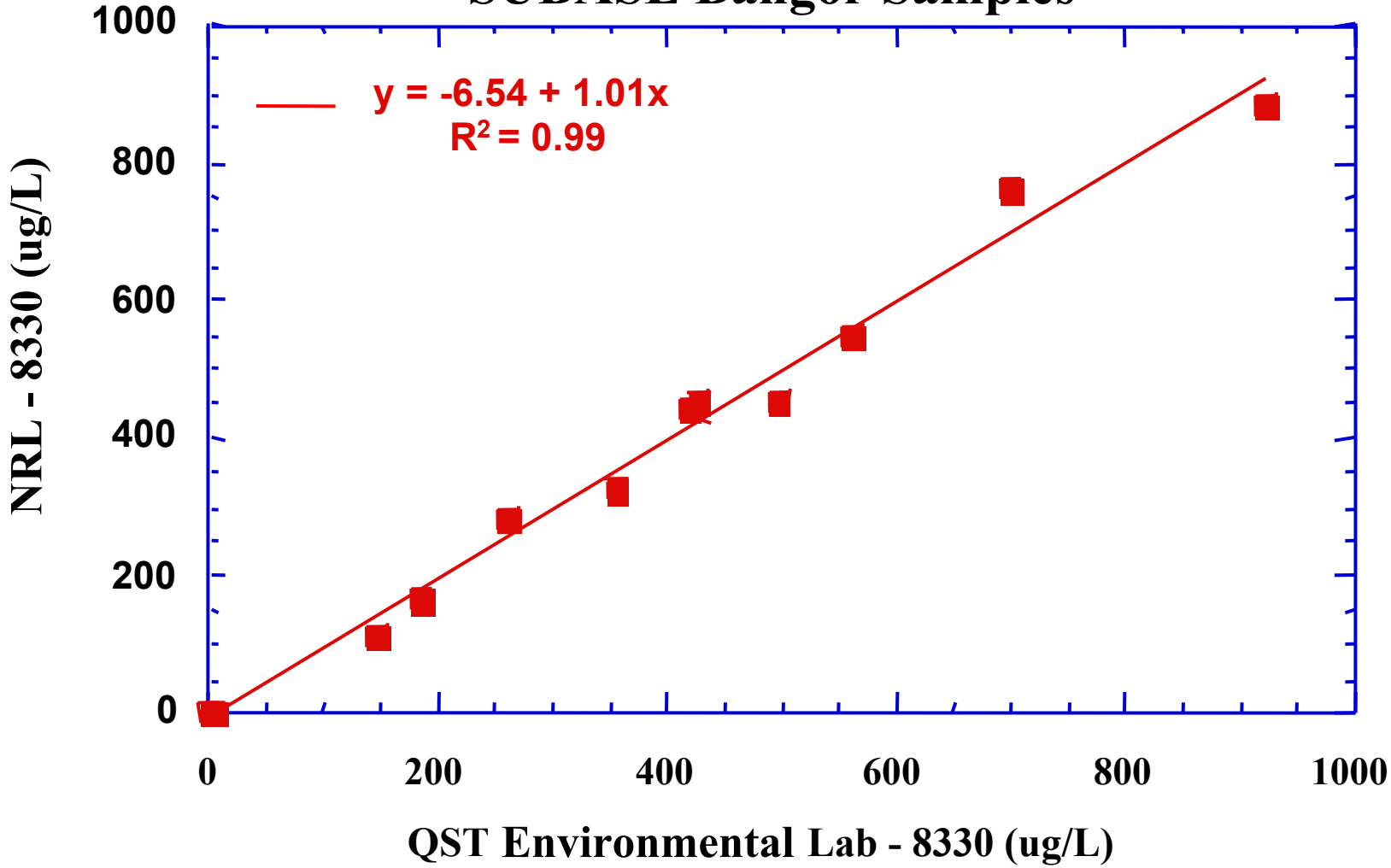


Figure 14

TNT and RDX Standard Curves

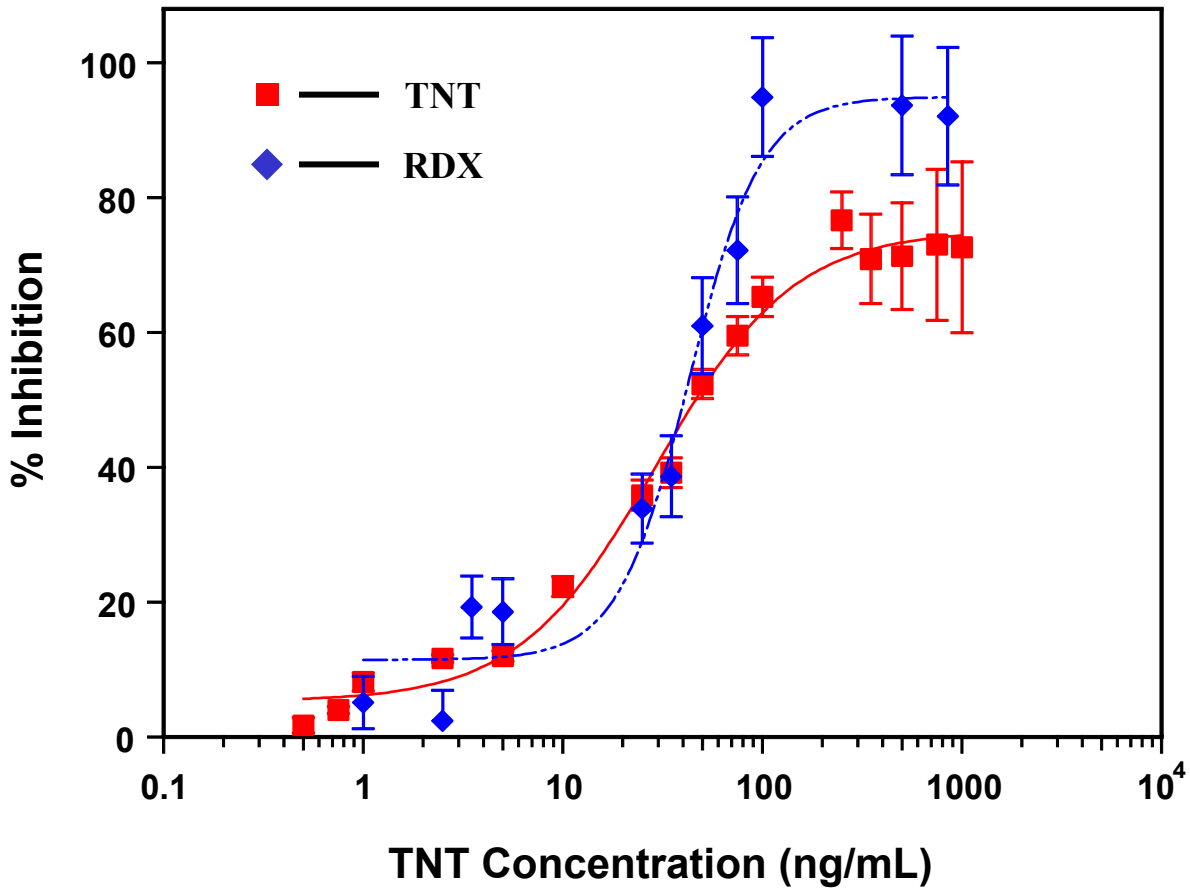


Figure 15

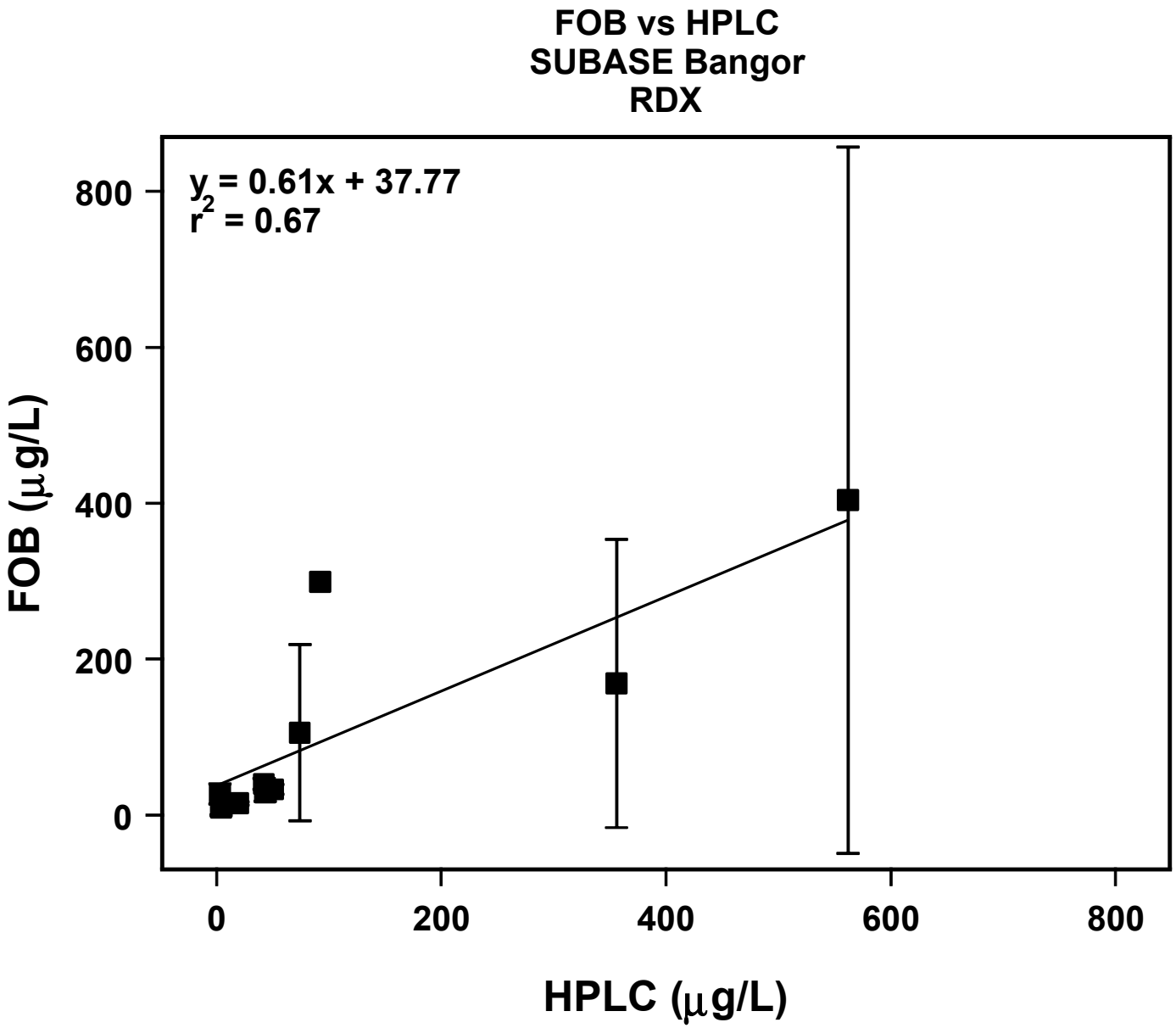

FOB vs HPLC
SUBASE Bangor
RDX
y = 0.61x + 37.77
r2 = 0.67
800
600
400
200
0
FOB (µg/L)
0
200
400
600
800
HPLC (µg/L)

Figure 16

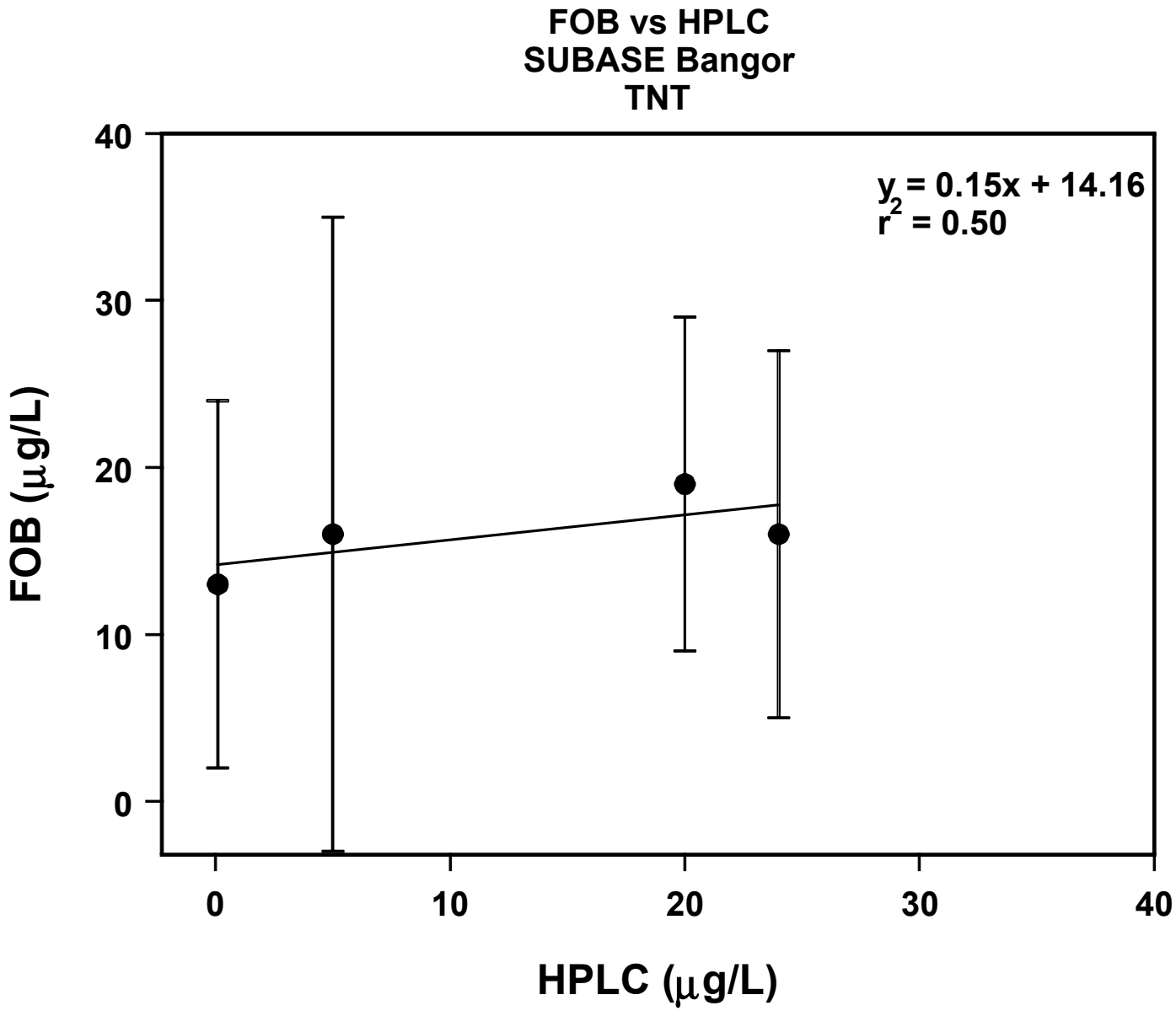

FOB vs HPLC
SUBASE Bangor
TNT
y = 0.15x + 14.16
r2 = 0.50
FOB (µg/L)
HPLC (µg/L)
40
30
20
10
0
0
10
20
30
40

Figure 17

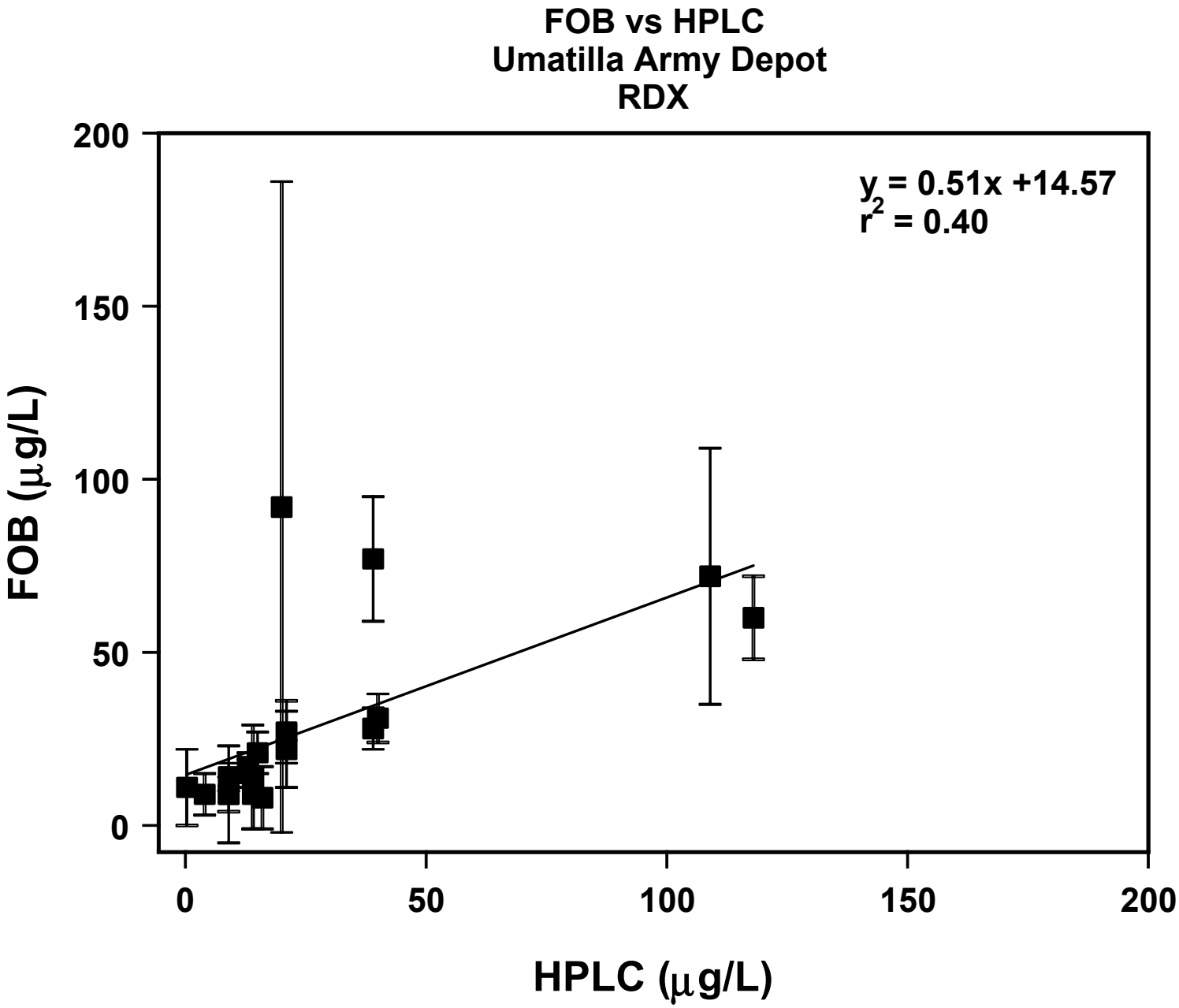

FOB vs HPLC
Umatilla Army Depot
RDX
y = 0.51x +14.57
r2 = 0.40
FOB (µg/L)
HPLC (µg/L)
0
50
100
150
200
0
50
100
150
200

Figure 18

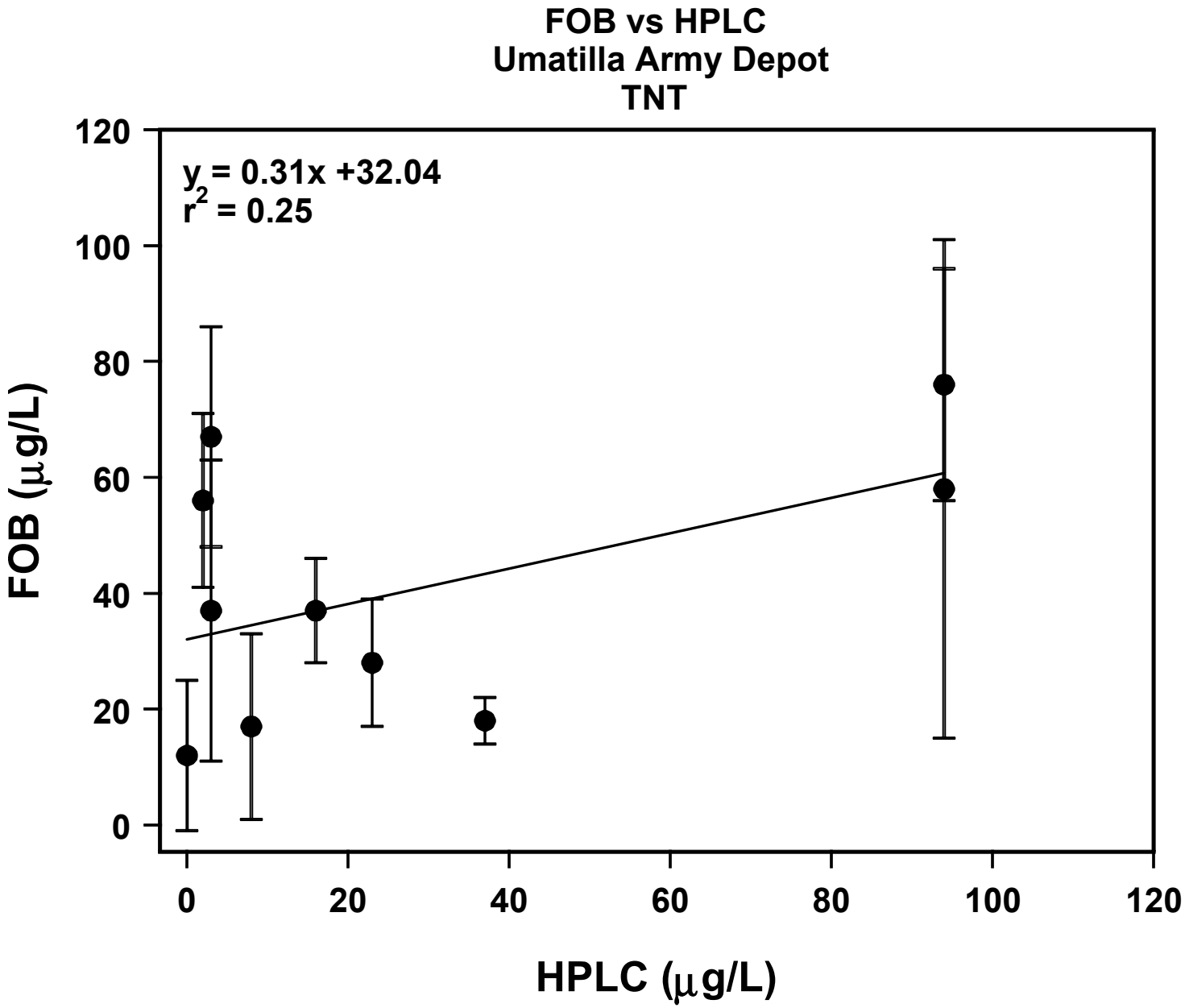

FOB vs HPLC
Umatilla Army Depot
TNT
y = 0.31x +32.04
r2 = 0.25
FOB (µg/L)
HPLC (µg/L)
0
20
40
60
80
100
120

Figure 19

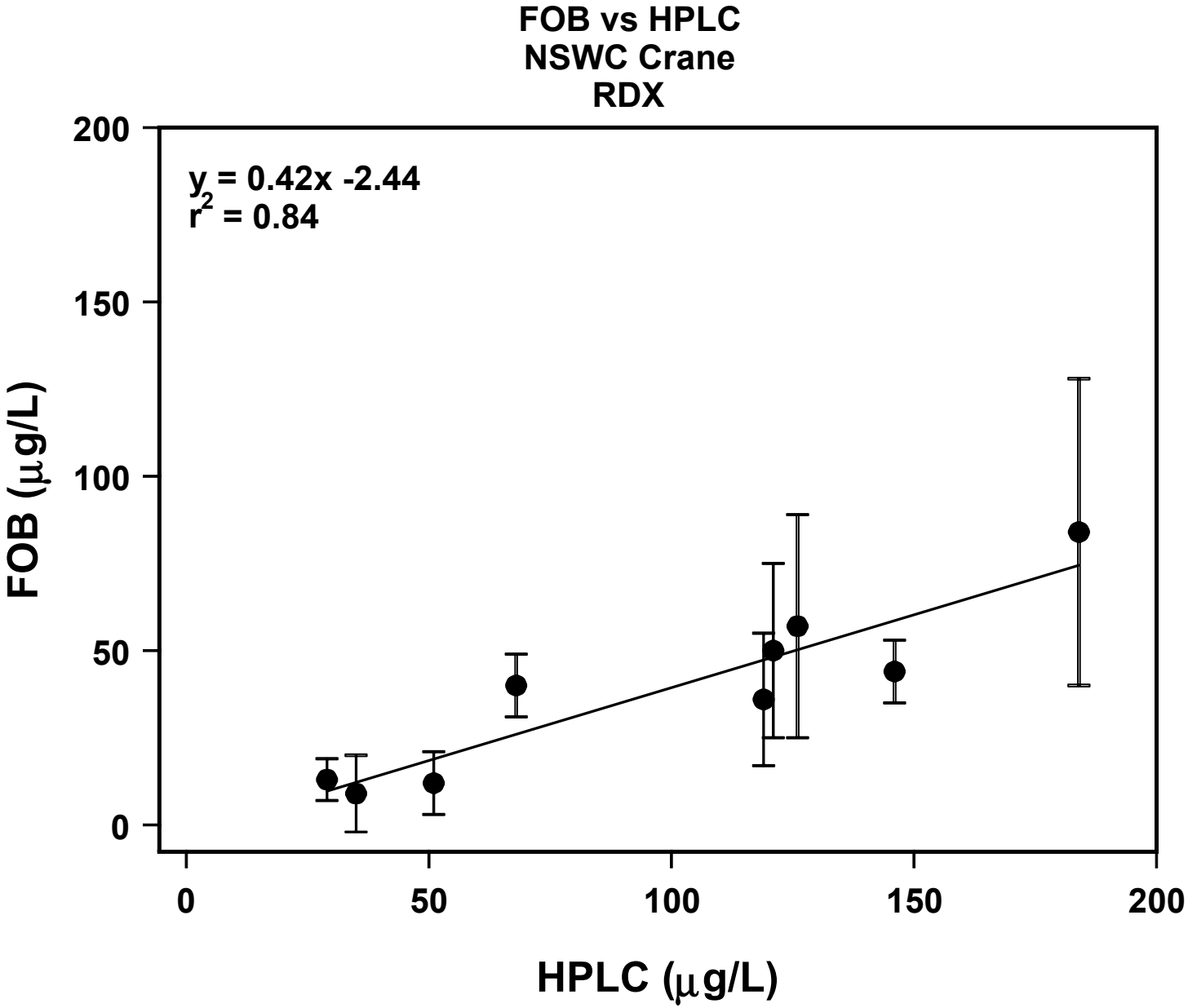

FOB vs HPLC
NSWC Crane
RDX
y = 0.42x -2.44
r2 = 0.84
FOB (µg/L)
HPLC (µg/L)
0
50
100
150
200
0
50
100
150
200

Figure 20

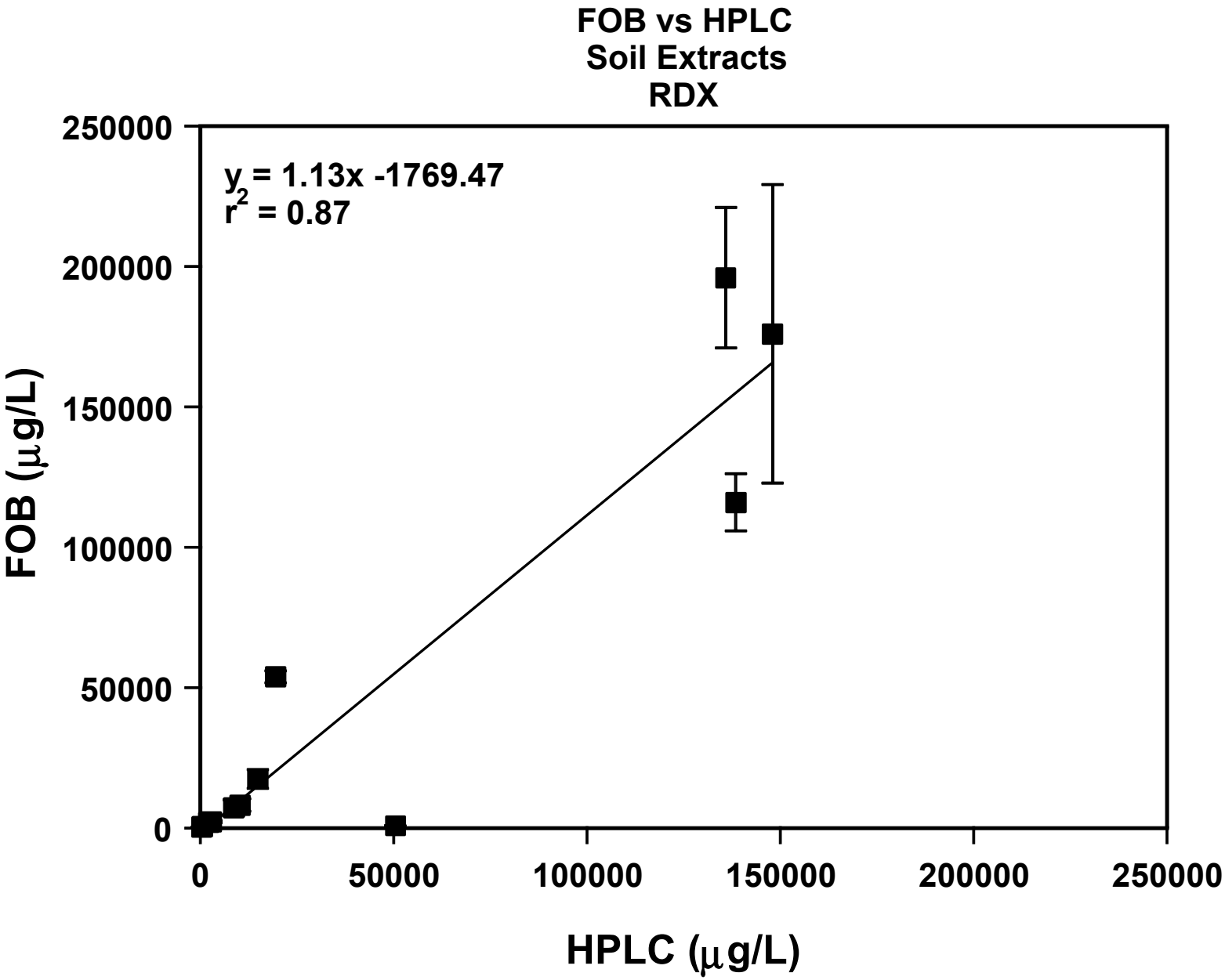

FOB vs HPLC
Soil Extracts
RDX
y = 1.13x -1769.47
r2 = 0.87
250000
200000
150000
100000
50000
0
FOB (µg/L)
0
50000
100000
150000
200000
250000
HPLC (µg/L)

Figure 21

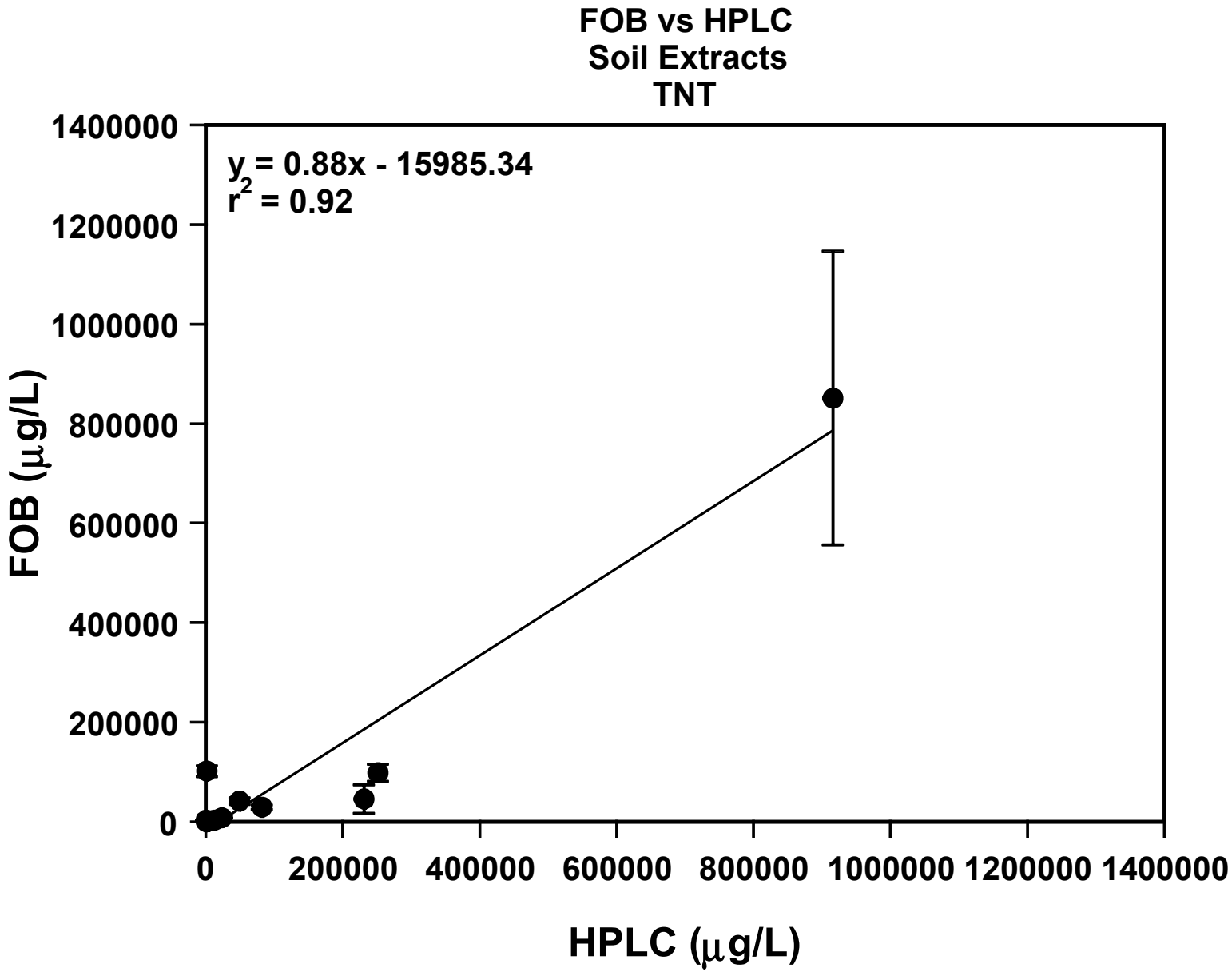

FOB vs HPLC
Soil Extracts
TNT
y = 0.88x - 15985.34
r2 = 0.92
1400000
1200000
1000000
800000
600000
400000
200000
0
FOB (µg/L)
0
200000
400000
600000
800000
1000000
1200000
1400000
HPLC (µg/L)

Figure 22

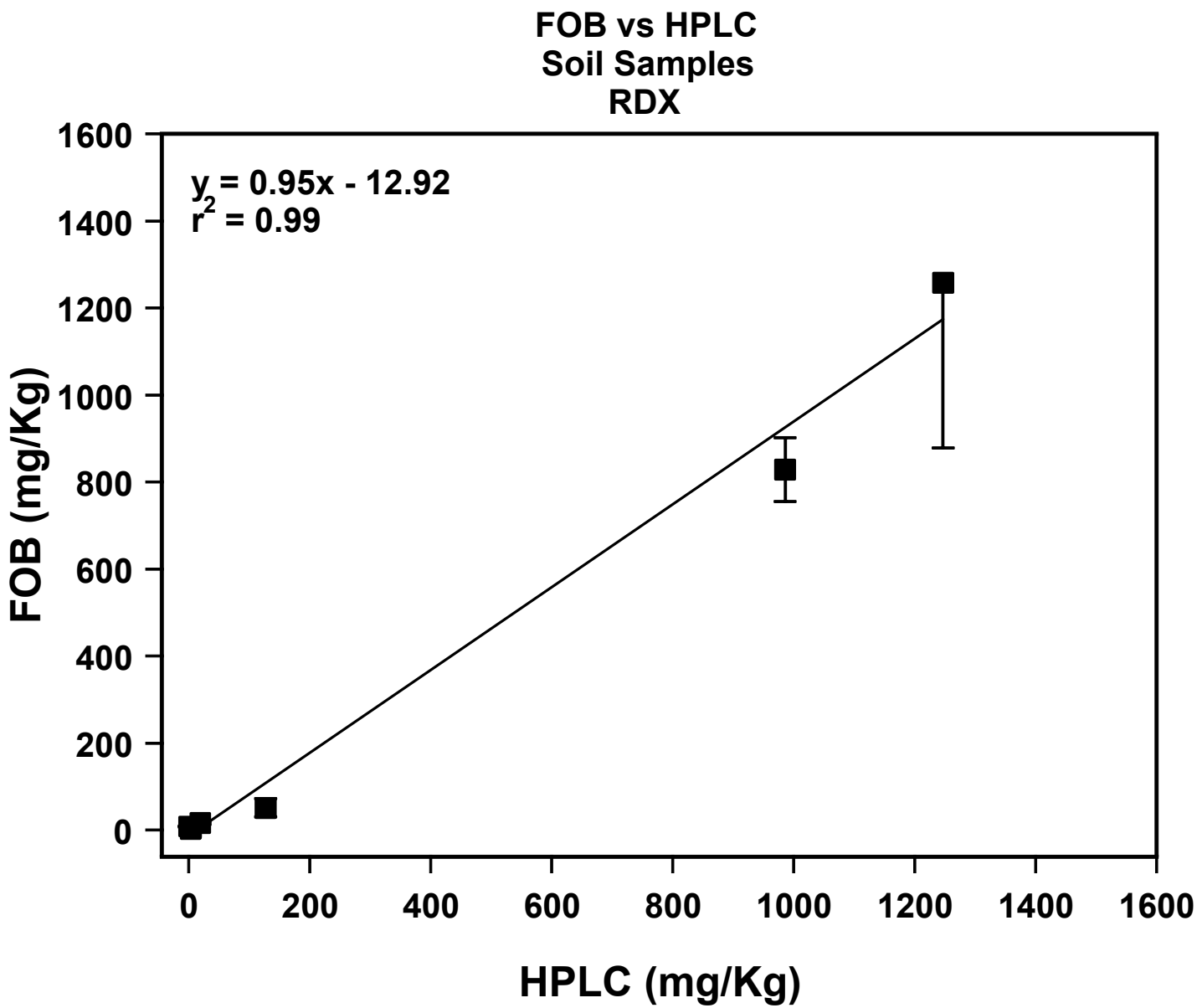

FOB vs HPLC
Soil Samples
RDX
y = 0.95x - 12.92
r2 = 0.99
FOB (mg/Kg)
HPLC (mg/Kg)
0
200
400
600
800
1000
1200
1400
1600

Figure 23

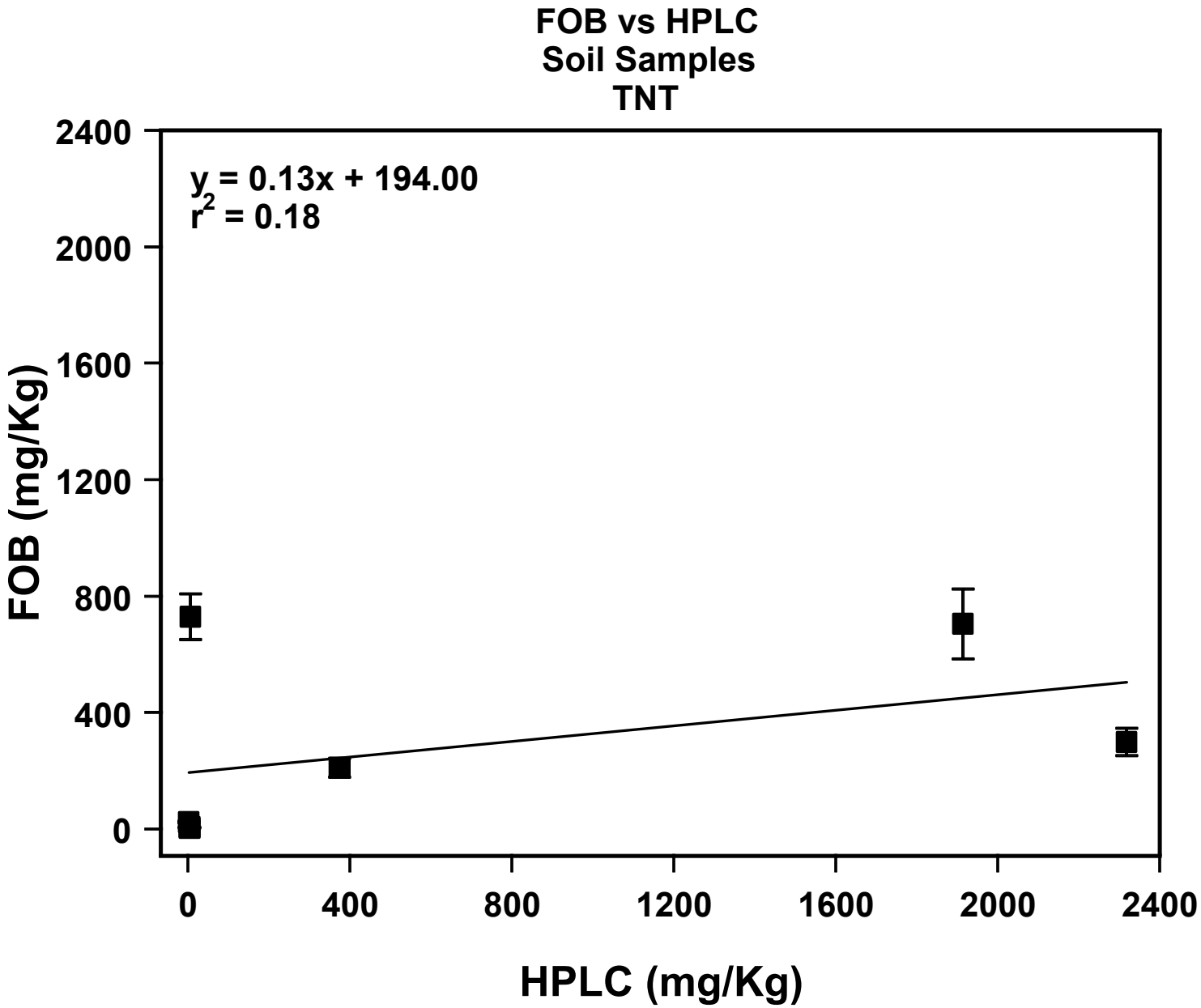

FOB vs HPLC
Soil Samples
TNT
y = 0.13x + 194.00
r2 = 0.18
FOB (mg/Kg)
HPLC (mg/Kg)
0
400
800
1200
1600
2000
2400

Figure 24

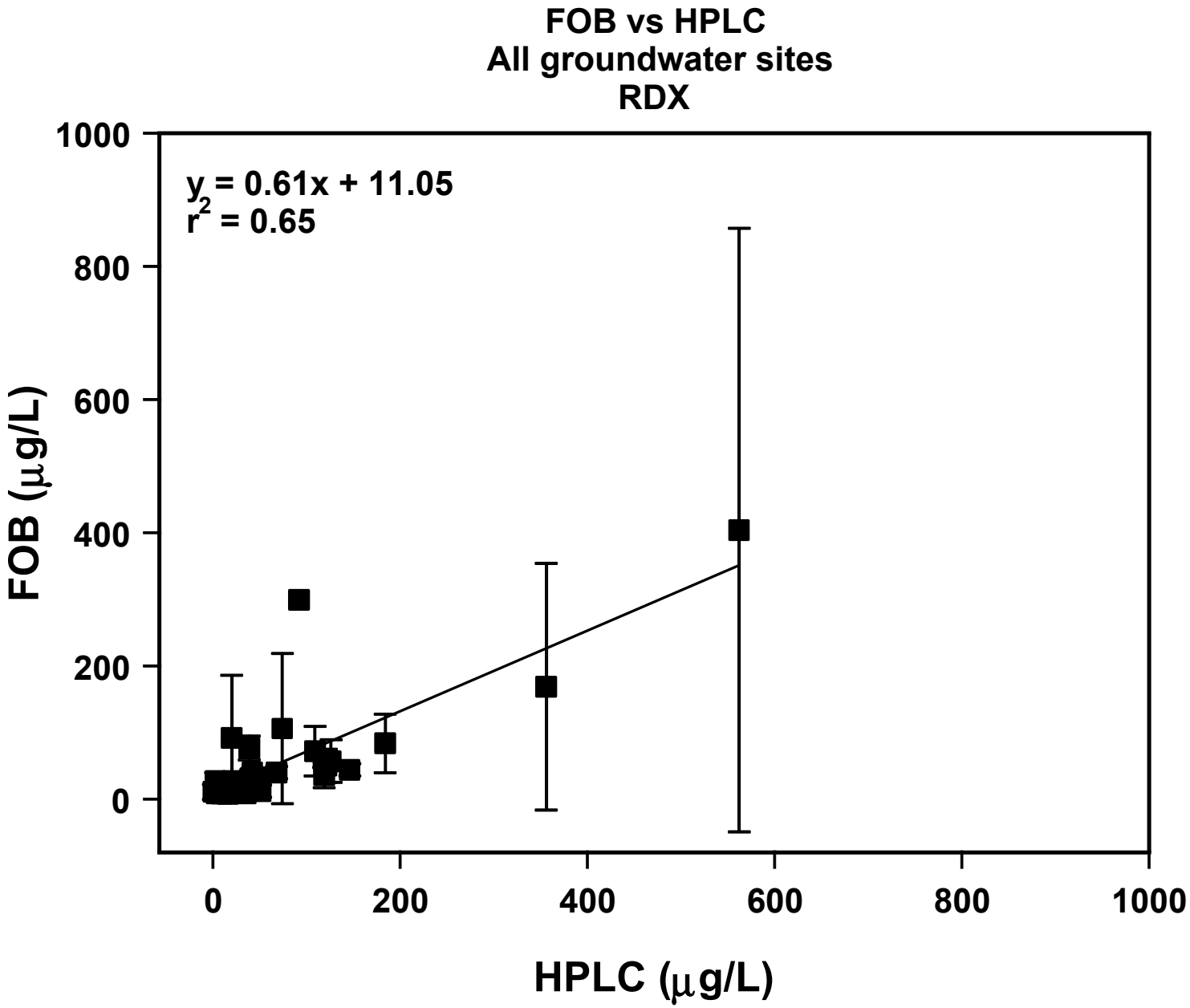

FOB vs HPLC
All groundwater sites
RDX
y = 0.61x + 11.05
r2 = 0.65
FOB (µg/L)
HPLC (µg/L)
1000
800
600
400
200
0
0
200
400
600
800
1000

Figure 25

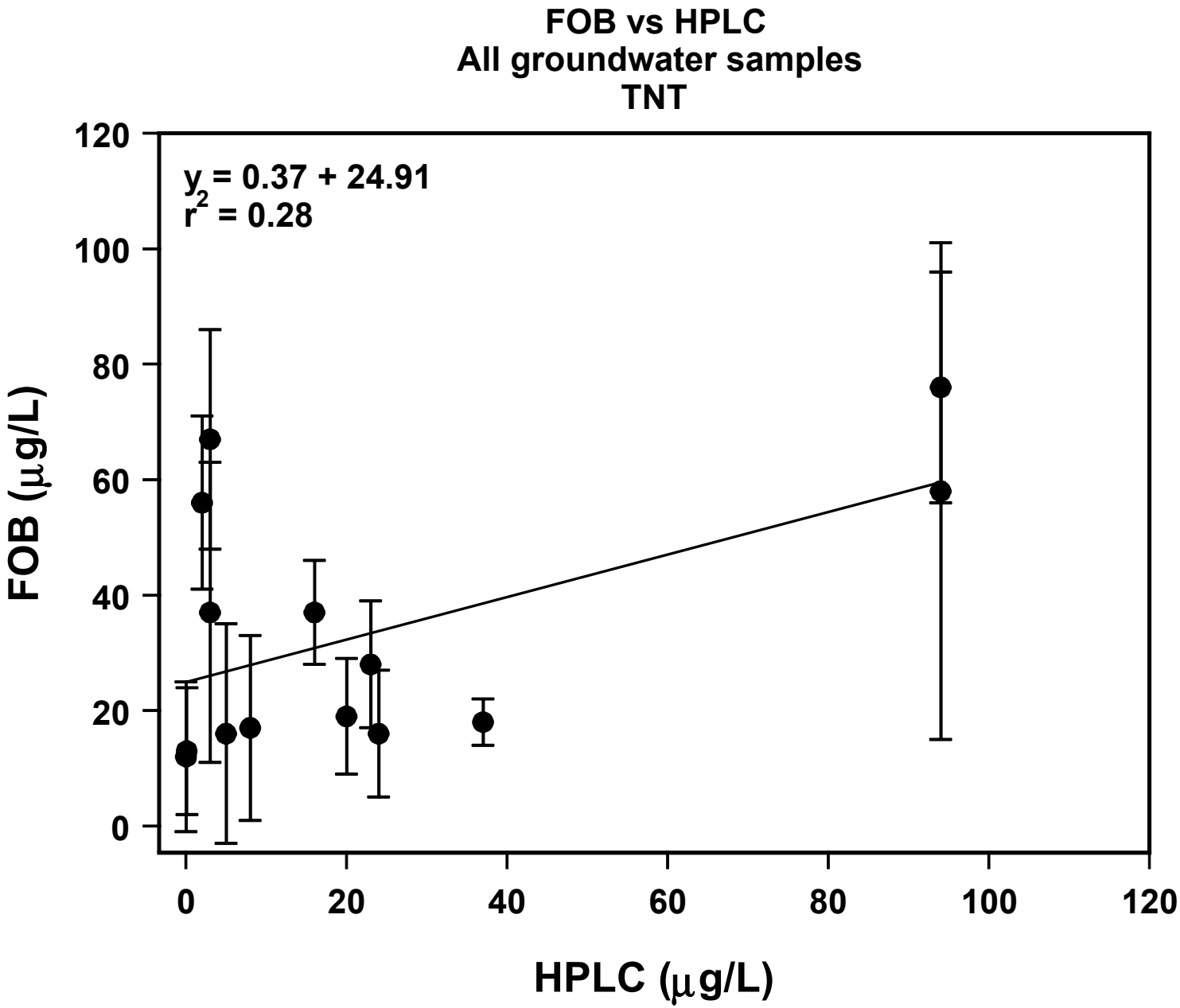

FOB vs HPLC
All groundwater samples
TNT
y = 0.37 + 24.91
r2 = 0.28
FOB (µg/L)
HPLC (µg/L)
0
20
40
60
80
100
120

Figure 26

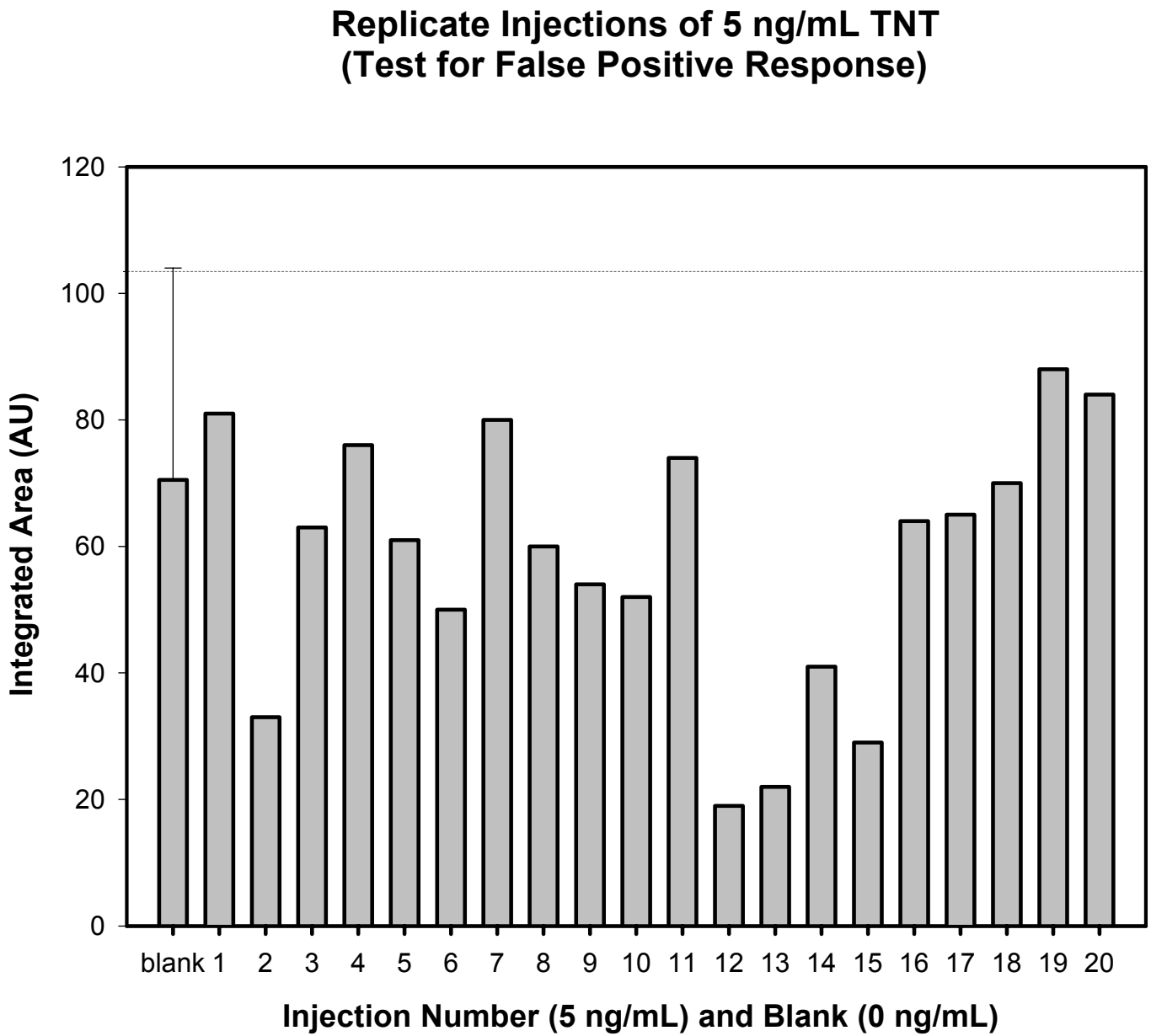

Replicate Injections of 5 ng/mL TNT
(Test for False Positive Response)
Integrated Area (AU)
120
100
80
60
40
20
0
blank 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Injection Number (5 ng/mL) and Blank (0 ng/mL)

Figure 27

Replicate Injections of 20 ng/mL TNT (Test for False Negative Response)

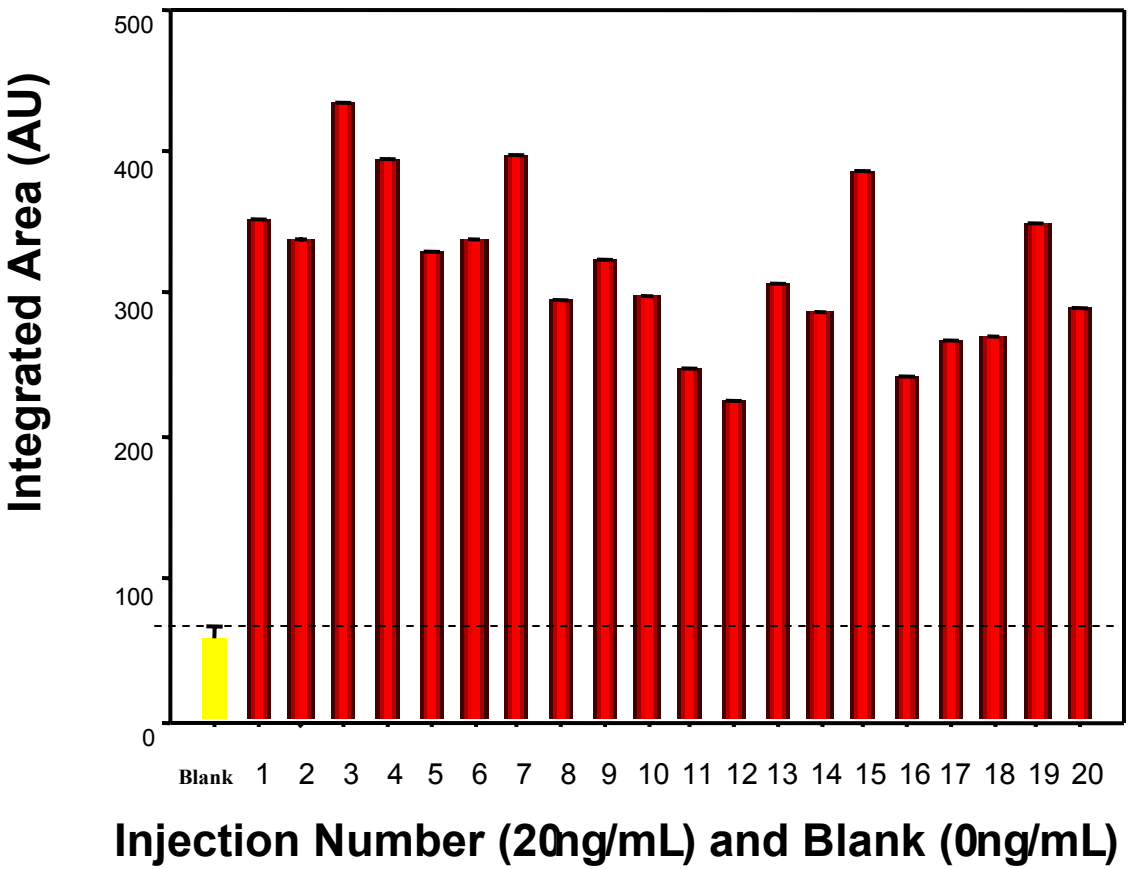


Figure 28

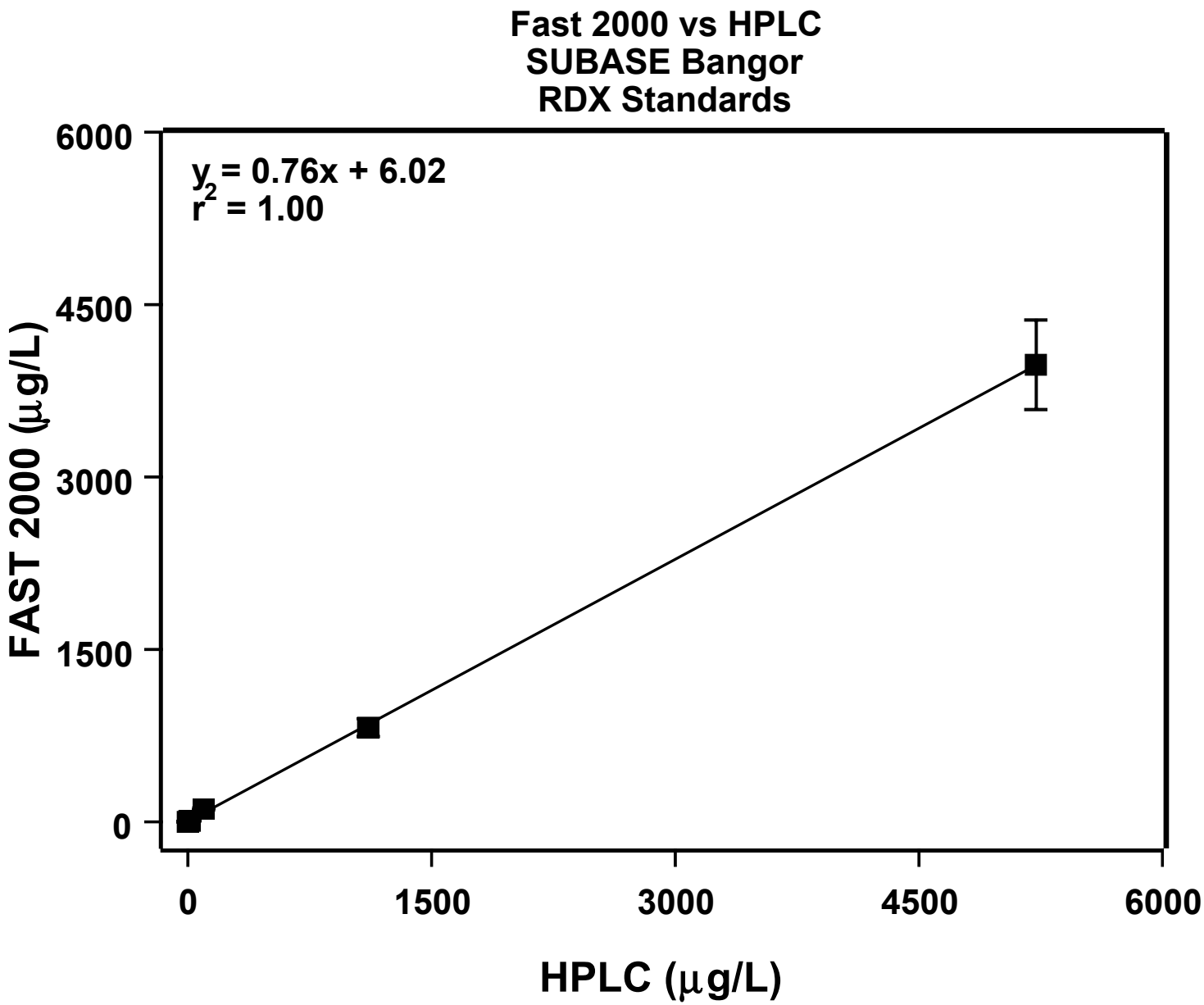

Fast 2000 vs HPLC
SUBASE Bangor
RDX Standards
y = 0.76x + 6.02
r2 = 1.00
6000
4500
3000
1500
0
FAST 2000 (µg/L)
0
1500
3000
4500
6000
HPLC (µg/L)

Figure 29

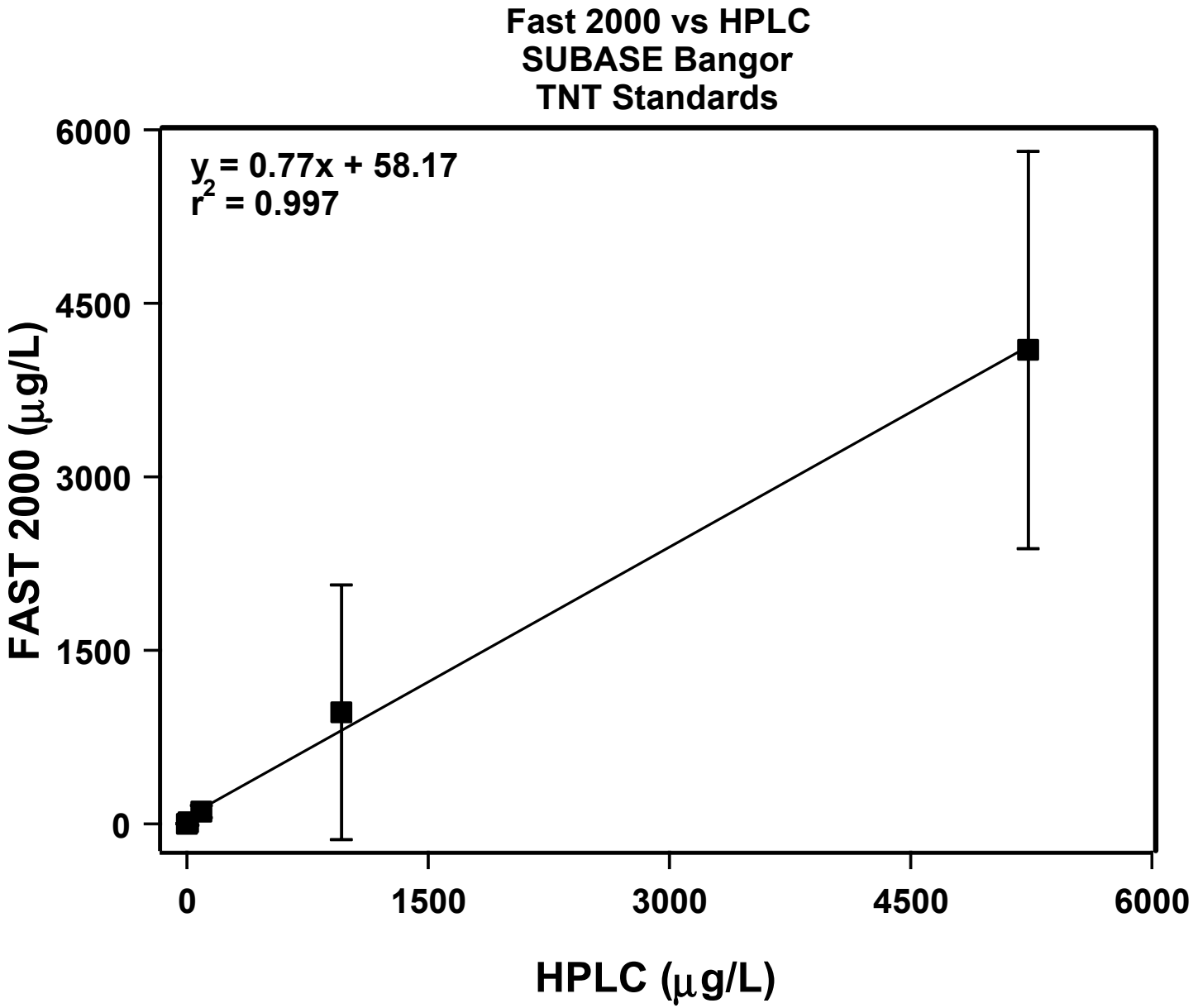

Fast 2000 vs HPLC
SUBASE Bangor
TNT Standards
y = 0.77x + 58.17
r2 = 0.997
6000
4500
3000
1500
0
FAST 2000 (µg/L)
0
1500
3000
4500
6000
HPLC (µg/L)

Figure 30

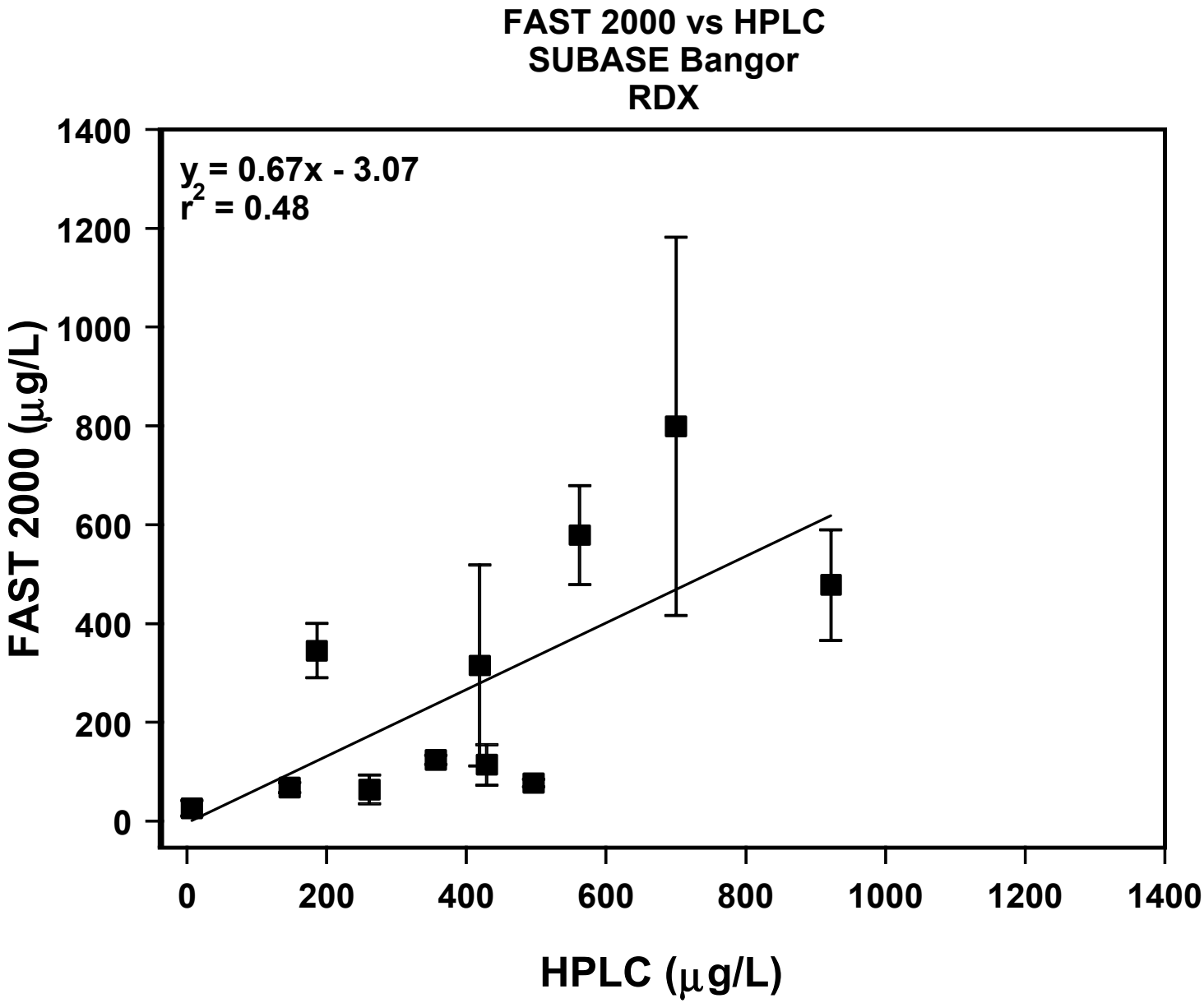

FAST 2000 vs HPLC
SUBASE Bangor
RDX
y = 0.67x - 3.07
r2 = 0.48
FAST 2000 (µg/L)
HPLC (µg/L)
0
200
400
600
800
1000
1200
1400

Figure 31

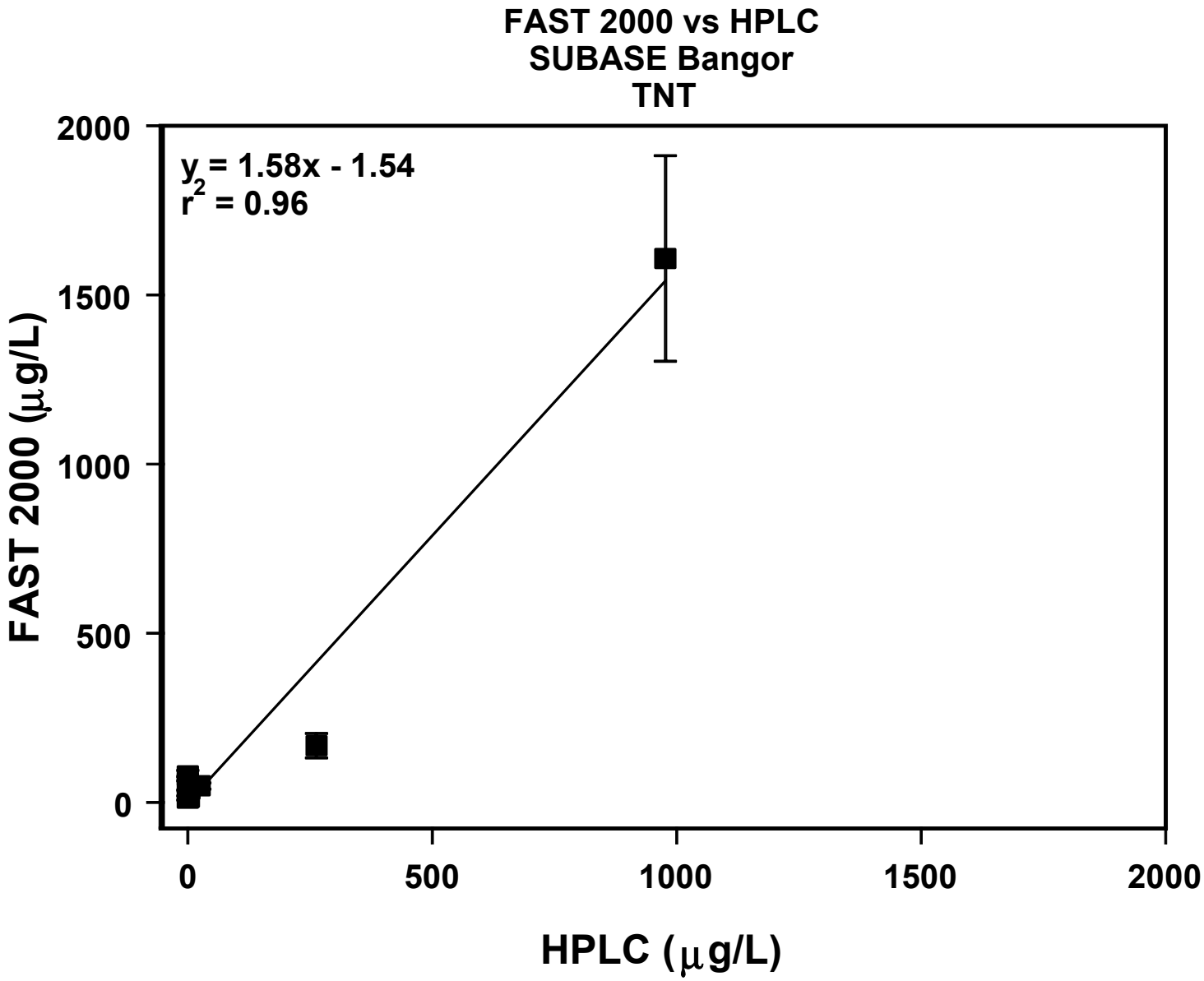

FAST 2000 vs HPLC
SUBASE Bangor
TNT
y = 1.58x - 1.54
r2 = 0.96
FAST 2000 (µg/L)
HPLC (µg/L)
0
500
1000
1500
2000

Figure 32

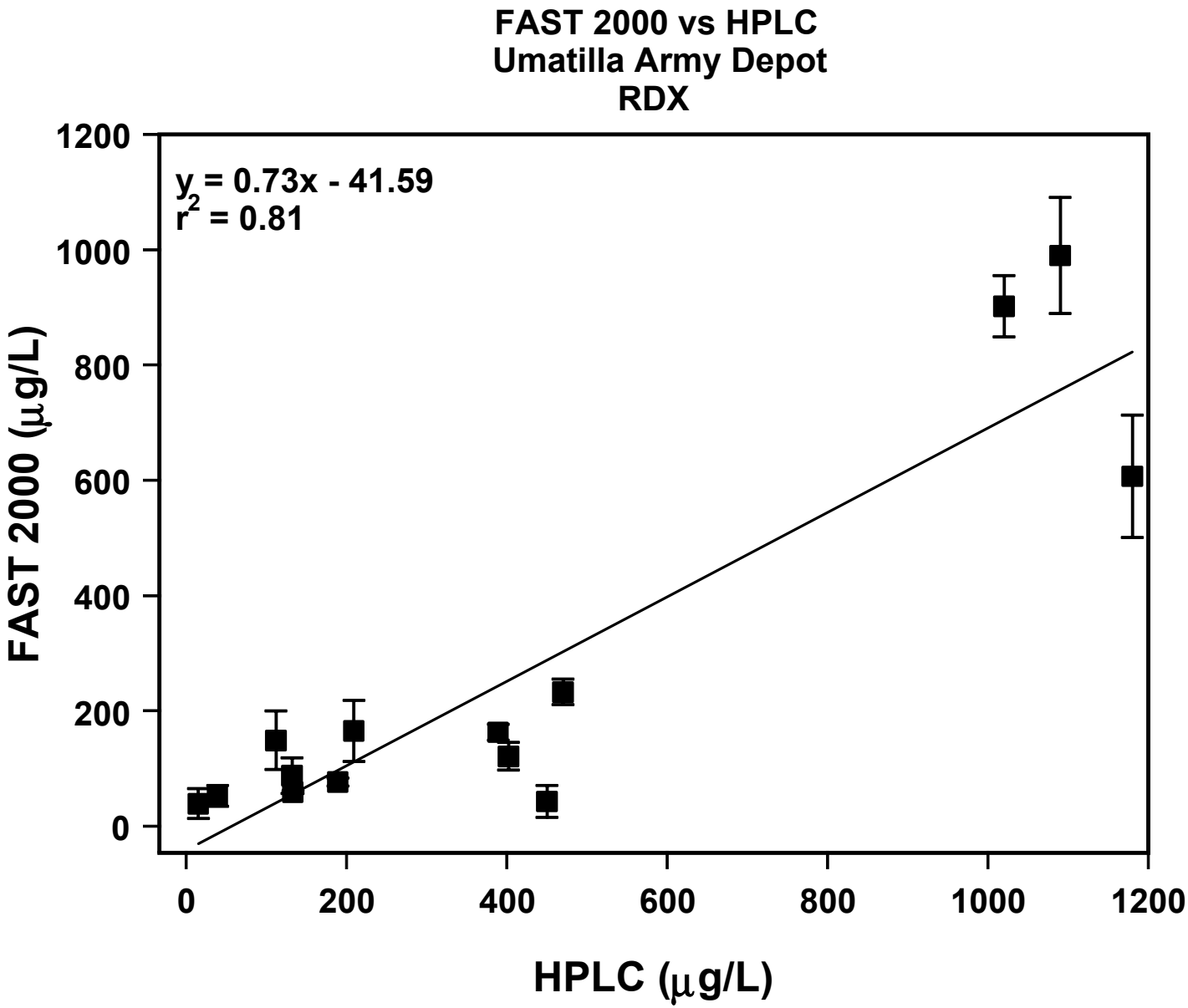

FAST 2000 vs HPLC
Umatilla Army Depot
RDX
y = 0.73x - 41.59
r2 = 0.81
FAST 2000 (µg/L)
HPLC (µg/L)
0
200
400
600
800
1000
1200

Figure 33

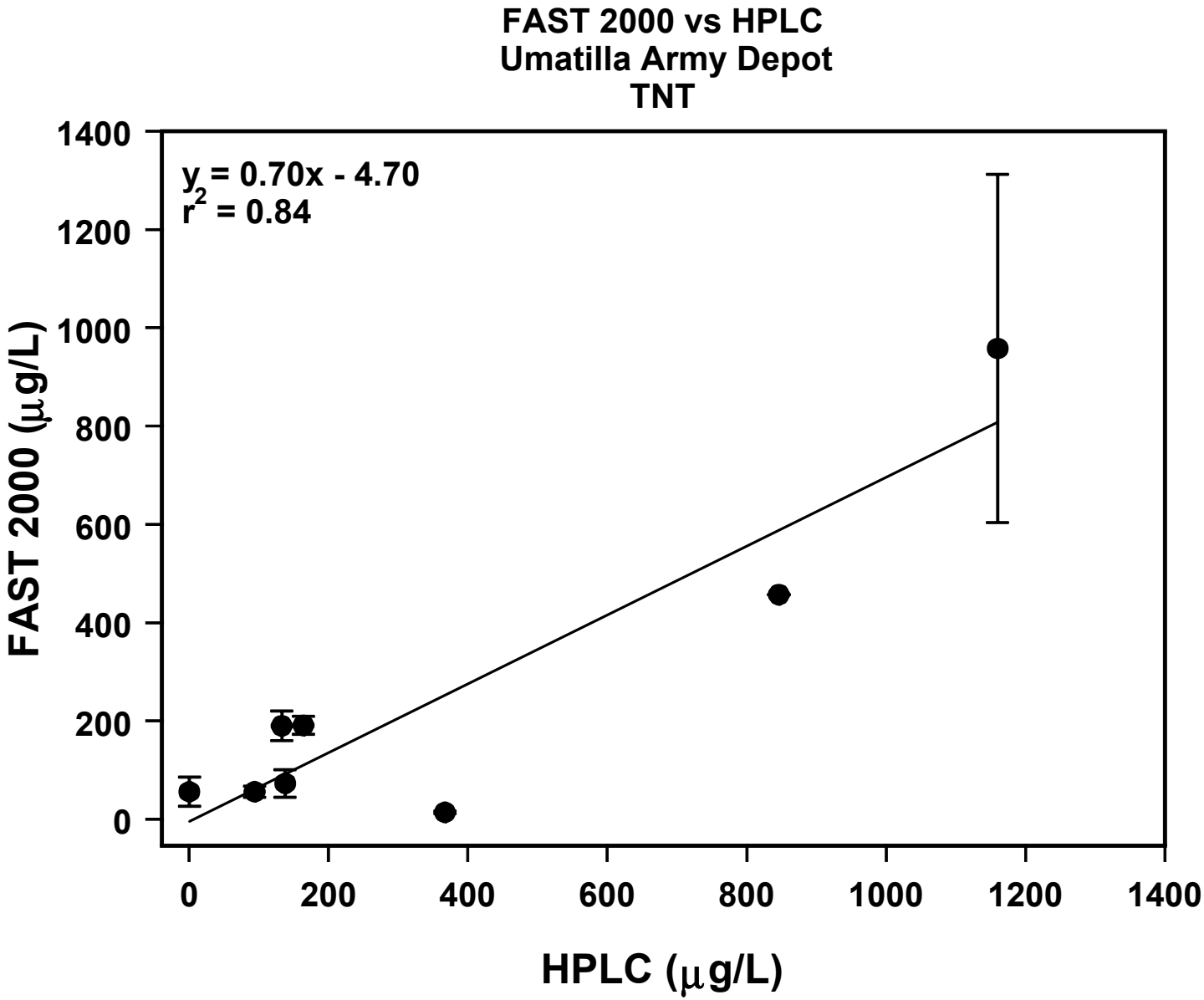

FAST 2000 vs HPLC
Umatilla Army Depot
TNT
y = 0.70x - 4.70
r2 = 0.84
FAST 2000 (µg/L)
HPLC (µg/L)
0
200
400
600
800
1000
1200
1400

Figure 34

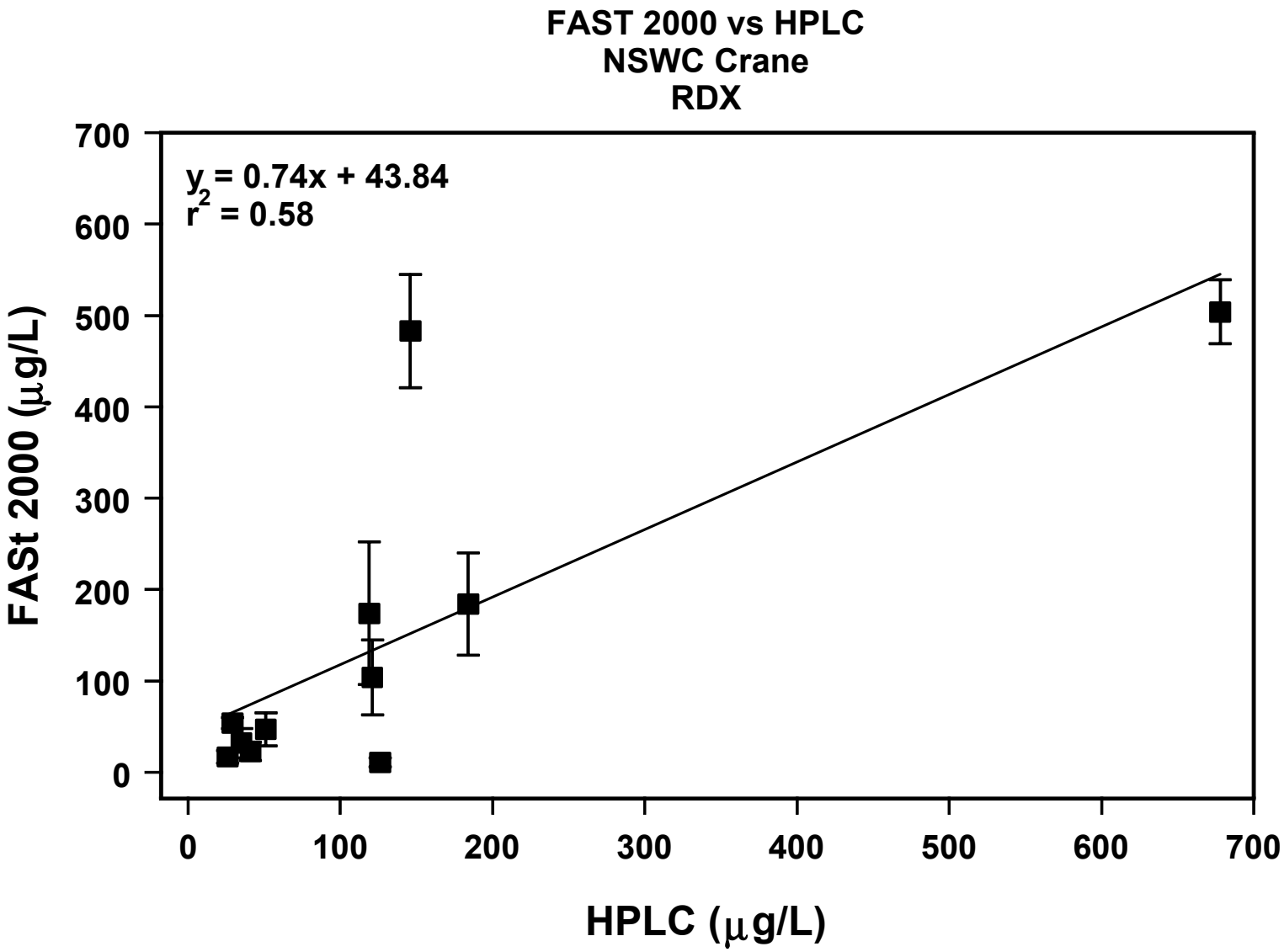

FAST 2000 vs HPLC
NSWC Crane
RDX
y = 0.74x + 43.84
r2 = 0.58
FASt 2000 (µg/L)
HPLC (µg/L)
0
100
200
300
400
500
600
700

Figure 35

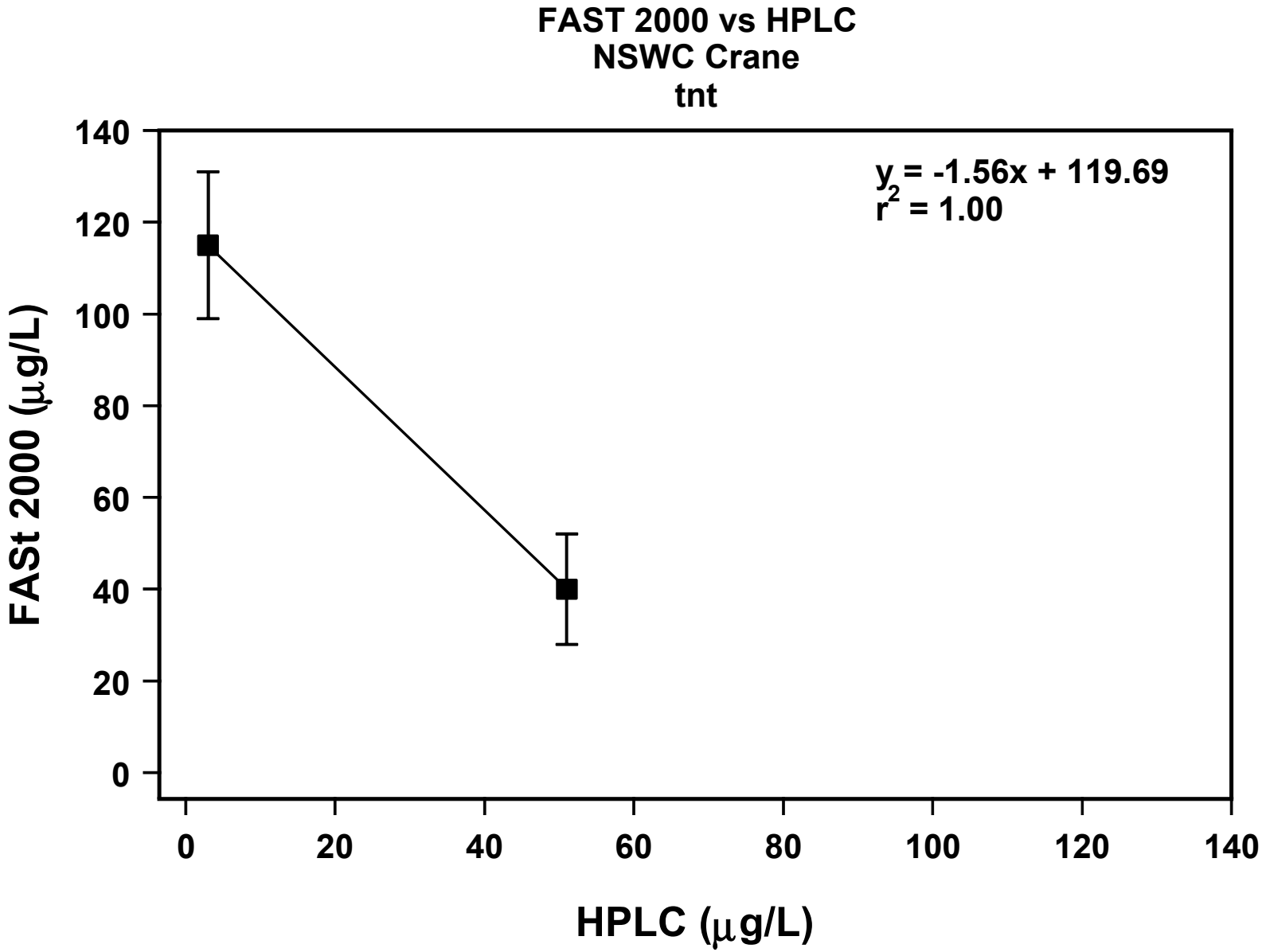

FAST 2000 vs HPLC
NSWC Crane
tnt
y = -1.56x + 119.69
r2 = 1.00
FASt 2000 (µg/L)
HPLC (µg/L)
0
20
40
60
80
100
120
140

Figure 36

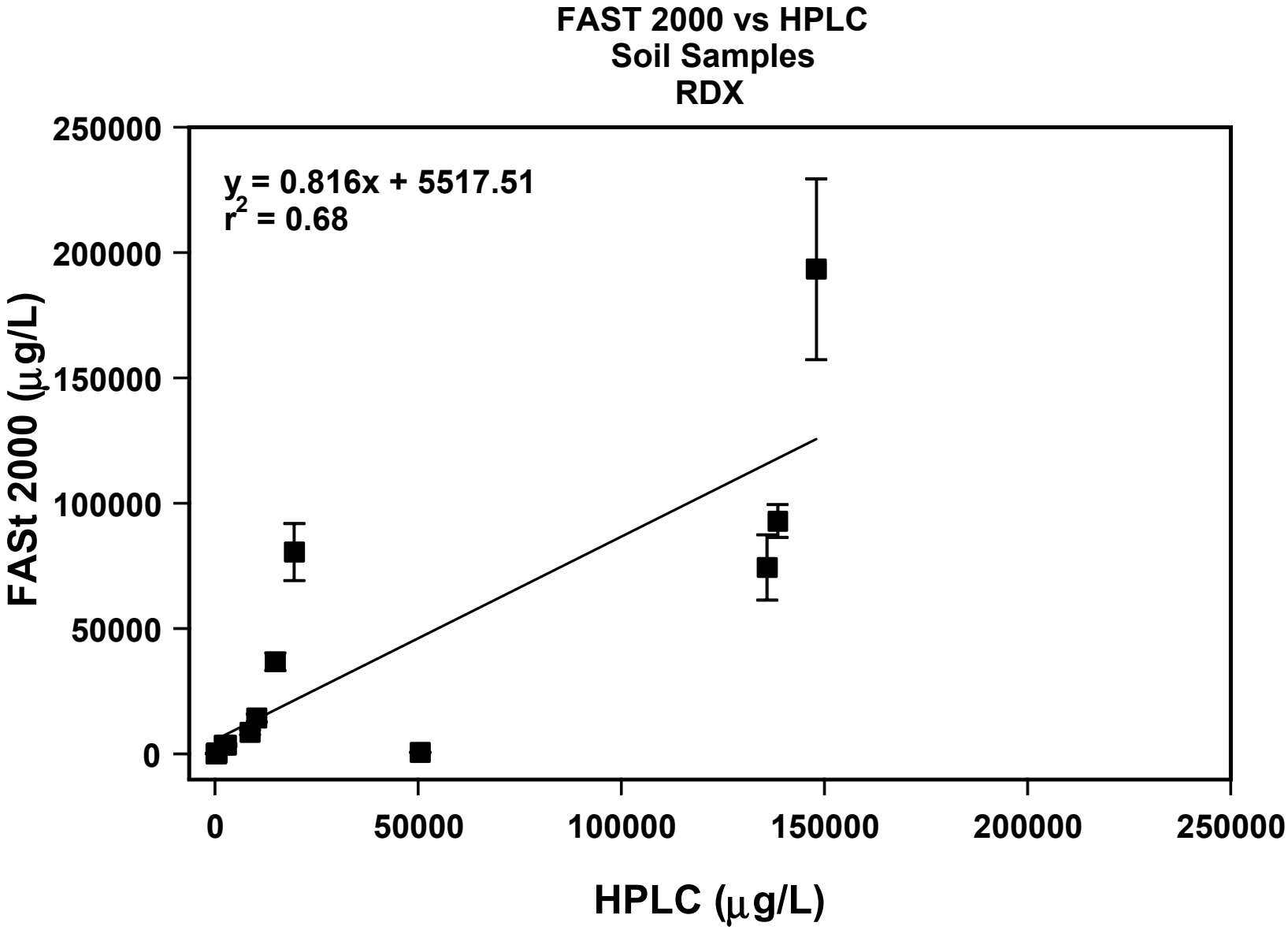

FAST 2000 vs HPLC
Soil Samples
RDX
y = 0.816x + 5517.51
r2 = 0.68
FASt 2000 (µg/L)
HPLC (µg/L)
0
50000
100000
150000
200000
250000

Figure 37

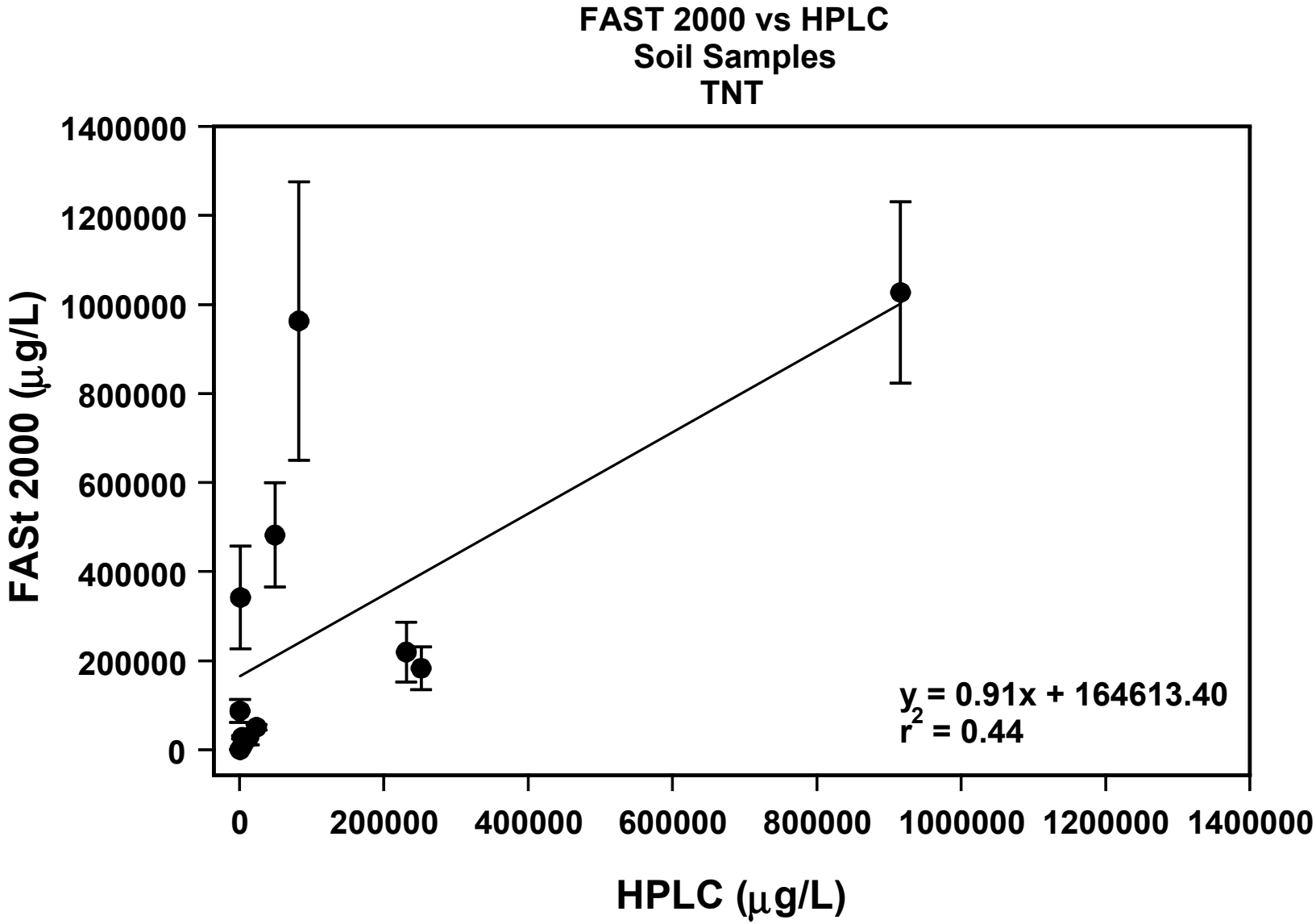

FAST 2000 vs HPLC
Soil Samples
TNT
FASt 2000 (µg/L)
HPLC (µg/L)
0
200000
400000
600000
800000
1000000
1200000
1400000
y = 0.91x + 164613.40
r2 = 0.44

Figure 38

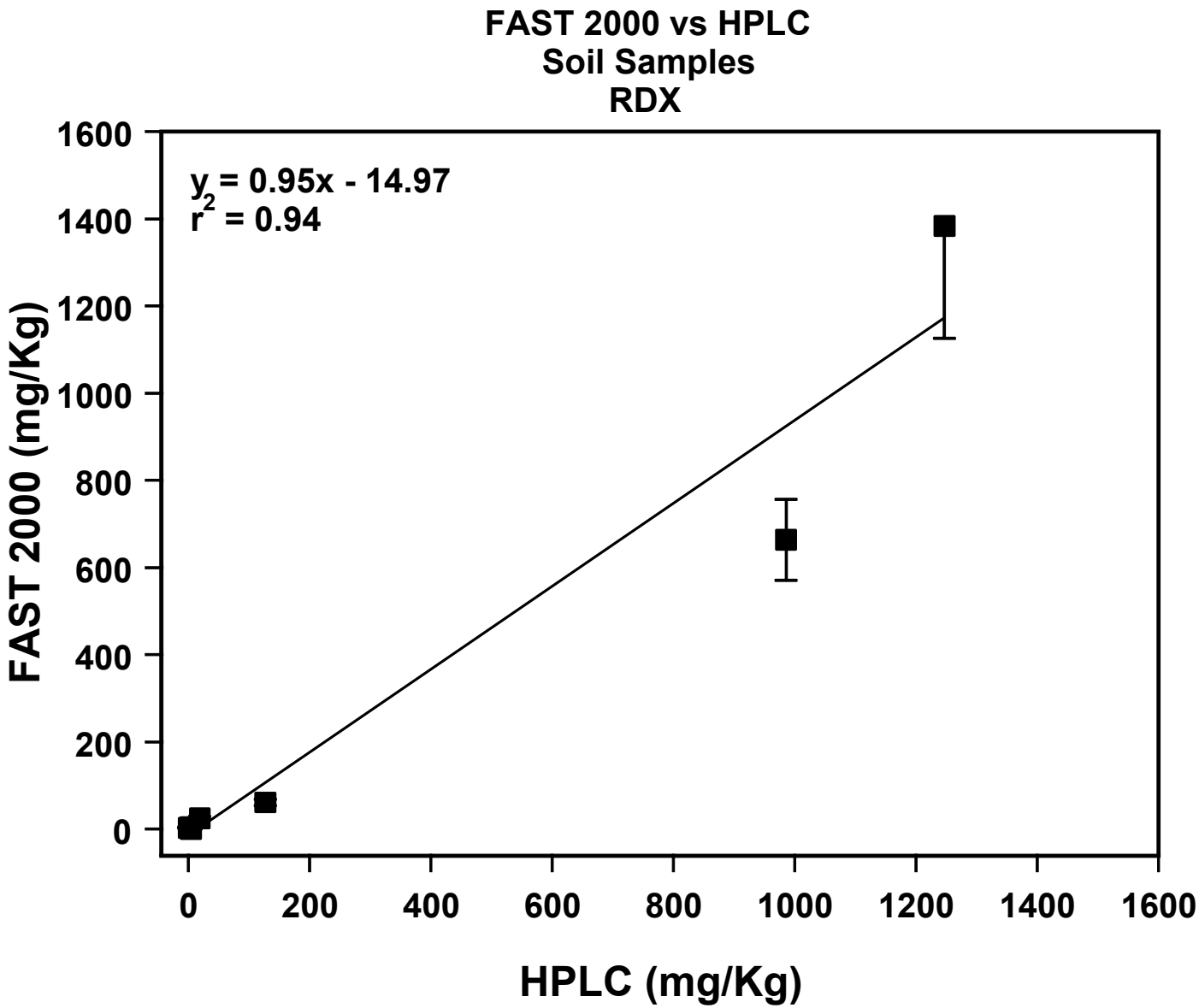

FAST 2000 vs HPLC
Soil Samples
RDX
y = 0.95x - 14.97
r2 = 0.94
FAST 2000 (mg/Kg)
HPLC (mg/Kg)
0
200
400
600
800
1000
1200
1400
1600

Figure 39

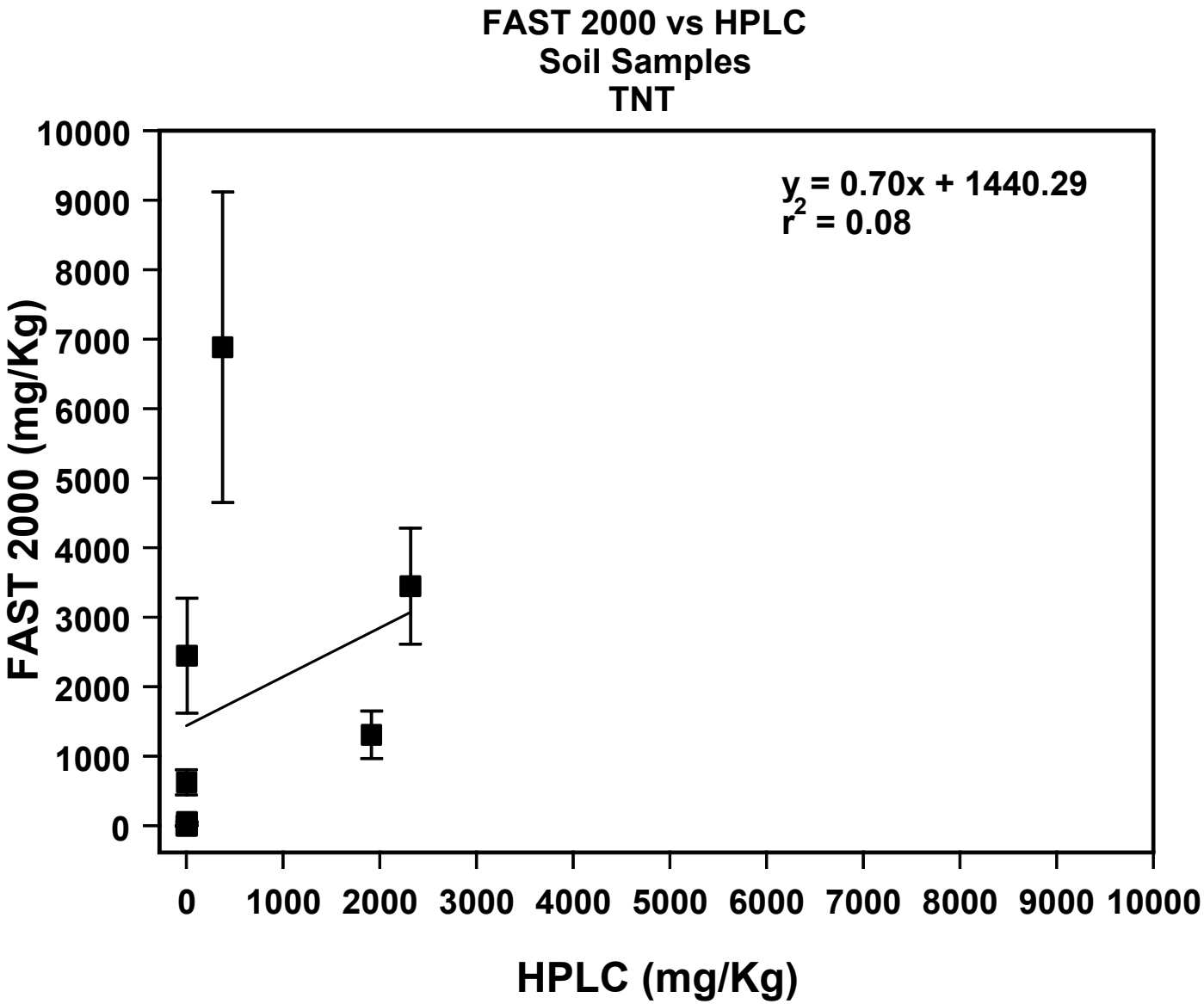

FAST 2000 vs HPLC
Soil Samples
TNT
y = 0.70x + 1440.29
r2 = 0.08
FAST 2000 (mg/Kg)
HPLC (mg/Kg)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000

Figure 40

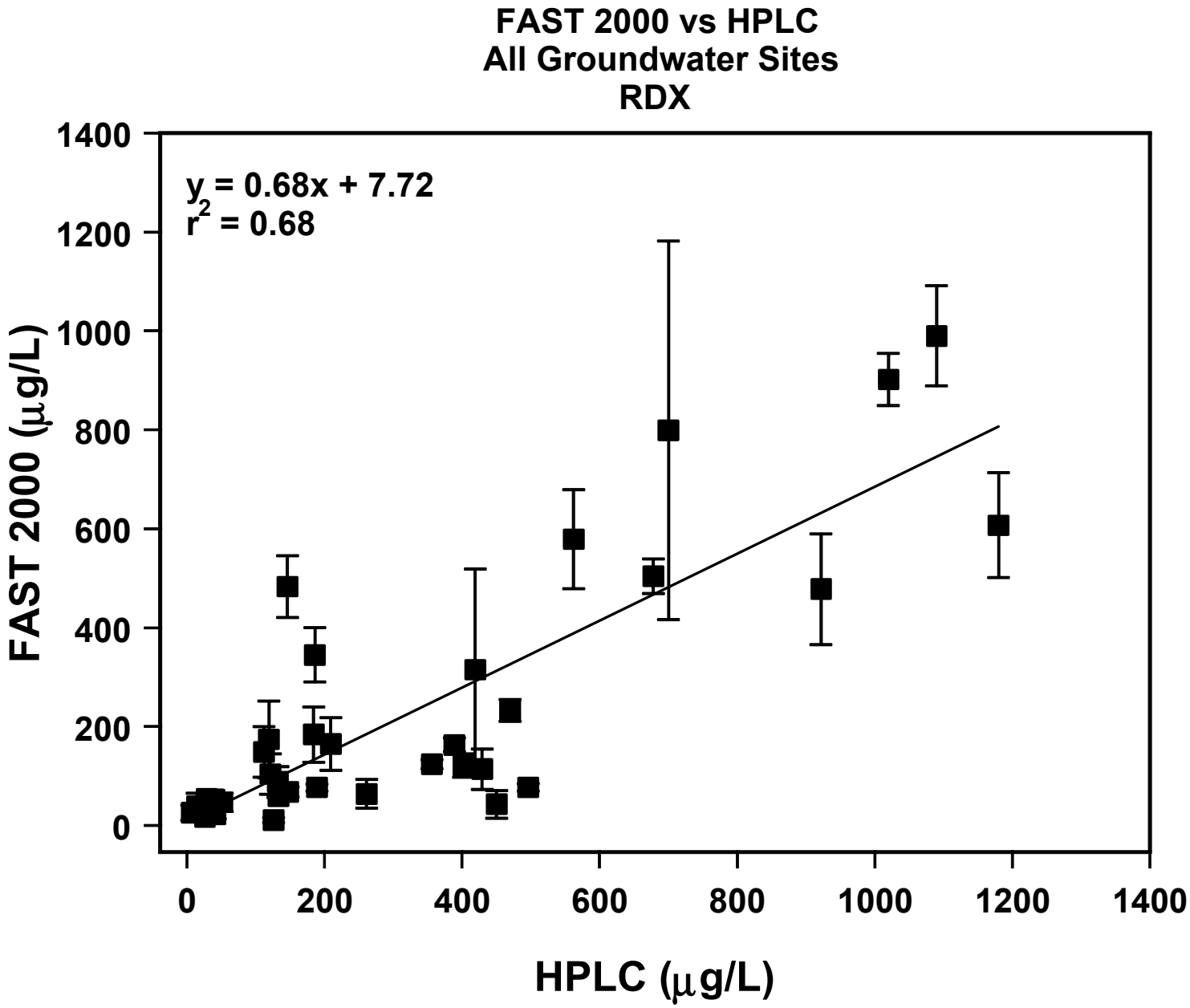

FAST 2000 vs HPLC
All Groundwater Sites
RDX
y = 0.68x + 7.72
r2 = 0.68
FAST 2000 (µg/L)
HPLC (µg/L)
0
200
400
600
800
1000
1200
1400

Figure 41

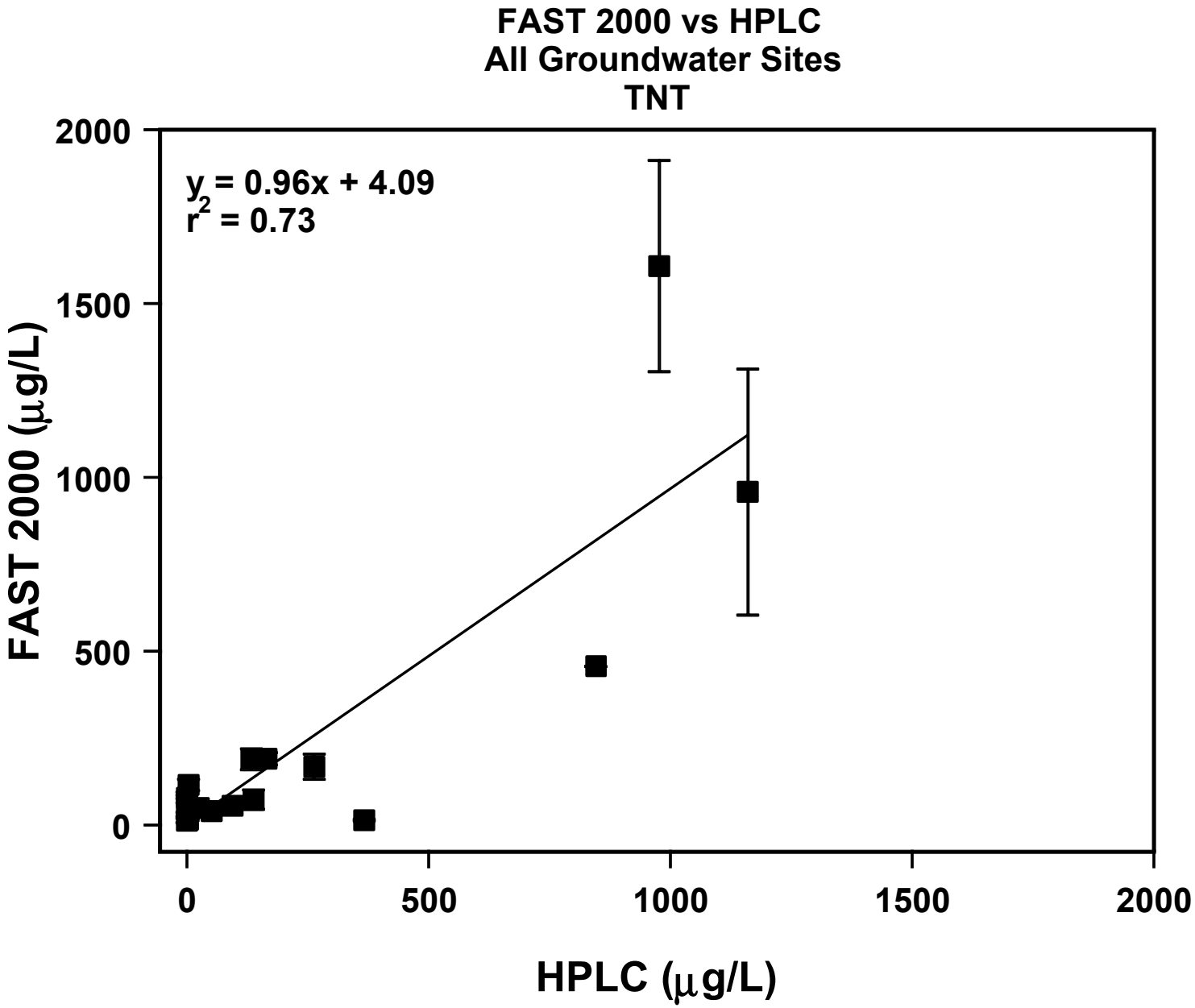

FAST 2000 vs HPLC
All Groundwater Sites
TNT
y = 0.96x + 4.09
r2 = 0.73
FAST 2000 (µg/L)
HPLC (µg/L)
0
500
1000
1500
2000

Figure 42

Site F Historical Features Map

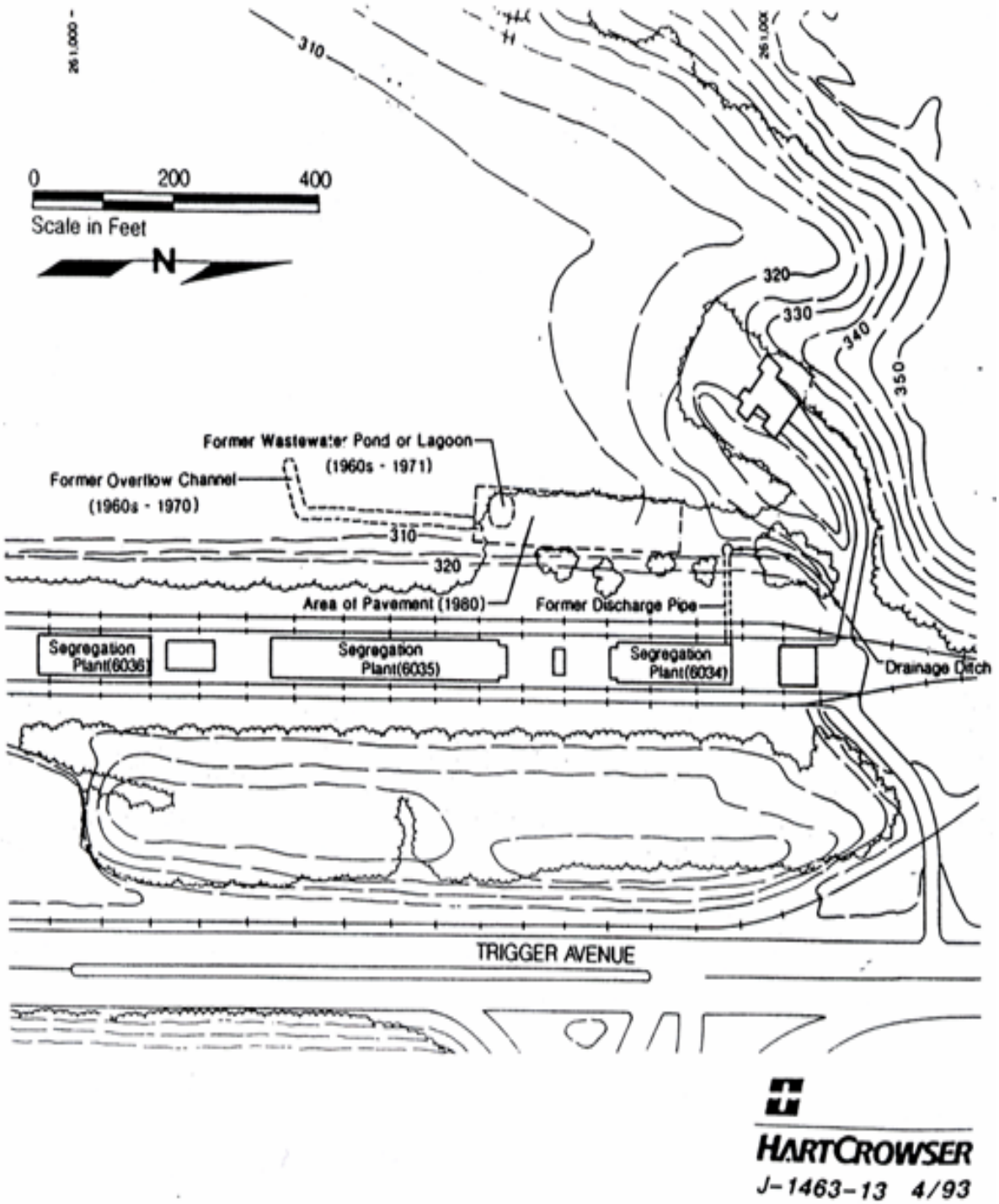
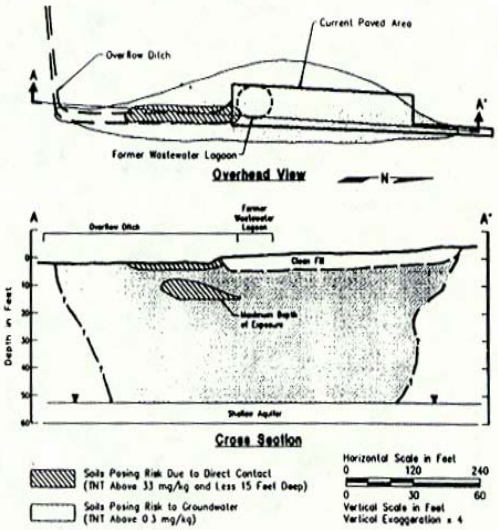
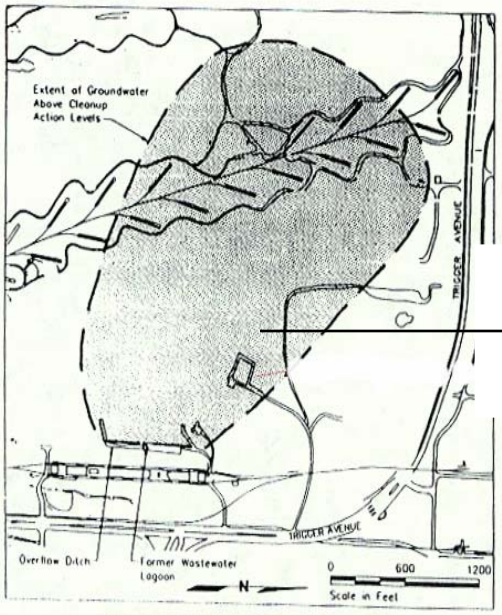


Figure 9

SITE F (Operable Unit 2)



Extent of Soil Above Cleanup Action Levels

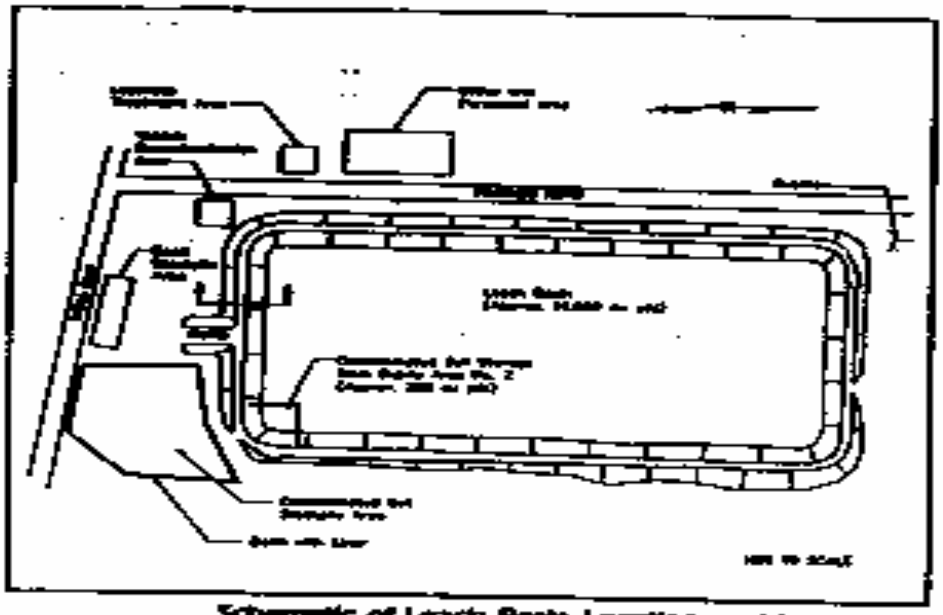


Treatment Facility

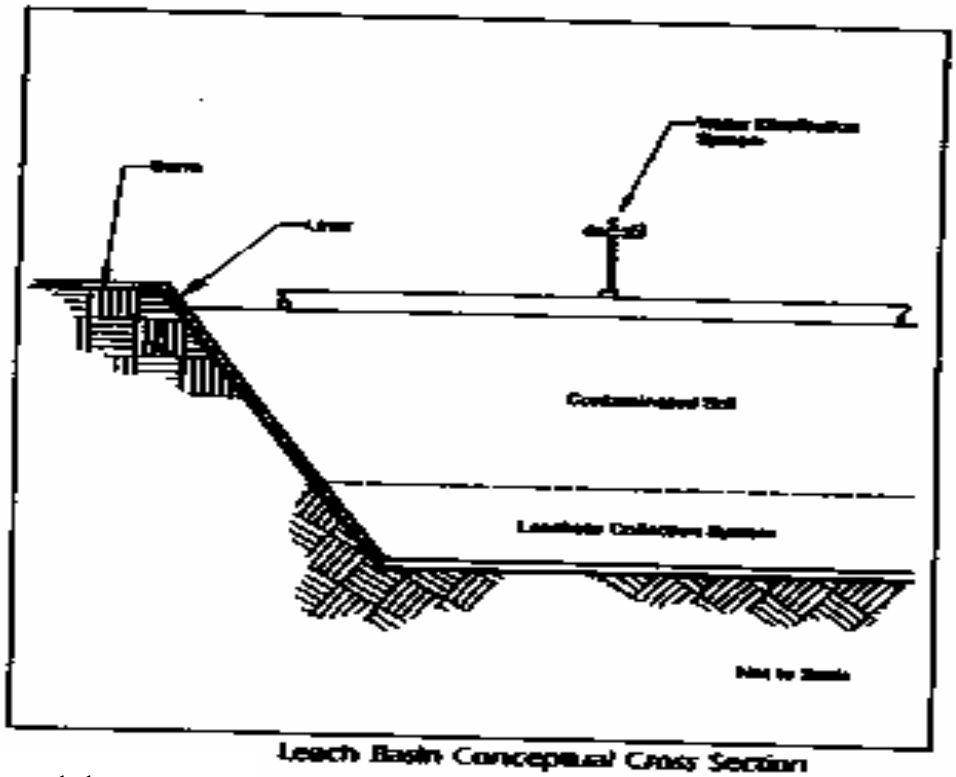
Extent of Groundwater Above Cleanup Action Levels

Figure 10

SITE A (Operable Unit 1)



Schematic of Leach Basin Location and Layout

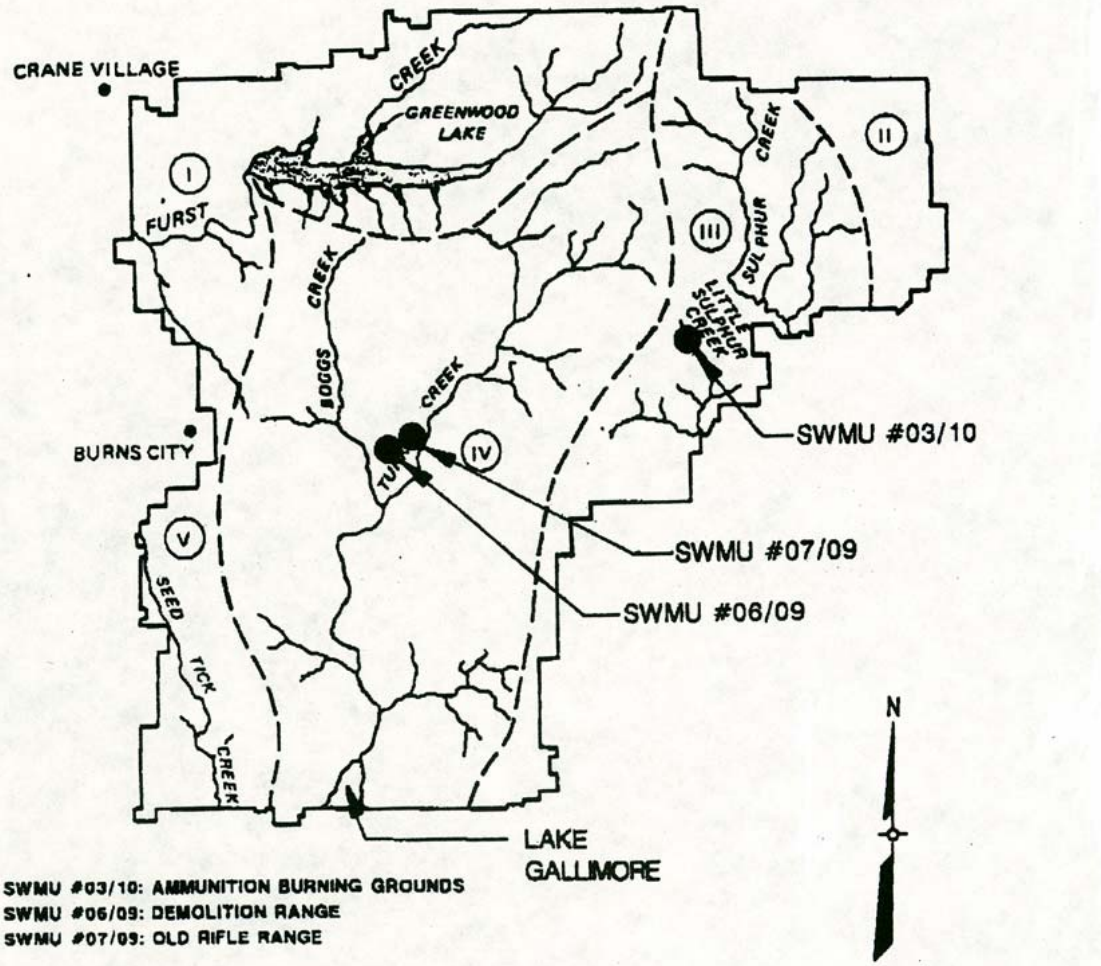


Leach Basin Conceptual Cross Section

Figure 11

CLEAN CTO #0076

EPA ID NO. IN5 170 023 498
NAVSURFWARCENDIV RA WP
JULY 1995



SWMU #03/10: AMMUNITION BURNING GROUNDS
SWMU #06/09: DEMOLITION RANGE
SWMU #07/09: OLD RIFLE RANGE

SOURCE: CHESAPEAKE DIVISION NAVAL FACILITIES COMMAND, 1979

RUST ENVIRONMENT & INFRASTRUCTURE

JULY 1995 FIGURE 3-2 20615

SURFACE DRAINAGE BASINS
RISK ASSESSMENT WORK PLAN
NAVSURFWARCENDIV
CRANE, INDIANA

Figure 13

Groundwater Results (ug/L)
SW-846 Method 8330
QST Laboratory

Sample	Extraction	2-amino	4-Amino	DNB	2,4-DNT	2,6-DNT	HMX	NB	2-NT	3-NT	RDX	Tetryl	TNB	TNT
Standards														
FLS-01	SO		0.049 Q											0.96
FLS-02	SO													7.64
FLS-03	DI													91.1
FLS-04	DI													960
FLS-05	DI													5230
FLS-06	SPE										1.14 J			
FLS-07	SPE										8.97 J			
FLS-08	DI										96.6			
FLS-09	DI										1110			
FLS-10	DI										5220			
FLS-11	DI												91.9	
FLS-12	DI				79									
FLS-13	DI	44.2												
FLS-14	DI												95.5	97
FLS-15	DI				82.7									92.5
FLS-16	DI	43.7												92
FLS-17	DI				82.9								96	94.1
FLS-18	DI	36.6											92.5	86.8
FLS-19	DI						119							
FLS-20	DI						125				87.1			
FLS-21	DI										94.1			94.1
FLS-22	DI						166				90.5			92.5
FLS-24	DI												104	94.6

Groundwater Results (ug/L)
SW-846 Method 8330
QST Laboratory

Sample	Extraction	2-amino	4-Amino	DNB	2,4-DNT	2,6-DNT	HMX	NB	2-NT	3-NT	RDX	Tetryl	TNB	TNT
Bangor														
BET-1	SPE										6.91 J		0.113 J	
INF-1	SO										429 J		0.718 J	1.9 J
INF-2	SO				0.35 J						445 J		0.766 J	1.6 J
EW-2	SO	0.054				0.213	29.5				356		7.31	24
EW-3	SPE	2.42 J	4.59 J	0.503 J	11.1 J	2.11 J	83.7 J				496 J		7.96 J	263 J
EW-4	SO										261		0.059	0.068
EW-5	SPE										186 J		3.08 J	0.057 J
EW-6	SO										419 J		0.202 J	
EW-7	SO	2.46		3.06	34	2.19	183				147		283	977 J
EW-8	SO		0.065 J				3.3				562		0.893	0.073 J
EW-9	SO										700 J		0.517 J	
EW-10	SO										922		0.616	
Umatilla														
4-25	SPE										20.9			
SB-3	SPE										14.2		0.152	
WO-22	SPE		0.372			0.094	73.2				14			0.21
4-112	SPE	1.35	4.69		3.79	0.665	89.1				15.3	0.948	615	164
4-24	SPE										39.2			
4-7	SPE						0.637				132		0.068	
4-114	SPE	0.314	0.32		1.31	0.299	29.4				16.4	0.123	133	93.9
4-114D	SPE	0.695			1.28		33.7				16.8		132	93.9
WO-24	SPE		0.083								470		0.222	
4-111	SPE	0.559	0.791		0.336		78.2	0.542			19.1		18.9	94.3
4-113	SPE	0.274	1.47		1.36		35.3	0.394			8.68	0.193	173	62.6
WO-21	SPE		1.37			0.474	23.7				389		0.396	
009	SPE	10.3			1.32		294	2.38			189		434	1160
4-3	SPE										133			0.072
4-117	SPE										209			
4-102	SPE	5.3	14.2				359				402		5.74	367
EW-1	SPE	2.11	6.45		0.266	1.41	350	2.91			450		0.263	126
EW-3	SPE	5.68			3.68		305				112		225	846
EW-4	SPE						1.53				1020		0.179	0.447
CI1	SPE	1.21	1.55		0.156		129	0.738			1180		33.1	138
CI2	SPE	1.27	3.76		0.778		124				1090		32	133

Groundwater Results (ug/L)
SW-846 Method 8330
QST Laboratory

Sample	Extraction	2-amino	4-Amino	DNB	2,4-DNT	2,6-DNT	HMX	NB	2-NT	3-NT	RDX	Tetryl	TNB	TNT
Crane NSWC														
03C03P2	SPE	8.39	10.8	0.089	0.063	1.8	70.8				678		12.5	4.27
03C09P2	SPE	0.084	0.246			0.697	2.73				146		0.058	
03C08AP2	SPE	3.04	4.45				38.2				126			
03C10	SPE	0.115	0.6			0.446	4.95				121			
03C12	SPE						27.8		0.131		25.6			
03C04	SPE									0.369				
SPRING2	SPE	2.77	5.02			0.102	28.2				124		0.272	3.33 J
10-08	SPE	13.1	14.2		0.292		64.6				23.8			0.98 J
10-07	SPE	6.57	6.91				69.7				28.6			1.21 J
SPRING	SPE	2.87	5.21			0.094	26.4				119		0.271	3.16 J
20-08	SPE	12.3	13.8		0.168		58.9				24.9			1.58 J
10C55P2	SPE	23.8	34		0.543	0.875	75.2				51.3		1.33	22.1 J
10C37	SPE													
10C55	SPE	2.25	2.64 Q		0.402	1.15	33.8				184		2.89	50.8 J
03-34	SPE	1.05	1.59				47.9				41			
10-17	DI	12.6 J	10.3 J				95.8 J				35.2 J			21.5 J
10C57	SPE													

SO = Salting Out Extraction
SPE = Solid Phase Extraction
DI = Direct Injection Method
J = Estimated value, see validation report for explanation
Q = Unable to confirm presence of compound due to interference, see validation report for explanation.
Blank indicates a non-detect. See attached table for detection limits.

Detection Limits (ug/L) SW-846 Method 8330 QST Laboratory			
	Extraction Method		
Compound	Salting Out (SO)	Solid Phase (SPE)	Direct Injection (DI)
4-amino-2, 6-Dinitrotoluene	0.042	0.051	4.22
2-amino-4, 6-Dinitrotoluene	0.041	0.049	4.08
1,3-Dinitrobenzene	0.040	0.048	4.00
2,4-Dinitrotoluene	0.030	0.036	3.01
2,6-Dinitrotoluene	0.040	0.048	3.98
HMX	0.081	0.097	8.10
Nitrobenzene	0.045	0.054	4.50
2-Nitrotoluene	0.079	0.095	7.89
3-Nitrotoluene	0.087	0.104	8.69
4-Nitrotoluene	0.080	0.096	8.00
RDX	0.080	0.096	8.03
Tetryl	0.046	0.055	4.62
1,3,5-Trinitrobenzene	0.040	0.048	3.99
2,4,6-Trinitroluene	0.042	0.050	4.19

Anticipated Standards Concentrations (ug/L) Manchester Laboratory							
Sample	**Extraction**	**2-amino**	**2,4-DNT**	**HMX**	**RDX**	**TNB**	**TNT**
Standards							
FLS-01	SO						1
FLS-02	SO						10
FLS-03	DI						100
FLS-04	DI						1000
FLS-05	DI						5000
FLS-06	SPE				1		
FLS-07	SPE				10		
FLS-08	DI				100		
FLS-09	DI				1000		
FLS-10	DI				5000		
FLS-11	DI					100	
FLS-12	DI		100				
FLS-13	DI	100					
FLS-14	DI					100	100
FLS-15	DI		100				100
FLS-16	DI	100					100
FLS-17	DI		100			100	100
FLS-18	DI	100				100	100
FLS-19	DI			100			
FLS-20	DI			100	100		
FLS-21	DI				100		100
FLS-22	DI			100	100		100
FLS-24	DI					100	100

Groundwater Results (ug/L) Crange NSWC SW-846 Method 8021	
Sample	**TCE**
03C03P2	168
03C09P2	101
03C08AP2	62.9
03C08AP2D	61.1
03C10	60.6
03C12	15.6
03C04	<1.00
03-34	2.83

Detection of Explosives (RDX Immunoassay)

SUBASE Bangor, Manchester, WA

Bangor RDX Flow Immunosensor FLS samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
FLS-6														
1rdx77	1rdx_1	45	94	423	RDX	used as std.	0.83	0.26	31%	0.36	N	1.14	1	-13%
	1rdx_2	45	94	356	RDX	0.84								
	1rdx_3	45	95	467	RDX	1.1								
	1rdx_4	49	92	411	RDX	0.97								
	1rdx_5	44	108	447	RDX	1.05								
	1rdx_6	44	94	280	RDX	0.66								
	1rdx_7	46	99	177	RDX	0.41								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
FLS-7														
10rdx77	7105645	46	90	947	RDX		7.84	1.75	22%	0.32	N	8.97	8	-11%
	10rdx_2	46	102	743	RDX	used as std.								
	10rdx_3	45	93	643	RDX	8.6								
	10rdx_4	46	100	587	RDX	7.9								
	10rdx_5	46	90	522	RDX	7								
	10rdx_6	46	100	760	RDX	10.2								
	10rdx_7	45	87	409	RDX	5.5								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
FLS-8														
100 ppb RDX	fls08_1	20	132	6410	RDX	Used as std.	113	8.16	7.20%		Y	96.6	113	16%
	fls08_2	19	161	7151	RDX	112								
	fls08_3	20	148	6871	RDX	107								
	fls08_4	21	202	11023	RDX	172				0.75				
	fls08_5	17	200	7869	RDX	123								
	fls08_6	18	196	7386	RDX	115								
	fls08_7	20	202	7576	RDX	118								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
FLS-9														
1krdx77	1krdx_1	37	149	111555	RDX	3507	822	77	9.40%	0.93	Y	1110	822	-30%
	1krdx_2	18	289	31807	RDX	Used as std.								
	1krdx_3	15	221	29119	RDX	915								
	1krdx_4	15	275	28194	RDX	886								
	1krdx_5	19	271	25070	RDX	788								
	1krdx_6	21	290	25465	RDX	800								
	1krdx_7	21	282	23022	RDX	723								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
FLS-10														
5khmx77	5krdx_1	48	151	117720	RDX	8929	3980	390	9.70%	0.81	Y	5220	3980	-27%
	5krdx_2	18	310	65920	RDX	Used as std.								
	5krdx_3	16	307	58407	RDX	4430								
	5krdx_4	18	309	55851	RDX	4230								
	5krdx_5	16	308	52492	RDX	3980								
	5krdx_6	19	307	51065	RDX	3870								
	5krdx_7	19	308	44727	RDX	3390								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
FLS-19														
100hmx77	100hmx_1	46	147	680	RDX	used as std.	65.7	31.8	48%	0.2	N	BDL	66	#VALUE!
	100hmx_2	49	147	646	RDX	95						(HMX is 119)		
	100hmx_3	47	142	557	RDX	81.9								
	100hmx_4	49	146	418	RDX	61.4								
	100hmx_5	40	132	414	RDX	60.8								
	100hmx_6	45	140	599	RDX	88								
	100hmx_7	49	141	457	RDX	67.2								
	10rdx_1a	30	107	193.4	RDX									
	10rdx_1b	32	94	269	RDX									
	10rdx_1c	40	109	203	RDX									

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
FLS - 20														
100 ppb RDX, HMX	fls08_1	20	273	9566	RDX	Used as std.	97.8	3.83	3.90%	0.016	N	87.1	98	12%
	fls20_2	22	268	9054	RDX	100								
	fls20_3	20	272	9004	RDX	99.4								
	fls20_4	21	271	9117	RDX	100.6								
	fls20_5	21	264	9137	RDX	100.9								
	fls20_6	23	272	8354	RDX	92.2								
	fls20_7	24	276	8488	RDX	93.7								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
FLS-21														
1crdxtnt	100_1	23	181	8281	RDX	Used as std.	124	30.5	24.50%	0.15	N	94.1	124	27%
	100a_1	18	262	13799	RDX	166								
	100a_2	21	272	11584	RDX	139								
	100a_3	16	274	12654	RDX	153								
	100a_4	14	278	8152	RDX	98.4								
	100a_5	15	270	9634	RDX	116								
	100a_6	11	265	6651	RDX	80.3								
	100a_7	13	289	9367	RDX	113								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
FLS - 22														
TNT, RDX, HMX 100 ppb	fls22_1	22	268	8436	RDX	Used as std.	94.3	12.1	12.80%	0.072	N	90.5	94	4%
	fls22_2	23	265	9394	RDX	111								
	fls22_3	27	276	8790	RDX	104								
	fls22_4	24	268	7060	RDX	83.6								
	fls22_5	25	273	7165	RDX	84.9								
	fls22_6	24	269	6979	RDX	82.7								

Bangor, RDX, Flow, Effluent and Influent samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
eff1_77														
	eff1_1	ND			RDX	ND				ND	ND	n/a	ND	n/a
	eff1_2	ND			RDX									
	eff1_3	ND			RDX									
	eff1_4	ND			RDX									
	eff1_5	ND			RDX									
	eff1_6	ND			RDX									
	eff1_7	ND			RDX									

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
Inf1_78														
	100rdx4	47	150	15158	RDX	Used as std.	114	41	36%	0.92	Y	429	114	-116.02%
	100rdx3	45	123	4471	RDX									
	inf1_1	44	148	19086	RDX	126								
	inf1_2	40	151	22092	RDX	146								
	inf1_3	42	150	201852	RDX	131								
	inf1_4	42	150	26294	RDX	173								
	inf1_5	51	157	11558	RDX	76								
	inf1_6	33	148	12780	RDX	84								
	inf1_7	46	150	11535	RDX	76								

Bangor RDX Flow Immunosensor EW samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
ew2_710														
	ew2_1	36	210	9184	RDX	105	124	8.9	7.20%		N	356	124	-97%
	ew2_2	35	252	11135	RDX	128								
	ew2_3	33	201	11180	RDX	128								
	ew2_4	35	208	11017	RDX	126								
	ew2_5	36	227	10429	RDX	119								
	ew2_6	37	252	11221	RDX	129								
	ew2_7	38	204	10058	RDX	115								
	RDX100_3 = 8731													

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
ew2_78														
	ew2_1	335	150	12197	RDX	140	116	36	31%					
	ew2_2	36	127	11764	RDX	135								
	ew2_3	37	143	5397	RDX	62								
	ew2_4	36	151	11054	RDX	127								
	ew2_5	35	140	-226	RDX									
	rdx100_3	40	150	8731.3	RDX	Used as std.								
	rdx100_4	22	243	18574	RDX									

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
ew2_79														
	rdx100_1	30	150	78156	RDX									
	rdx100_2	22	440	21817	RDX									

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
ew3_78														
	ew3_1	42	116	8193	RDX	63	77	8.4	11%	0.26	N	496	77	-146%
	ew3_2	25	141	10135	RDX	78								
	ew3_3	34	149	10687	RDX	82								
	ew3_4	33	149	11606	RDX	89								
	ew3_5	34	149	10517	RDX	81								
	ew3_6	37	149	9099	RDX	70								
	ew3_7	39	149	9977	RDX	77								
	rdx100_	38	151	13022	RDX	Used as std.								
	rdx100_2	40	150	7670	RDX									

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc.	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
ew4_77														
	ew4_1	34	111	1973	RDX	21	64	29	45%	0.216	N	261	64	-121%
	ew4_2	33	127	3534	RDX	37								
	ew4_3	33	138	4352	RDX	46								
	ew4_4	20	173	7289	RDX	77								
	ew4_5	23	197	8315	RDX	87								
	ew4_6	21	199	7953	RDX	84								
	ew4_7	23	197	9016	RDX	95								
	rdx100_1	22	188	9518	RDX	Used as std.								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330	Fast 2000	RPD
ew5_77														
	ew5_1	16	306	7287	RDX	388	345.29	55.17				186	345	60%
	ew5_2	15	307	5069	RDX	270								
	ew5_3	17	308	7075	RDX	377								
	ew5_4	17	302	5076	RDX	271								
	ew5_5	19	301	6575	RDX	351								
	ew5_6	17	310	6562	RDX	350								
	ew5_7	18	308	7683	RDX	410								
	100rdx_1	44	305	1876	RDX	used as std.								
	1krdx_1	21	306	34742	RDX									

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
ew6_77														
	10_1	15	28	674	RDX		315	204	65%	0.12	N	419	315	-28%
	100_1	23	309	5912	RDX	Used as std.								
	ew6_1	12	262	13831	RDX	234								
	ew6_2	19	252	13770	RDX	233								
	ew6_3	28	310	25566	RDX	433								
	ew6_4	48	310	35474	RDX	600								
	ew6_5				RDX									
	ew6_6	93	306	4378	RDX	74								
	ew6_7	20	250	159	RDX	2.6								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
ew7_77														
	100ng_2	14	282	8910	RDX	Used as std.	67.6	9.6	14%	0.32	N	147	67.6	-74%
	ew7_1	20	254	6795	RDX	76								
	ew7_2	19	282	7554	RDX	85								
	ew7_3	20	280	6012	RDX	67								
	ew7_4	16	270	5601	RDX	63								
	ew7_5	19	268	5544	RDX	62								
	ew7_6	20	286	5624	RDX	63								
	ew7_7	20	293	5068	RDX	57								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
ew8_797														
	100_2	18	84	2513			579	99.6	17%	0.17	N	562	579	3%
	1000_1	15	279	26602		Used as std.								
	ew8_1	12	296	18759		705								
	ew8_2	21	289	15482		582								
	ew8_3	11	253	17564		660								
	ew8_4	19	285	16980		638								
	ew8_5	19	260	11834		445								
	ew8_6	15	296	15158		570								
	ew8_7	17	273	12088		454								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
ew9_78														
	ew9_1	23	304	21268	RDX	531	799	383	48%	0.16	N	700	799	13%
	ew9_2	23	241	19400	RDX	484								
	ew9_3	24	245	19956	RDX	498								
	ew9_4	39	309	48459	RDX	1209								
	ew9_5	53	307	53994	RDX	1347								
	ew9_6	82	304	29148	RDX	727								
	ew9_7	no peak			RDX									
	ew9_8	no peak			RDX									
	st1000_1	24	307	40074	RDX									
	st1000_2	30	306	43797	RDX									

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
ew10_797														
	ew1_7	no peak			RDX		478	112	23%	0.7	Y	922	478	-63%
	ew10_1	20	286	15120	RDX	377								
	ew10_2	19	292	16360	RDX	408								
	ew10_3	22	290	17394	RDX	434								
	ew10_4	20	307	20694	RDX	516								
	ew10_5	26	300	26267	RDX	655								
	ew10_6	45	306	52387	RDX	1307								
	RDX1000 = 40074													

Bangor RDX Flow Immunosensor BET samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
bet1_78														
	bet1_1	81	151	4690	RDX	57.50	25.51	16.30	44%	0.69	Y	6.91	25.51	115%
	bet1_2	60	123	2000	RDX	24.5								
	bet1_3	69	131	1270	RDX	15.5								
	bet1_4	4	56	2865	RDX	35.1								
	bet1_5	25	59	1763	RDX	21.6								
	bet1_6	25	60	831	RDX	10.1								
	bet1_7	15	60	1773	RDX	14.3								
	10rdx1	108	139	695	RDX									
	100rdx1	23	114	10001	RDX									
	100rdx2	38	124	8149	RDX	Used as std.								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	Q Value	Reject	QST 8330 (ppb)	Fast 2000 (ppb)	RPD
bet2_78														
	bet2_1	33	90	468	RDX	12.4	9.8	3	30.60%	N	ND	n/a	9.8	n/a
	bet2_2	34	71	382	RDX	10								
	bet2_3	39	82	281	RDX	7.4								
	bet2_4	39	75	523	RDX	14								
	bet2_5	34	58	287	RDX	7.6								
	bet2_6	32	60	211	RDX	5.6								
	bet2_7	31	54	458	RDX	12								
	rdx10_1	40	78	376	RDX	Used as std.								
	rdx10_2	43	79	277	RDX									

Detection of Explosives (TNT Immunoassay)

Bangor SUBASE, Manchester, WA

Flow Immunosensor, TNT, EW samples

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
ew2														
	ew2_1	35	78	246	TNT	49	49	9.1	18.50%			24	49	68%
	ew2_2	33	71	215	TNT	42								
	ew2_3	37	88	306	TNT	60								
	ew2_4	33	75	326	TNT	64								
	ew2_5	37	73	226	TNT	45								
	ew2_6	35	69	208	TNT	45								
	ew2_7	36	74	225	TNT	44								
	100tnt_1	43	90	506	TNT	std. used								
	100tnt_2	45	105	169	TNT	n/a								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
ew3														
	ew3_1	16	62	1552	TNT	104	168	35.6	21.20%			263	168	-44%
	ew3_2	37	145	2499	TNT	168								
	ew3_3	36	115	2576	TNT	173								
	ew3_4	34	118	2508	TNT	159								
	ew3_5	33	137	2453	TNT	165								
	ew3_6	36	131	2551	TNT	171								
	ew3_7	39	138	3373	TNT	227								
	100ppb	38	137	2551	TNT	n/a								
	1000ppb	1045	139	1488	TNT	std. used								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
ew4														
	ew4_1	35	50	110	TNT	62	57	19.8	34.60%			0.068	57	200%
	ew4_2	35	55	128	TNT	72								
	ew4_3	37	51	91	TNT	51								
	ew4_4	41	62	122	TNT	69								
	ew4_5	41	55	60	TNT	34								
	ew4_6	33	58	148	TNT	83								
	ew4_7	40	58	53	TNT	30								
	tnt10_1	36	76	270	TNT	n/a								
	std100_7	39	100	178	TNT	std. used								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
ew5														
	ew5_1	37	56	539	TNT	44	13	5.8	45%	0.61	Y	0.057	13	198%
	ew5_2	37	55	216	TNT	18								
	ew5_3	34	57	270	TNT	22								
	ew5_4	36	48	114	TNT	9								
	ew5_5	21	47	132	TNT	11								
	ew5_6	29	48	115	TNT	9								
	ew5_7	32	51	98	TNT	8								
	std100_1	36	136	1237	TNT	std. used								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
ew6														
	ew6_1	37	91	566	TNT	76	45	18.2	40.90%			n/a	45	n/a
	ew6_2	37	105	452	TNT	61								
	ew6_3	33	83	344	TNT	46								
	ew6_4	38	61	190	TNT	26								
	ew6_5	34	63	304	TNT	41								
	ew6_6	35	64	242	TNT	33								
	ew6_7	31	63	216	TNT	29								
	std100_1	36	117	742	TNT	std. used								
	std100_2	37	95	409	TNT	n/a								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
ew7														
	ew7_1	42	146	18309	TNT	2184	1608	303.9	18.90%			977	1608	49%
	ew7_2	41	150	15502	TNT	1849								
	ew7_3	41	148	12749	TNT	1521								
	ew7_4	39	150	10973	TNT	1308								
	ew7_5	40	149	9236	TNT	1520								
	ew7_6	38	150	8758	TNT	1446								
	ew7_7	41	151	8668	TNT	1427								
	1ktnt_1	39	147	8384	TNT	std. used 1-4								
	1ktnt_2	40	149	60075	TNT	std. used 5-7								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
ew8														
	ew8_1	40	77	671	TNT	62	79	15	19%			0.073	79	200%
	ew8_2	34	90	943	TNT	88								
	ew8_3	33	110	946	TNT	88								
	ew8_4	37	93	568	TNT	53								
	ew8_5	33	112	963	TNT	90								
	ew8_6	39	103	875	TNT	81								
	ew8_7	39	103	943	TNT	88								
	100tnt_3	33	126	1075	TNT	std. used								
	100tnt_4	40	119	598	TNT	n/a								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
ew9														
	ew9_1	43	100	311	TNT		690	427.9	62%			n/a	690	n/a
	ew9_2	38	60	111	TNT									
	ew9_3	38	111	929	TNT									
	ew9_4	33	110	612	TNT									
	ew9_5	37	119	1432	TNT									
	ew9_6	33	120	808	TNT									
	ew9_7	32	95	608	TNT									

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
ew10														
	ew10_1	39	77	372	TNT	24	39	21.6	56.10%	0.93	Y	n/a	39	n/a
	ew10_2	36	76	369	TNT	24								
	ew10_3	42	72	280	TNT	18								
	ew10_4	42	99	1054	TNT	68								
	ew10_5	42	100	976	TNT	63								
	ew10_6	98	145	11987	TNT	773								
	ew10_7	34	80	523	TNT	34								
	100	44	117	1550	TNT	std. used								
	1000	35	89	1990	TNT	n/a								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
inf_1														
	inf_1	34	58	233	TNT	15	16	2.8	17.30%			1.9	16	158%
	inf_2	36	64	223	TNT	15								
	inf_3	35	62	201	TNT	13								
	inf_4	24	62	264	TNT	17								
	inf_5	34	65	196	TNT	13								
	inf_6	39	72	300	TNT	20								
	inf_7	35	73	283	TNT	19								
	10tnt_3	45	93	133	TNT	n/a								
	10tnt_4	41	107	152	TNT	std. used								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
eff1_714														
	eff1_1	35	60	316	TNT	BDL	91	12	13.30%	0.77	Y	n/a	91	n/a
	eff1_2	35	60	78	TNT	BDL								
	eff1_3	35	60	80	TNT	BDL								
	eff1_4	35	60	105	TNT	BDL								
	eff1_5	35	82	102	TNT	BDL								
	eff1_6	35	60	82	TNT	BDL								
	eff1_7	35	52	97	TNT	BDL								
	blk_1	35	60	43	TNT	BDL								

Bangor SUBASE
TNT, flow, fls samples

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-1														
1ppb TNT	1_1	35	82	1487		1	1	0.14	15.70%			0.96	1	-4.08%
	1_1_11b3	21	60	244	TNT	n/a								
	1_1	35	110	1459	TNT	std. used								
	1_2_11b3	36	81	158	TNT	n/a								
	1_4	35	120	1175	TNT	1								
	1_4_11b3	23	62	95	TNT	n/a								
	1_5	35	107	1522	TNT	1								
	1_5_11b3	30	80	62	TNT	n/a								
	1_6	36	92	1262	TNT	0.8								
	1_6_11b3	32	65	47	TNT	n/a								
	1_7	37	109	1021	TNT	0.7								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-2														
10ppb TNT	fls2_1	38	78	484	TNT	37	15	12.1	19.40%			7.64	15	-65.02%
	fls2_2	36	66	ND	TNT									
	fls2_3	38	77	144	TNT	11								
	fls2_4	40	73	99	TNT	8								
	**fls2_5	41	82	132	TNT	10								
	fls2_6	40	87	164	TNT	12								
	fls2_7	38	76	114	TNT	9								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-3														
100ppb TNT	fls3_1	36	78	926	TNT	std. used	105	52.6				91.1	105	-14.18%
	fls3_2	45	113	1512	TNT	163								
	fls3_3	44	138	1499	TNT	162								
	fls3_4	48	125	542	TNT	59								
	fls3_5	46	106	720	TNT	78								
	fls3_6	45	108	576	TNT	62								
	fls3_7	41	113	461	TNT	50								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls_3														
blank	blnk_1	33	119	10538	TNT	21								
	blnk_2	84	126	1642	TNT	6								
	blnk_3	83	109	1541	TNT	11								
	100tnt_1	38	281	51306	TNT	std. for 1								
	100tnt_2	77	279	28808	TNT	std. for 2								
	100tnt_3	41	199	14345	TNT	std. for 3								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-4														
1000ppb TNT	fls4_1	33	151	5219	TNT	3318	965	1102.6	114.30%			960	965	1%
	fls4_2	35	150	4331	TNT	2753								
	fls4_3	41	116	1573	TNT	std. used								
	fls4_4	37	134	1570	TNT	998								
	fls4_5	32	144	2004	TNT	1274								
	fls4_6	13	108	1488	TNT	946								
	fls4_7	43	132	1008	TNT	641								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-5														
5000ppb TNT	fls5_1	33	114	1971	TNT	3638	4097	1717.9	41.90%			5230	4097	-24%
	fls5_2	38	139	2075	TNT	3830								
	fls5_3	41	150	3071	TNT	5668								
	fls5_4	39	142	1754	TNT	3237								
	fls5_5	37	139	2709	TNT	std. used								
	fls5_6	37	150	3510	TNT	6478								
	fls5_7	38	97	938	TNT	1731								

NOT USED

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-5														
5000 ppb TNT	5000_1	30	271	23544	TNT	9964	6201	5137	78.10%					
	***5000_2	42	270	11815	TNT	5000								
	5000_3	22	247	7839	TNT	3317								
	5000_4	21	297	8747	TNT	3702								
	5000_5	24	311	35437	TNT	14997								
	5000_6	19	212	5603	TNT	2371								
	5000_7	26	283	6750	TNT	2857								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-11														
TNB 100ppb	100_1	40	149	3468	TNT		1877.4	850.6	45.30%			-	1877.4	-
	100_2	40	148	2534	TNT									
	100_3	41	149	1930	TNT									
	100_4	40	146	1479	TNT									
	100_5	40	151	1291	TNT									
	100_6	40	149	1293	TNT									
	100_7	41	147	1147	TNT									

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-12														

100 DNT	100_1	44	93	490	TNT	160	95	32.2	33.90%			-	95	-
	100_2	38	101	349	TNT	114								
	100_3	42	96	240	TNT	78								
	100_4	45	101	306	TNT	std. used								
	100_5	43	109	217	TNT	71								
	100_6	42	110	216	TNT	71								
	100_7	40	105	264	TNT	86								
	100_8	36	106	259	TNT	85								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-13														
	fls13_1	43	72	889	TNT	84	48.6	31.3	64.40%			n/a	48.6	n/a
	fls13_2	40	78	873	TNT	83								
	fls13_3	35	84	661	TNT	63								
	fls13_4	42	77	278	TNT	26								
	fls13_5	34	73	133	TNT	13								
	fls13_6	33	81	130	TNT	12								
	fls13_7	24	113	624	TNT	59								
	100tnt_1	44	120	1052	TNT	std. used								
	100tnt_2	35	137	1153	TNT	n/a								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-14														
	fls14_1	40	148	5396	TNT	std. used	99.7	39.2	39.40%			97	99.7	3%
	fls14_2	33	150	7775	TNT	144								
	fls14_3	34	151	8132	TNT	151								
	fls14_4	45	150	5413	TNT	100								
	fls14_5	43	149	3849	TNT	71								
	fls14_6	41	151	3457	TNT	64								
	fls14_7	38	150	3692	TNT	68								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-15														
TNT, 2,4-DNT	fls15_1	36	79	880	TNT		558	204.3	36.60%			92.5	558	143%
100ppb	fls15_2	36	104	764	TNT									
	fls15_3	37	76	599	TNT									
	fls15_4	36	72	501	TNT									
	fls15_5	35	75	444	TNT									
	fls15_6	37	80	417	TNT									
	fls15_7	36	74	300	TNT									

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-16														
	fls16_1	43	96	359	TNT		112.1	13.4	12%			92	112.1	20%
	fls16_2	40	124	617	TNT									
	fls16_3	36	104	412	TNT									
	fls16_4	34	110	484	TNT									
	fls16_5	30	116	316	TNT									
	fls16_6	33	102	392	TNT									
	fls16_7	35	111	534	TNT									

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-17														
100 mix	100_1	35	148	1827	TNT	1007	111.9	11.1				94.1	111.8	17%
TNT,TNB, 2,4 DNT	100_2	43	150	1101	TNT									
100ppb	100_3	45	149	1149	TNT									
	100_4	45	148	1006	TNT									
	100_5	43	145	861	TNT									
	100_6	47	149	1027	TNT									
	100_7	51	149	898	TNT									

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-18														
100 mix b	100_1	47	149	5877	TNT		2996.6	1579.5	52.70%			86.8	2996.6	189%
TNT,TNB,2 amino-DNT	100_2	47	148	4134	TNT									
100ppb	100_3	44	147	2906	TNT									
	100_4	56	149	2007	TNT									
	100_5	42	141	2930	TNT									
	100_6	40	148	1925	TNT									
	100_7	43	97	1197	TNT									

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
fls-21														
100 TNT/RDX	100_1	38	113	526	TNT		379.1	101.5	26.80%			94.1	379.1	120%
100ppb	100_2	46	148	305	TNT									
	100_3	46	150	375	TNT									
	100_4	41	146	336	TNT									
	100_5	46	143	399	TNT									
	100_6	48	148	231	TNT									
	100_7	38	139	482	TNT									

Bangor SUBASE
Flow Immunosensor, TNT, bet samples

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
bet1														
	bet1_1	43	106	115	TNT	BDL	BDL	BDL				n/a	BDL	n/a
	bet1_2	40	106	-121	TNT	BDL								
	bet1_3	40	100	-16	TNT	BDL								
	bet1_4	40	100	128.2	TNT	BDL								
	bet1_5	40	100	24.1	TNT	BDL								
	bet1_6	40	100	20	TNT	BDL								
	bet1_7	40	100	-19	TNT	BDL								
	tnt10_1	40	100	-59	TNT	BDL								

Sample	Injection #	Start	End	Integral	Analysis	TNT Conc. (ppb)	Mean	Std. Dev.	RSD	Q value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
bet2														
	bet2_1	35	80	0	TNT	BDL	BDL			0.62	Y	n/a	BDL	n/a
	bet2_2	33	73	176	TNT	3.7								
	bet2_3	33	70	421	TNT	8.9								
	bet2_4	33	67	359	TNT	7.6								
	bet2_5	33	66	420	TNT	8.9								
	bet2_6	32	70	400	TNT	8.5								
	bet2_7	36	68	367	TNT	7.8								

Detection of Explosives (RDX Immunoassay)

CraneNSWC

Date: September 6, 1997

Crane RDX Flow Immunosensor, Numbered samples

03C samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
03c03														
	03c03_1.dat	38	296	19636	RDX	442	504	35				678	504	-29%
	03c03_2.dat	38	295	21938	RDX	494								
	03c03_3.dat	36	296	21456	RDX	482								
	03c03_4.dat	36	295	24514	RDX	552								
	03c03_5.dat	38	298	22363	RDX	503								
	03c03_6.dat	36	296	23344	RDX	509								
	03c03_7.dat	37	297	24971	RDX	545								
	10rdx_1.dat	34	213	2917	RDX	10								
	100rdx_1.dat	35	291	18412	RDX	100								
	100rdx_2.dat	37	260	16699	RDX	100								
	1krdx_1.dat	35	298	44442	RDX	1000								
	1krdx_2.dat	37	298	45848	RDX	1000								
	1krdx_3.dat	35	298	48350	RDX	1000								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
03c04														
	03c04r_1.dat	n/a	n/a	none	RDX	BDL	BDL	BDL				n/a	BDL	n/a
	03c04r_2.dat	n/a	n/a	none	RDX	BDL								
	03c04r_3.dat	n/a	n/a	none	RDX	BDL								
	03c04r_4.dat	n/a	n/a	none	RDX	BDL								
	03c04r_5.dat	n/a	n/a	none	RDX	BDL								
	03c04r_6.dat	n/a	n/a	none	RDX	BDL								
	03c04r_7.dat	n/a	n/a	none	RDX	BDL								
	rdx1n1.dat	17	52	208	RDX	1								
	rdx10n1.dat	17	98	1585	RDX	10								
	rdx10n2.dat	21	67	292	RDX	10								
	rdx100n2.dat	34	374	21585	RDX	100								
	rdx100n3.dat	42	486	16393	RDX	100								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
03c08														
	03c08_1.dat	n/a	n/a	none	RDX	BDL	11.2	4.7				126	11	-168%
	03c08_2.dat	n/a	n/a	none	RDX	BDL								
	03c08_3.dat	73	129	1051	RDX	11.6								
	03c08_4.dat	69	166	2993	RDX	5.2								
	03c08_5.dat	68	187	4341	RDX	7.6								
	03c08_6.dat	68	211	8620	RDX	14								
	03c08_7.dat	69	231	10230	RDX	16.7								
	10rdx_1.dat	39	221	5739	RDX	10								
	10rdx_2.dat	44	269	6129	RDX	10								
	1krdx_1.dat	25	279	90362	RDX	1000								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
03c09														
	03c09r_1/dat	42	100	5575	RDX	467	483	62				146	483	107%
	03c09r_2.dat	41	134	5536	RDX	464								
	03c09r_3.dat	41	128	5792	RDX	485								
	03c09r_4.dat	41	169	7283	RDX	610								
	03c09r_5.dat	42	162	5929	RDX	497								
	03c09r_6.dat	41	180	5255	RDX	440								
	03c09r_7.dat	41	200	4977	RDX	417								
	10rdx_3.dat	41	150	1363	RDX	10								
	1krdx_4.dat	41	126	7344	RDX	1000								
	1krdx_5.dat	41	209	11941	RDX	1000								
	1krdx_6.dat	41	257	15105	RDX	1000								
	1krdx_7.dat	40	271	13339	RDX	1000								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
03c10														
	03c_10_1.dat	51	192	6052	RDX	145	104	41				121	104	-15%
	03c_10_2.dat	53	183	5251	RDX	126								
	03c_10_4.dat	54	184	3870	RDX	93								
	03c_10_5.dat	51	159	6320	RDX	152								
	03c_10_6.dat	48	131	1764	RDX	42								
	03c_10_7.dat	53	151	2673	RDX	64								
	rdx100_1.dat	38	249	1989	RDX	100								
	rdx100_3.dat	37	181	13860	RDX	100								
	rdx1000_2.dat	38	204	15945	RDX	1000								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
03c12														
	03c12_1.dat	38	50	285	RDX	7.6	17	7				25.6	17	-40%
	03c12_2.dat	37	51	303	RDX	8.1								
	03c12_3.dat	37	55	497	RDX	13.2								
	03c12_4.dat	38	80	817	RDX	22								
	03c12_5.dat	37	75	812	RDX	22								
	03c12_6.dat	38	90	897	RDX	24								
	03c12_7.dat38	38	76	833	RDX	22								
	10rdx_1.dat	44	75	183	RDX	10								
	100rdx_1.dat	38	76	1288	RDX	100								
	100rdx_2.dat	38	100	1122	RDX	100								
	rdx1000.dat	35	213	37575	RDX	1000								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
03_34														
	03-34r_1.dat	42	133	1226	RDX	29	23.08	9.80				41	23	-56%
	03-34r_2.dat	33	164	1262	RDX	30								
	03-34r_3.dat	41	164	1262	RDX	30								
	03-34r_4.dat	41	149	1200	RDX	28								
	03-34r_5.dat	43	170	602	RDX	14								
	03-34r_6.dat	38	121	319	RDX	7.5								
	100rdx_4.dat	45	298	14719	RDX	100								
	100rdx_5.dat	36	228	4226	RDX	100								
	100rdx_6.dat	37	249	4379	RDX	100								

10_ samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
10_07														
	10-07_1.dat	38	80	585	RDX	52	54	6.2				28.6	54	62%
	10-07_2.dat	34	86	664	RDX	59								
	10-07_3.dat	40	87	561	RDX	50								
	10-07_6.dat	37	98	565	RDX	62.3								
	10-07_7.dat	38	80	427	RDX	47								
	10rdx_2.dat	52	84	76	RDX	10								
	100rdx_3.dat	39	112	906	RDX	100								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
10_08														
	10-8_1.dat	n/a	n/a	none	RDX	BDL	BDL	-				23.8	BDL	BDL
	10-8_2.dat	n/a	n/a	none	RDX	BDL								
	10-8_3.dat	n/a	n/a	none	RDX	BDL								
	10-8_4.dat	n/a	n/a	none	RDX	BDL								
	10-8_5.dat	n/a	n/a	none	RDX	BDL								
	10-8_6.dat	n/a	n/a	none	RDX	BDL								
	10-8_7.dat	n/a	n/a	none	RDX	BDL								
	10rdx_3.dat	43	299	8640	RDX	10								
	10rdx_4.dat	61	223	4549	RDX	10								
	100rdx_1.dat	50	298	59462	RDX	100								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
10_17														
	10-17_1.dat	38	69	616	RDX	13.6	31.63	16.51				35.2	32	-10%
	10-17_2.dat	36	94	1899	RDX	42								
	10-17_3.dat	36	92	1793	RDX	39.8								
	10-17_4.dat	37	93	1774	RDX	37.4								
	10-17_5.dat	32	94	218	RDX	2.6								
	10-17_6.dat	35	105	1975	RDX	44								
	10-17_7.dat	38	89	1885	RDX	42								
	10rdx_1.dat	33	71	633	RDX	10								
	100rdx_1.dat	37	164	8342	RDX	100								
	100rdx_2.dat	n/a	n/a	n/a	RDX	100								
	rdx1000_1.dat	36	207	44980	RDX	1000								

10C samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
10c37														
	10c37_1.dat	n/a	n/a	none	RDX	BDL	BDL	BDL				n/a	BDL	n/a
	10c37_2.dat	n/a	n/a	none	RDX	BDL								
	10c37_3.dat	n/a	n/a	none	RDX	BDL								
	10c37_4.dat	n/a	n/a	none	RDX	BDL								
	10c37_5.dat	n/a	n/a	none	RDX	BDL								
	10c37_6.dat	n/a	n/a	none	RDX	BDL								
	10c37_7.dat	n/a	n/a	none	RDX	BDL								
	10rdx_5.dat	63	294	6613	RDX	10								
	10rdx_7.dat	70	193	3454	RDX	10								
	10rdx_8.dat	73	215	6802	RDX	10								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
10c55														
	10c55_1.dat	23	258	27698	RDX	120.7	184	56				184	184	0%
	10c55_2.dat	22	304	32257	RDX	140.6								
	10c55_3.dat	21	353	40500	RDX	176.6								
	10c55_6.dat	21	223	14044	RDX	235								
	10c55_7.dat	17	263	14782	RDX	247.6								
	1rdx_1.dat	24	60	126	RDX	1								
	10rdx_1.dat	25	51	224	RDX	10								
	rdx100n1.dat	43	199	22931	RDX	100								
	100rdx_2.dat	44	286	11656	RDX	100								
	1000rd_2.dat	14	338	59698	RDX	1000								
	1000rd_3.dat	16	374	56400	RDX	1000								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
10c55R														
	10c55r_1.dat	29	190	3431	RDX	34.9	47	18				51.3	47	-9%
	10c55_2.dat	35	162	2608	RDX	26.5								
	10c55r_3.dat	34	224	3842	RDX	39								
	10c55r_5.dat	38	199	4362	RDX	44.4								
	10c55r_6.dat	39	207	5037	RDX	61.3								
	10c55_r_7.dat	36	280	7253	RDX	73.8								
	10rdx_1.dat	33	179	1123	RDX	10								
	10rdx_2.dat	36	157	982	RDX	10								
	100rdx_2.dat	39	283	8738	RDX	100								
	100rdx_3.dat	41	297	9268	RDX	100								

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
10c57														
	10c57r_1.dat	28	55	1657	RDX	117	66	33				n/a	66	n/a
	10c57r_2.dat	38	64	1183	RDX	83.8								
	10c57r_3.dat	35	61	1086	RDX	76.9								
	10c57r_4.dat	37	55	619	RDX	32.9								
	10c57_6.dat	35	56	624	RDX	33.2								
	10c57_7.dat	36	61	925	RDX	49.2								
	1krdx_1.dat	39	193	11249	RDX	1000								
	1krdx_2.dat	35	208	14110	RDX	1000								
	1krdx_3.dat	36	300	18788	RDX	1000								

Spring samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean (ppb)	Std. Dev. (ppb)	RSD	Q-Value	Reject	QST 8330	FAST 2000	RPD
Spring														
	spring_1.dat	50	137	4627	RDX	111	174	78				119	174	38%
	spring_2.dat	49	146	8236	RDX	198								
	spring_3.dat	51	162	6258	RDX	151								
	spring_4.dat	49	214	7435	RDX	179								
	spring_5.dat	50	214	7352	RDX	177								
	spring_6.dat	43	170	2858	RDX	69								
	spring_7.dat	34	198	13941	RDX	336								
	rdx10_1.dat	38	62	415	RDX	10								
	rdx100_1.dat	42	113	11915	RDX	100								
	rdx1k_1.dat	38	273	36530	RDX	1000								

Detection of Explosives (TNT Immunoassay)

Crane NSWC
Date: September 6, 1997
Flow Immunosensor, Numbered samples

03c samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03co3												
	03co3_1.dat	n/a	n/a	nothing	TNT	BDL	BDL			4.27	BDL	BDL
	03co3_2.dat	n/a	n/a	none	TNT	BDL						
	03co3_3.dat	n/a	n/a	none	TNT	BDL						
	03co3_4.dat	n/a	n/a	none	TNT	BDL						
	03co3_5.dat	n/a	n/a	none	TNT	BDL						
	03co3_6.dat	n/a	n/a	none	TNT	BDL						
	03co3_7.dat	n/a	n/a	none	TNT	BDL						
	03co3_8.dat	n/a	n/a	none	TNT	BDL						
	10tnt_1.dat	17	43	316	TNT	10						
	10tnt_2.dat	15	49	253	TNT	10						
	1ktnt.dat	25	63	1298	TNT	1000						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03co4												
	03co4_1.dat	n/a	n/a	nothing	TNT	BDL	BDL			n/a	BDL	n/a
	03co4_2.dat	n/a	n/a	nothing	TNT	BDL						
	03co4_3.dat	n/a	n/a	nothing	TNT	BDL						
	03co4_4.dat	n/a	n/a	nothing	TNT	BDL						
	03co4_5.dat	n/a	n/a	none	TNT	BDL						
	03co4_6.dat	n/a	n/a	none	TNT	BDL						
	03co4_7.dat	n/a	n/a	none	TNT	BDL						
	tnt100n.dat	38	86	1811	TNT	100						
	tnt100n2.dat	n/a	n/a	none?	TNT	100						
	tnt100n3.dat	33	115	467	TNT	100						
	tnt100n4.dat	39	112	296	TNT	100						
	tnt1000n.dat	33	172	2995	TNT	1000						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03c08												
	03c08_1.dat	19	27	29	TNT	4.9	14	9.4	68%	n/a	14.0	n/a
	03c08_2.dat	16	28	63*	TNT	10.8						
	03c08_3.dat	18	27	38	TNT	6.5						
	03c08_4.dat	18	26	32	TNT	5.5						
	03c08_5.dat	11	30	161	TNT	27.5						
	03c08_6.dat	n/a	n/a	no response	TNT	BDL						
	03c08_6.dat	18	32	99	TNT	16.9						
	03c08_7.dat	17	34	146	TNT	24.9						
	10tnt_7.dat	8	34	59	TNT	10						
	100tnt_1.dat	21	(1)43	230(1030)	TNT	100						
	100tnt_2.dat	20	86	586	TNT	100 **						
	100tnt_3.dat	15	98	371	TNT	100						

* there was a sharp peak at the beginning
** Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03c09												
	03c09_1.dat (P2)	n/a	n/a	none	TNT	BDL	BDL			n/a	BDL	n/a
	03c09_2.dat (P2)	n/a	n/a	none	TNT	BDL						
	03c09_3.dat (P2)	n/a	n/a	none	TNT	BDL						
	03c09_4.dat (P2)	n/a	n/a	none	TNT	BDL						
	03c09_5.dat (P2)	n/a	n/a	none	TNT	BDL						
	03c09_6.dat(P2)	n/a	n/a	none	TNT	BDL						
	03c09_7.dat (P2)	n/a	n/a	none	TNT	BDL						
	10tnt_7.dat	38	85	792	TNT	10						
	10tnt_8.dat (P2)	38	84	480	TNT	10						
	1ktnt_2.dat	39	111	11413	TNT	1000						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03c10												
	03c10_1.dat	n/a	n/a	none	TNT	BDL	BDL			n/a	BDL	n/a
	03c10_2.dat	n/a	n/a	none	TNT	BDL						
	03c10_3.dat	n/a	n/a	none	TNT	BDL						
	03c10_4.dat	n/a	n/a	none	TNT	BDL						
	03c10_5.dat	n/a	n/a	none	TNT	BDL						
	03c10_6.dat	n/a	n/a	none	TNT	BDL						
	03c10_7.dat	n/a	n/a	none	TNT	BDL						
	10tnt_8.dat	21	48	73	TNT	10						
	10tnt_9.dat	20	61	97	TNT	10						
	10tnt_10.dat	19	40	396	TNT	10						
	1ktnt_2.dat	18	87	3692	TNT	1000						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03c12												
	03c12_1.dat	17	30	97*	TNT	5	6	3.4	55%	n/a	6.0	n/a
	03c12_2.dat	18	27	60	TNT	3.1						
	03c12_3.dat	16	27	85	TNT	4.4						
	03c12_4.dat	17	26	59	TNT	3						
	03c12_5.dat	17	28	109	TNT	5.6						
	03c12_6.dat	17	32	220	TNT	11.3						
	03c12_7.dat	18	32	208	TNT	10.7						
	10tnt_3.dat	17	46	194	TNT	10 **						
	10tnt_4.dat	17	37	28(?)	TNT	10						
	10tnt_5.dat	18	26	10(?)	TNT	10						

** Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03_34												
	03c17ns1.dat	43	56	298*	TNT	BDL	BDL			n/a	BDL	n/a
	03c17ns2.dat	43	54	142*	TNT	BDL						
	03_34_1a.dat	n/a	n/a	none	TNT	BDL						
	03_34_2.dat	n/a	n/a	none	TNT	BDL						
	03_34_3.dat	n/a	n/a	none	TNT	BDL						
	03_34_4.dat	n/a	n/a	none	TNT	BDL						
	03_34_5.dat	n/a	n/a	none	TNT	BDL						
	03_34_6.dat	n/a	n/a	none	TNT	BDL						
	03_34_7.dat	n/a	n/a	none	TNT	BDL						
	03_34_1.dat(std.)	36	117	872	TNT	100						
	tnt4.dat	37	97	3038	TNT	100						
	tnt10n2.dat	34	91	764	TNT	10						
	tnt100n4.dat	34	104	577	TNT	100						
	tnt100n5.dat	35	103	707	TNT	100						

* there was a sharp peak at the beginning

10c samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10c37												
	10c37_1.dat	n/a	n/a	none	TNT	BDL	BDL			n/a	BDL	n/a
	10c37_2.dat	n/a	n/a	none	TNT	BDL						
	10c37_3.dat	n/a	n/a	none	TNT	BDL						
	10c37_4.dat	n/a	n/a	none	TNT	BDL						
	10c37_5.dat	n/a	n/a	none	TNT	BDL						
	10c37_6.dat	n/a	n/a	none	TNT	BDL						
	10c37_7.dat	n/a	n/a	none	TNT	BDL						
	10tnt_18.dat	21	56	86	TNT	10						
	10tnt_17.dat	25	59	274	TNT	10						
	1tnt_1.dat	-	-	BDL	TNT	1						
	1tnt_2.dat	28	66	117	TNT	1						
	1ktnt_3.dat	22	73	1227	TNT	-						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10c55R												
	10c55_1.dat (P2)	n/a	n/a	none	TNT	-	BAD MEM					
	10c55_2.dat (P2)	n/a	n/a	none	TNT	-						
	10c55_3.dat	n/a	n/a	none	TNT	-						
	10c55_4.dat	n/a	n/a	none	TNT	-						
	10c55_5.dat	n/a	n/a	none	TNT	-						
	10tnt_14.dat	17	46	265	TNT	10						
	10tnt_15.dat	20	36	141	TNT	10						
	10tnt_16.dat	21	48	164	TNT	10						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10c55												
	10c55_1.dat	38	62	146	TNT	43	40.2	11.7	12%	50.8	40.0	-23.79%
	10c55_2.dat	36	65	159	TNT	46						
	10c55_3.dat	37	66	155	TNT	45						
	10c55_4.dat	35	64	123	TNT	34						
	10c55_5.dat	33	63	117	TNT	47						
	10c55_6.dat	31	70	161	TNT	47						
	10c55_7.dat	34	73	170	TNT	50						
	10tnt_3.dat	37	72	251	TNT	10						
	10tnt_4.dat	37	77	241	TNT	36						
	10tnt_5.dat	40	71	152	TNT	44						
	10tnt_6.dat	38	69	148	TNT	10						
	100tnt_1.dat	39	98	343	TNT	100 **						

** Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10c57												
	10c57_1.dat	n/a	n/a	none	TNT	BDL	BDL			n/a	BDL	n/a
	10c57_2.dat	n/a	n/a	none	TNT	BDL						
	10c57_3.dat	n/a	n/a	none	TNT	BDL						
	10c57_4.dat	n/a	n/a	none	TNT	BDL						
	10c57_5.dat	n/a	n/a	none	TNT	BDL						
	10c57_6.dat	n/a	n/a	none	TNT	BDL						
	10c57_7.dat	n/a	n/a	none	TNT	BDL						
	10tnt_9.dat (P2)	35	84	487	TNT	10						
	10tnt_10.dat	36	84	491	TNT	10						
	10tnt_11.dat	36	93	453	TNT	10						
	10tnt_12.dat	38	84	271	TNT	10						

10_ samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10_07												
	10_07_1.dat	n/a	n/a	none	TNT	BDL	BDL	BDL		1.21	BDL	BDL
	10_07_2.dat	n/a	n/a	none	TNT	BDL						
	10_07_3.dat	n/a	n/a	none	TNT	BDL						
	10_07_4.dat	n/a	n/a	none	TNT	BDL						
	10_07_5.dat	n/a	n/a	none	TNT	BDL						
	10_07_6.dat	n/a	n/a	none	TNT	BDL						
	10_07_7.dat	n/a	n/a	none	TNT	BDL						
	tnt10n1.dat	35	80	83	TNT	10						
	tnt100n1.dat	34	87	1739	TNT	100						
	tnt100n2.dat	37	108	386	TNT	100						
	tnt100n3.dat	n/a	n/a	none	TNT	100						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10_08												
	10-8_1.dat	n/a	n/a	none	TNT	BDL	5	2.8	57%	0.98	5	######
	10-8_2.dat	14	26	42	TNT	1.5						
	10-8_3.dat	14	27	71	TNT	2.5						
	10-8_4.dat	17	29	111	TNT	4						
	10-8_5.dat	15	25	155	TNT	5.6						
	10-8_6.dat	18	32	200	TNT	7.2						
	10-8_7.dat	17	33	244	TNT	8.7						
	10tnt_11.dat	19	37	266	TNT	10						
	10tnt_12.dat	20	37	191	TNT	10						
	10tnt_14.dat	20	53	279	TNT	10 **						

** Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10c17												
	03c17_1.dat	36	50	108*	TNT	3.6	7	3.1	43%	21.5	7	######
	03c17_2.dat	35	53	297*	TNT	9.9						
	03c17_3.dat	34	50	255*	TNT	8.5						
	03c17_4.dat	33	47	100*	TNT	3						
	03c17_5.dat	n/a	n/a	none	TNT	BDL						
	03c17_6.dat	37	49	298*	TNT	9.1						
	03c17_7.dat	32	49	275*	TNT	9.1						
	tnt10n1	36	88	927	TNT	10						
	tntn3.dat	35	140	496	TNT	100						
	tnt100n1	39	101	3013	TNT	100 **						
	tnt100n2	37	123	1092	TNT	100						

* there was a sharp peak at the beginning
** Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
Spring												
	spr_1.dat	36	60	385	TNT	94.6	115	16	#####	3.16	115	######
	spr_2.dat	35	59	452	TNT	111						
	spr_3.dat	36	59	442	TNT	108.7						
	spr_4.dat	37	60	436	TNT	107						
	spr_5.dat	35	60	461	TNT	113.3						
	s1000.dat	38	102	1958	TNT	1000						
	spr_6.dat	36	62	569	TNT	139.8						
	spr_7.dat	35	62	539	TNT	132.4						
	tnt10_1.dat	38	98	505?	TNT	10						
	tnt100_1.dat	-	-	no response	TNT	100						
	std100_3.dat	37	89	407	TNT	100**						
	tnt100_4.dat	39	74	212	TNT	100						
	st1000_1.dat	35	115	1687	TNT	1000						

** Standard used for Quantitation

Soil extracts - CFI RDX analysis

Sample	#		intergral	conc	avg	std	rsd	conc*dil	HPLC	rpd
TJ001		1	20057.39	413	400	64	0.16	400	0	200
		2	17741.73	366						
		3	14750.98	304						
		4	18105.46	373						
		5	21332.53	514						
		6	17317.53	418						
		7	16999.57	410						
	500_1		26823.72		24259					
	500_2		21694.72		20740					
	500_3		19784.38							
TJ002		1	21184.07	589	530	51	0.10	530	352	40
		2	18168.92	505						
		3	19250.53	536						
		4	16766.98	466						
		5	17116.73	569						
		6	17274.32	575						
		7	14037.36	467						
	500_1		18850.87		17972					
	500_2		17093.63		15032					
	500_3		12970.46							
TJ003		1	4275.27	78	61	14	0.23	61	209	-110
		2	4104.02	75						
		3								
		4	3531.5	65						
		5	2661.76	49						
		6	2536.36	46						
		7	2779.64	51						
	500_1		29004.4		27322					
	500_2		25638.92		27385					
	500_3		29131.53							
TJ004		1	1058.36	23	36	7	0.21	36	407	-167
		2	1630.41	36						
		3	1936.02	43						
		4	1502.26	33						
		5	1693.73	35						
		6	2199.43	46						
		7	1702.52	36						
	500_1		23047.79		22706					
	500_2		22364.08		23961					
	500_3		25558.73							
TJ005		1	28802.6	759	598	123	0.21	598	50456	-195
		2	22814.75	601						
		3	21134.92	557						
		4	22483.51	592						
		5	2448.79	752						
		6	13629.39	419						
		7	16533.93	508						
	500_1		21042.95		18981					
	500_2		16918.9		16272					
	500_3		15625.86							
TJ006		2	91066.88	1917	1329	424	0.32	13290	147985	-167
(1:10)		3	73948.88	1557						
		4	82271.58	1732						
		6	39771.78	842						
		7	39996.36	847						
		8	52537.84	1112						
		9	69387.91	1298						
	500_2		27006.79		23748					
	500_3		20489.09		23614					
	500_4		26738.72							
TJ007		2	29211.44	988	856	92	0.11	8560	8633	-1
(1:10)		3	26727.92	906						
		4	27267.29	922						
		6	22210.87	797						
		7	21494.38	771						
		8	20390.48	732						
		9	24439.77	877						
	500_1		26766.93							
	1000_2		29579.99		27861					
	1000_3		26142.05							
TJ008		2	26908.62	983	929	65	0.07	92900	138500	-39
(1:100)		3	23296.85	851						
		4	25791.44	942						
		5	23091.1	844						
		6	26414.52	982						
		7	26075.06	969						
	500_1		13682.95		13569					
	500_2		13455.56							
	500_3		35957.31							
TJ009		1	17784.44	352	365	37	0.10	365	526	-36
		2	21028.32	416						
		3	20259.61	401						
		4	19795.64	392						
		5	18920.98	336						
		6	18921.52	336						
		7	18274.62	324						
	500_1		25455.83		25259					
	500_2		25062.41		28189					
	500_3		31315.65							

TJ003		1	1033.93	48.53	59	10	0.17	59	209	-112
		2	1301	51.13						
		3	1407.78	52.17						
		4	1556.39	53.62						
		5	2683.13	64.58						
		6	2610.45	63.88						
		7	3828.61	75.73						
	100_		6322.286							
	50_1		1184.736							
TJ004		1	4100.34	101.02	110	9	0.08	110	407	-115
		2	3909.92	96.33						
		3	5046.38	124.33						
		4	4389.22	108.14						
		5	4658.83	114.78						
		6	4513.18	111.19						
		7	4545.03	111.98						
	100_1		11124.26							
	100_2		4058.86							
TJ006		1	24791.42	2451.9	1934	361	0.19	193400	147985	27
(1:100)	2*		14650.32	1488.93						
		3	20468.78	2024.39						
		4	21307.96	2107.38						
		5	23475.31	1932.55						
		6	19219.99	1582.24						
		7	18310.76	1507.39						
	1000_4		10111.11							
	1000_5		12147.32							

TJ010		1	52125.57	674	665	103	0.16	665	2818	-124
		2	58739.61	760						
		3	60863.67	787						
		4	50702.46	707						
		5	47978.05	670						
		6	39403.68	550						
		7	36328.18	507						
	500_1		36806.87		38669					
	500_2		40530.43		35808					
	500_3		31084.6							
	1000_1		35003.7							

TJ010										
1:10		1	5457.77	441.35	347	52	0.15	3470	2818	21
		2	3771.17	304.96						
		3	3796.39	307						
		4	3624.24	293.08						
		5	3367.96	376.22						
		6	3155.61	352.5						
		7	3175.01	354.67						
	500_1		6473.398		6183					
	500_2		5891.932		4476					
	500_3		3059.078							

G18-L3-A		2	47527.64	642	662	42	0.06	662	10259	-176
		3	48061.39	650						
		4	47233.83	638						
		5	54090.1	747						
		6	49485.42	684						
		7	44983.61	622						
		8	46870.09	648						
	500_1		34168.74		36996					
	500_2		39822.98		36181					
	500_3		32539.09							

G18-L3-A		3	5213.316	1278.46	811	238	0.29	16224.13	10259	45
1:20		4	3333.406	817.45	718	72	0.10	14355	10259	33
		5	3142.101	770.54						
		6	4448.47	675.79						
		7	4396.979	667.97						
		8	4324.948	657.03						
	500_1		4077.803							
	500_2		6582.625							

G51-L1-A		1	55921.58	1506	1426	108	0.08	1426	2203	-43
		2	57013.43	1535						
		3	54460.73	1467						
		4	48085.32	1295						
		5	51837.23	1518						
		6	47423.65	1389						
		7	43494.89	1274						
	500_1		30110.89							
	1000_2		37130.34							
	1000_3		34145.8							

G51-L1-A		1	31349.92	302.57	355	29	0.08	3550	2203	47
1:10		2	38850.79	374.96						
		3	39399.96	380.26						
		4	35479.37	342.42						
		5	38551.95	372.07						
		6	47423.65							
		7	36826.41	355.42						
	500_1		49746.39		51807					
	1000_2		53866.93							

G55-X-A		1	37759.71	762	744	130	0.17	74400	135885	-58
(1:100)		2	35540.11	717	792	67	0.08			
		3	37321.43	753						
		4	40857.09	825						
		5	41936.2	785						
		6	24664.96	462						
		7	48451.51	907						
	500_1		25145.07		24770					
	500_2		24394.2		26704					
	500_3		29013.36							

G16-L2-A		2	13472.12	315	368	35	0.10	36800	14850	85
(1:100)		3	16074.68	376						
		4	14812.85	347						
		5	14561.14	360						
		6	17140.95	423						
		7	16165.11	399						
		8	14393.21	356						
	500_1		20628.34		21361					
	500_2		22093.57		20243					
	500_3		18393.38							

G18-L1-A		2	31920.32	1448	897	264	0.29	80500	19492	122
(1:100)		3	20756.26	942	805	114	0.14			
		4	19696.15	894						
		5	18562.8	624						
		6	22419.99	754						
		7	22960.55	772						
		8	25142.6	845						
	500_1		20108.13							
	1000_1		22041.72							
	1000_2		29752.89							

Soil Samples 1-99 Fast 2000 from T. Jenkins (TJ) and Umatilla (Um)

****Standard Deviation of the samples is calculated from the original data

last printed 4-29-99

Sample	Area (AU)							
Criteria:	TNT	Conc.	avg	std	rsd	conc*dil	HPLC	RPD
TJ 001-1	544	22	**22**	**6**	0.26	22	BDL	#VALUE!
TJ 001-2	483	19						
TJ 001-3	826	33						
TJ 001-4	638	25						
TJ 001-5	595	24						
TJ 001-6	402	16						
TJ 001-7	419	17						
STD 100-2	2520	100						
STD 100-3 *ugly	1427							
STD 100-4	1514							

Sample	Area (AU)							
Criteria:	TNT	Concentration						
TJ 002-1	10979	584	**367**	**113**	0.31	367	551	-40
TJ 002-2	7199	383						
TJ 002-3	7307	389						
TJ 002-4	6515	347						
TJ 002-5	4980	265						
TJ 002-6	6940	369						
TJ 002-7	4367	232						
STD 100-1	1879	100						
STD 1000-2	4493							
STD 1000-3	3850	looked funny						

Sample	Area (AU)							
Criteria:	TNT	Concentration						
TJ 003-1	98087	45385	**17561**	**13348**	0.76	17561	915965	-192
TJ 003-2	39860	18443						
TJ 003-3	38086	17622						
TJ 003-4	37930	17550						
TJ 003-5	24690	11424						
TJ 003-6	14635	6772						
TJ 003-7	12380	5728						
STD 1000-1	2161	1000						
STD 1000-3	not pretty 3483							

Sample	#	intergral	conc	avg	std	rsd	conc*dil	HPLC	rpd
TJ003	1	1270.93	727	1027	204	0.20	1027286	915965	11
(1:1000)	2	1860.86	1065						
	3	1708.2	977						
	4	1669.42	1308						
	5	1464.34	1148						
	6	1471.78	1153						
	7	1037.6	813						
	1000_5	2138.32		1748					
	1000_6	1357.43		1276					
	1000_7	1194.36							

Sample	Area (AU)							
Criteria:	TNT	Conc						
TJ 004-1	maxed out	5562	**844**	**323**	0.38	8442	49054	-141
TJ 004-2 (1:10)	22592	1123						
TJ 004-3 (1:10)	25397	1262						
TJ 004-4 (1:10)	19303	959						
TJ 004-5 (1:10)	14534	722						
TJ 004-6 (1:10)	short run	538						
TJ 004-7 (1:10)	9269	461						
STD 100-1	2665							
STD 100-2	2012	100						
STD 1000-3	1402							

Sample	#	intergral	conc	avg	std	rsd	conc*dil	HPLC	rpd
TJ004	3	3329.49	599	482	117	0.24	481714.3	49054	163
(1:1000)	4	2724.57	490						
	5	1877.42	338						
	6	1698.02	306						
	7	1620.49	598						
	8	1438.5	530						
	9	1385.47	511						
	500_1	4048.71		2778					
	500_3	1507.97		1356					
	500_5	1204.82							
	1000_2	4044.71		2884					
	1000_4	1722.92							

Sample	Area (AU)	Bright Yellow						
Criteria:	TNT	Conc						
TJ 005-1 (1:100)	8093	4802	**3422**	**1156**	0.34	342248	1205	199
TJ 005-2 (1:100)	7495	4448						
TJ 005-3 (1:100)	6639	3940						
TJ 005-4 (1:100)	3788	2248						
TJ 005-5 (1:100)	3650	2166						
TJ 005-6 (1:100)	6913	4102						
TJ 005-7 (1:100)	3795	2252						
STD 1000-1	5858							
STD 1000-2 dip	1685	1000						
STD 1000-3 ugly	1530							
STD 1000-4	1577							

Sample	Area (AU)							
Criteria:	TNT	Conc						
TJ 006-1 maxed out	61049	35680	**4616**	**1460**	0.32	46160	82118	-56
TJ 006-2 (1:10)	12763	7459						
TJ 006-3 (1:10)	7300	4266						
TJ 006-4 (1:10)	8135	4755						
TJ 006-5 (1:10)	6806	3978						
TJ 006-6 (1:10)	6418	3751						
TJ 006-7 (1:10)	5966	3487						
STD 100-1 blip -	564							
STD 1000-2 noisey	1711	1000						
STD 1000-3 ugly	1503							

Sample	#	intergral	conc	avg	std	rsd	conc*dil	HPLC	rpd
TJ006	2	963.13	1322	963	313	0.32	963142.9	82118	169
(1:1000)	3	1040.49	1440						
	4	762.67	1017						
	5	632.93	820						
	6	607.79	826						
	7	466.4	616						
	8	523.84	701						
	500_2	422.64							
	500_5	388.41							
	1000_1	1458.31							
	1000_3	751.33							
	1000_4	724.9							

Sample	Area (AU)							
Criteria:	TNT	Conc						
TJ 007-1 maxed out	60172	22949	**1832**	**480**	0.26	183166	251548	-31
TJ 007-2 (1:10)	25537	9740						
TJ 007-3 (1:100)	2873	1096						
TJ 007-4 (1:100)	6398	2440						
TJ 007-5 (1:100)	4946	1886						
TJ 007-6 (1:100)	4761	1816						
TJ 007-7 (1:100)	5035	1920						
STD 100-1 steep baseline	939							
STD 1000-2	2622	1000						
STD 1000-3	1951							

Sample	Area (AU)							
Criteria:	TNT	Conc						
TJ 008-1	22842	12876	**730**	**102**	0.14	7301	BDL	#VALUE!
TJ 008-2 (1:10)	1569	884						
TJ 008-3 (1:10)	1372	773						
TJ 008-4 (1:10)	1249	704						
TJ 008-5 (1:10)	1124	634						
TJ 008-6 (1:10)	1162	655						
STD 100-1	603							
STD 1000-2	1774	1000						
STD 1000-3 mtn-like	1136							

Sample	Area (AU)							
Criteria:	TNT	Conc						
TJ 009-1	20935	4246	**142**	**10**	0.07	14223	BDL	#VALUE!
TJ 009-2 (1:10)	7117	1444						
TJ 009-3 (1:100) blip -	741	150						
TJ 009-4 (1:100)	709	144						
TJ 009-5 (1:100)	757	154						
TJ 009-6 (1:100)	633	128						
TJ 009-7 (1:100)	666	135						
STD 100-1	493	100						
STD 1000-3	1670							

Sample	Area (AU)	
Criteria:	TNT	Conc
TJ 010-1		
TJ 010-2	inconclusive	
TJ 010-3		
TJ 010-4		
TJ 010-5		
TJ 010-6		
TJ 010-7		
STD 100-1		
STD 100-2		
STD 100-3		

Sample	#	intergral	conc	avg	std	rsd	conc*dil	HPLC	rpd
TJ010	2	3703.33	793	871	256	0.29	87085.71	434	198
(1:100)	3	3542.91	759						
	4	2192.4	469						
	5	3150.9	1243						
	6	2822.65	1114						
	7	1951.25	770						
	8	2401.09	948						
	500_1	3142.15		2335					
	500_2	1527.17		1267					
	500_4	1005.95							
	1000_3	1366.7							
	1000_5	1638.65							

Sample	Area (AU)							
Criteria:	TNT	Conc						
G-16-L2-A 1:10 1	16045	3134	**2858**	**1051**	0.37	28576	12797	76
G-16-L2-A 1:10 2	13626	2662						
G-16-L2-A 1:10 3	13224	2583						
G-16-L2-A 1:10 4	14711	2874						
G-16-L2-A 1:10 5 strange	12043	2353						
G-16-L2-A 1:10 6 strange	25202	4923						
G-16-L2-A 1:10 7 strange	7545	1474						
STD 100-1 ugly	1285							
STD 1000-2	5119	1000						
STD 1000-3	3347							

Sample	#	intergral	conc	avg	std	rsd	conc*dil	HPLC	rpd
G16-L2-A	1	239.5	136	272	160	0.59	27171.43	12797	72
(1:100)	2	344.52	196						
	3	476.12	271						
	4	543.32	309						
	5	292.89	166						
	6	380.87	216						
	7		608						
	500_1	713.36		880					
	500_2	1047.13							
	500_3								

Sample	Area (AU)							
Criteria:	TNT	Conc						
G-51-L1-A 1:10 1 ugly	10220	2826	**1601**	**672**	0.42	16006	2660	143
G-51-L1-A 1:10 2 ugly	5612	1552						
G-51-L1-A 1:10 3 ugly	7642	2113						
G-51-L1-A 1:10 4	5067	1401						
G-51-L1-A 1:10 5	3402	941						
G-51-L1-A 1:10 6	5190	1435						
G-51-L1-A 1:10 7	3382	935						
STD 100-1 ugly	526							
STD 1000-2 ugly	6290							
STD 1000-3 std used	3616	1000						

Sample	#	intergral	conc	avg	std	rsd	conc*dil	HPLC	rpd
G51-L1-A	1	4962.16	667	553	135	0.24	5534.286	2660	70
(1:10)	2	5132.48	690						
	3	4213.24	566						
	4	2231.45	300						
	5	4039.32	586						
	6	3148.8	457						
	7	4188.83	608						
	500_1	3219.31		3720					
	500_2	4220.25		3444					
	500_3	2667.25							

Sample	Area (AU)							
Criteria:	TNT	Conc						
G-18-L1-A 1:10 1	17075	7030	**3613**	**1845**	0.51	72270	23482	102
G-18-L1-A 1:20 2	11812	4863						
G-18-L1-A 1:20 3	9708	3997						
G-18-L1-A 1:20 4	5795	2386						
G-18-L1-A 1:20 5	7318	3013						
G-18-L1-A 1:20 6	4872	2006						
G-18-L1-A 1:20 7 ugly	4860	2001						
STD 1000-1	4750	1000						
STD 1000-2	2429							

Sample	#	intergral	conc	avg	std	rsd	conc*dil	HPLC	rpd
G18-L1-A	1	2420.69	565	506	63	0.12	50614.29	23482	73
(1:100)	2	2100.21	490						
	3	1842.01	430						
	4	2096.56	489						
	5	1716.92	563						
	6	1756.25	576						
	7	1311.53	430						
	500_1	2708.09		2143					
	500_2	1577.18		1524					
	500_3	1470.35							

Sample	Area (AU)							
Criteria:	TNT	Conc						
G-55-X-A 1:100 1	6043	3475	**2194**	**670**	0.31	219363	231011	-5
G-55-X-A 1:100 2	4124	2371						
G-55-X-A 1:100 3	4100	2358						
G-55-X-A 1:100 4	3847	2212						
G-55-X-A 1:100 5	3272	1882						
G-55-X-A 1:100 6	2539	1460						
G-55-X-A 1:100 7	2778	1597						
STD 100-1 ugly	288							
STD 1000-2	1739	1000						
STD 1000-3	745							

Sample	Area (AU)							
Criteria:	TNT	Concentration						
G-18-L3 1	10944	3061	**1799**	**325**	0.18	17987	3698	132
G-18-L3 1:10 2	8245	2306						
G-18-L3 1:10 3	6929	1938						
G-18-L3 1:10 4	7031	1967						
G-18-L3 1:10 5	5489	1535						
G-18-L3 1:10 6	5460	1527						
G-18-L3 1:10 7	5428	1518						
STD 1000-1	1657							
STD 1000-2	3575	1000						
STD 1000-3	2303							

Sample	#	intergral	conc	avg	std	rsd	conc*dil	HPLC	rpd
G18-L3-A	1	880.98	305	279	33	0.12	27857.14	3698	153
(1:100)	2	644.15	223						
	3	788.05	273						
	4	747.27	259						
	5	719.66	293						
	6	801.68	326						
	7	665.85	271						
	250_6	721.46							
	250_7	614.74							

Detection of Explosives (RDX Immunoassay)
FAST 2000 Field Trial Results
Umatilla Army Depot (Umatilla, OR)
Date: Aug 4 - 8, 1997

Numbered samples

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	RDX Conc. (ppb)	Mean (ppb)	Stand. Dev. (ppb)	RSD (%)	Q Value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
4_7	_1.dat	38	170	895	7361	137	88	31	35%			132	88	-40.00%
	_2.dat	33	141	860	6561	121								
	_3.dat	33	143	860	3808	71								
	_4.dat	32	145	849	3532	66								
	_5.dat	34	128	840	2640	49								
	_6.dat	36	228	767	4575	85								
	_7.dat	32	226	758	4718	88								
RDX100	_2.dat	36	257	931	19447									
	_3.dat	34	221	740	5386									

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	RDX Conc. (ppb)	Mean (ppb)	Stand. Dev. (ppb)	RSD (%)	Q Value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
4_24	_1.dat	ND	ND	ND	ND	ND	53	18	34%			39.2	53	29.93%
	_2.dat	28	252	615	7914	53								
	_3.dat	31	252	600	8472	56								
	_4.dat	36	252	580	10767	72								
	_5.dat	37	252	600	7885	52								
	_6.dat	38	252	600	9433	63								
	_7.dat	51	302	460	2872	19								
RDX 100	_1.dat	16	274	400	15035									

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	RDX Conc. (ppb)	Mean (ppb)	Stand. Dev. (ppb)	RSD (%)	Q Value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
4-102														
	_1.dat	32	175	579	10536	114	121	24	19.80%			402	121	-107.46%
	_2.dat	39	173	573	7997	86								
	_3.dat	40	197	563	9710	106								
	_4.dat	39	214	569	12476	136								
	_5.dat	38	212	561	10093	110								
	_6.dat	34	239	536	13278	144								
	_7.dat	41	238	508	14179	154								
RDX 100	_1.dat	34	172		9196									
	_2.dat	39	193		9742									

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	RDX Conc. (ppb)	Mean (ppb)	Stand. Dev. (ppb)	RSD (%)	Q Value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
4-112	_1.dat	1	298	445	7868	88	39	26	66%			15.3	39	87.29%
	_2.dat	37	93	425	785	9								
	_3.dat	4	98	340	1609	18								
	_4.dat	33	89	430	5017	56								
	_5.dat	31	116	360	3446	39								
	_6.dat	33	106	295	3294	37								
	_7.dat	33	86	276	2885	32								
RDX 100	_1.dat	44	192	705	8942									
RDX 100	_2.dat	32	97	370	1747									

Umatilla, Flow, RDX, EW samples

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	RDX Conc. (ppb)	Mean (ppb)	Stand. Dev. (ppb)	RSD (%)	Q Value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
EW-1	_1a.dat	17	250	1154	16099	83	43	28	65%			450	43	-165.11%
	_1.dat	19	124	73	8188	42								
	_3a.dat	24	242	1280	5486	28								
	_3.dat	20	185	995	3925	20								
	_4a.dat	ND	ND	ND	ND	ND								
RDX 100	_2.dat	36	257	931	19447									

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	RDX Conc. (ppb)	Mean (ppb)	Stand. Dev. (ppb)	RSD (%)	Q Value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
EW-3	_1.dat	23	271	465	8619	114	149	51	34%			112	149	28.35%
	_2.dat	20	284	455	10021	132								
	_3.dat	14	257	445	9687	127								
	_4.dat	27	223	435	9951	131								
	_5.dat	31	284	420	10444	239								
	_6.dat	24	249	780	4369	58								
RDX 100	_1.dat	12	223		7574									

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	RDX Conc. (ppb)	Mean (ppb)	Stand. Dev. (ppb)	RSD (%)	Q Value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
EW-4	_1.dat	40	296	455	36225	880	902	53	5.80%			1020	902	-12.28%
	_2.dat	40	291	415	36624	890								
	_3.dat	39	292	400	36415	885								
	_4.dat	39	293	390	34669	843								
	_5.dat	39	294	365	37457	910								
	_6.dat	43	293	365	36851	896								
	_7.dat	41	294	350	41623	1012								
RDX 1000	_1.dat	40	295	41148										
	_2.dat	47	298	50594										

Umatilla, Flow, RDX, WO samples

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	RDX Conc. (ppb)	Mean (ppb)	Stand. Dev. (ppb)	RSD (%)	Q Value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
WO-21	_1.dat	22	283	770	13117	150	163	14	8.50%			389	163	-81.88%
	_2.dat	23	226	680	12283	140								
	_3.dat	23	265	640	15655	179								
	_4.dat	25	234	600	14561	166								
	_5.dat	25	255	565	15482	177								
	_6.dat	20	226	550	14703	168								
	_7.dat	24	269	530	14059	161								
RDX 100	_1.dat	12	223	870	7574									

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	RDX Conc. (ppb)	Mean (ppb)	Stand. Dev. (ppb)	RSD (%)	Q Value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
WO-24	_1.dat	42	290	272	16913	249	233	22.4	9.60%			470	233	-67.43%
	_2.dat	38	292	247	17936	265								
	_3.dat	41	287	236	16936	250								
	_4.dat	41	287	236	13624	201								
	_5.dat	41	291	222	15474	228								
	_6.dat	42	289	225	15002	221								
	_7.dat	41	280	225	14742	217								
RDX 100	_1.dat	14	189	270	8629									
	_2.dat	39	276	225	6780									

Umatilla, Flow, RDX, Combine samples

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	RDX Conc. (ppb)	Mean (ppb)	Stand. Dev. (ppb)	RSD (%)	Q Value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
Comb1	_1.dat	31	295	520	29169	742	607	106	17.40%			1180	607	-64.13%
	_2.dat	34	288	464	27646	703								
	_3.dat	38	274	449	26588	676								
	_4.dat	29	190	447	19778	688								
	_5.dat	39	221	424	19809	689								
	_6.dat	33	242	388	24597	856								
	_7.dat	40	253	361	19354	673								
RDX1000	_1.dat	32	266		39293									
	_2.dat	40	249		28724									

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	RDX Conc. (ppb)	Mean (ppb)	Stand. Dev. (ppb)	RSD (%)	Q Value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
Comb2	_1.dat	ND		ND	ND	ND	990	101	10.20%			1090	990	-9.62%
	_2.dat	36	262	335	22189	962								
	_3.dat	34	236	330	19365	840								
	_4.dat	40	291	332	24271	1053								
	_5.dat	36	269	315	22344	969								
	_6.dat	32	288	316	22488	975								
	_7.dat	40	295	315	26355	1143								
RDX 1000	_1.dat	36	235		23056									
	_2.dat	30	267		33442									

Umatilla, Flow, RDX, WO samples

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	RDX Conc. (ppb)	Mean (ppb)	Stand. Dev. (ppb)	RSD (%)	Q Value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
WO-21	_1.dat	22	283	770	13117	150	163	14	8.50%			389	163	######
	_2.dat	23	226	680	12283	140								
	_3.dat	23	265	640	15655	179								
	_4.dat	25	234	600	14561	166								
	_5.dat	25	255	565	15482	177								
	_6.dat	20	226	550	14703	168								
	_7.dat	24	269	530	14059	161								
RDX 100	_1.dat	12	223	870	7574									

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	RDX Conc. (ppb)	Mean (ppb)	Stand. Dev. (ppb)	RSD (%)	Q Value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
WO-24	_1.dat	42	290	272	16913	249	233	22.4	9.60%			470	233	######
	_2.dat	38	292	247	17936	265								
	_3.dat	41	287	236	16936	250								
	_4.dat	41	287	236	13624	201								
	_5.dat	41	291	222	15474	228								
	_6.dat	42	289	225	15002	221								
	_7.dat	41	280	225	14742	217								
RDX 100	_1.dat	14	189	270	8629									
	_2.dat	39	276	225	6780									

Umatilla, Flow, RDX, Combine samples

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	RDX Conc. (ppb)	Mean (ppb)	Stand. Dev. (ppb)	RSD (%)	Q Value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
Comb1	_1.dat	31	295	520	29169	742	607	106	17.40%			1180	607	-64.13%
	_2.dat	34	288	464	27646	703								
	_3.dat	38	274	449	26588	676								
	_4.dat	29	190	447	19778	688								
	_5.dat	39	221	424	19809	689								
	_6.dat	33	242	388	24597	856								
	_7.dat	40	253	361	19354	673								
RDX1000	_1.dat	32	266		39293									
	_2.dat	40	249		28724									

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	RDX Conc. (ppb)	Mean (ppb)	Stand. Dev. (ppb)	RSD (%)	Q Value	Reject	QST 8330 (ppb)	FAST 2000 (ppb)	RPD
Comb2	_1.dat	ND		ND	ND	ND	990	101	10.20%			1090	990	-9.62%
	_2.dat	36	262	335	22189	962								
	_3.dat	34	236	330	19365	840								
	_4.dat	40	291	332	24271	1053								
	_5.dat	36	269	315	22344	969								
	_6.dat	32	288	316	22488	975								
	_7.dat	40	295	315	26355	1143								
RDX 1000	_1.dat	36	235		23056									
	_2.dat	30	267		33442									

Detection of Explosives (TNT Immunoassay)

Umatilla Army Depot Field Trials

Date: Aug 4 - 8, 1997

Numbered samples

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	TNT Conc. (ppb)	Mean	Stand. Dev.	RSD (%)	Q-Value	Reject (Y or N)	QST 8330 Conc. (ppb)	FAST 2000 Conc. (ppb)	RPD (%)
4_7	_.1dat	43	77	572	725	48								
	_.2dat	42	88	454	800	53	33	18.6	57	0.113	N	ND	33	ND
	_.3dat	43	100	234	644	43								
	_.4dat	47	105	195	676	45								
	_.5dat	48	78	166	175	12								
	_.6dat	48	69	142	140	9								
	_.7dat	46	91	134	282	19								
TNT 100	_1.dat	43	106	1505										

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	TNT Conc. (ppb)	Mean	Stand. Dev.	RSD (%)	Q-Value	Reject (Y or N)	QST 8330 Conc. (ppb)	FAST 2000 Conc. (ppb)	RPD (%)
4_25	_.1dat	33	53	275	233	29	32	6.5	20	0.32	N	32	ND	ND
	_.2dat	35	55	250	267	34								
	_.3dat	38	67	245	299	38								
	_.4dat	34	55	235	307	39								
	_.5dat	34	64	230	298	38								
	_.6dat	36	60	199	215	27								
	_.7dat	36	60	200	171	22								
TNT 100	_1.dat	36	80	236										

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	TNT Conc. (ppb)	Mean	Stand. Dev.	RSD (%)	Q-Value	Reject (Y or N)	QST 8330 Conc. (ppb)	FAST 2000 Conc. (ppb)	RPD (%)
4-102	_.1dat	34	105	222	1162	20	14	3.4	24	0.42	N	367	14	-185.30%
	_.2dat	37	107	207	863	15								
	_.3dat	34	103	195	747	13								
	_.4dat	40	121	183	915	16								
	_.5dat	40	103	178	703	12								
	_.6dat	35	104	173	664	11								
	_.7dat	40	93	165	587	10								
TNT 10	_1.dat	33	81	580										

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	TNT Conc. (ppb)	Mean	Stand. Dev.	RSD (%)	Q-Value	Reject (Y or N)	QST 8330 Conc. (ppb)	FAST 2000 Conc. (ppb)	RPD (%)
4-112	_.1dat	43	148	520	5916	217	191	18.1	9.4	0.66	N	164	191	15.21%
	_.2dat	45	146	505	5833	214								
	_.3dat	45	148	500	5263	193								
	_.4dat	44	147	500	5087	186								
	_.5dat	46	146	485	5006	184								
	_.6dat	47	147	490	4732	173								
	_.7dat	49	146	500	4694	172								
TNT 100		36	117	810	2728	100								

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	TNT Conc. (ppb)	Mean	Stand. Dev.	RSD (%)	Q-Value	Reject (Y or N)	QST 8330 Conc. (ppb)	FAST 2000 Conc. (ppb)	RPD (%)
4-114d	_.1dat	54	172	374	2556	68.9	56.1	11.2	20	0	N	93.9	56	-50.57%
	_.2dat	55	174	351	2558	68.9								
	_.3dat	55	201	323	2358	63.5								
	_.4dat	56	187	298	1707	46								
	_.5dat	53	197	278	2084	56.1								
	_.6dat	56	167	266	1727	46.5								
	_.7dat	55	181	248	1590	42.8								
TNT 10	_1.dat	44	120	1377										
TNT100	_2.dat	50	151	3709.3	(Used as Std.)									

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	TNT Conc. (ppb)	Mean	Stand. Dev.	RSD (%)	Q-Value	Reject (Y or N)	QST 8330 Conc. (ppb)	FAST 2000 Conc. (ppb)	RPD (%)
9_	_.1dat	37	148	840	22572	1461	958	354	37	0.187	N	1160	958	-19.07%
	_.2dat	36	149	712	19592	1268								
	_.3dat	37	149	640	15055	974								
	_.4dat	38	150	540	12862	833								
	_.5dat	38	149	500	10714	694								
	_.6dat	ND												
	_.7dat	38	149	570	7992	517								
TNT 1000	_1.dat	35	130	1080	15449									

	FAST 2000	QST 8330	
4_3	BDL *	0.072	
4-111	BDL	94.3	
4-113	BDL	62.6	
4-114	BDL	93.9	(Matrix effect)
4_117	BDL	BDL	
4_24	BDL	BDL	
W0-22	BDL	0.21	
W0-24	BDL	BDL	

* = Below Detection Limit

CRANE CRANE CRANE CRANE CRANE CRANE

03co samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03co3												
	03co3_1.dat	n/a	n/a	nothing	TNT	BDL						
	03co3_2.dat	n/a	n/a	none	TNT	BDL						
	03co3_3.dat	n/a	n/a	none	TNT	BDL						
	03co3_4.dat	n/a	n/a	none	TNT	BDL						
	03co3_5.dat	n/a	n/a	none	TNT	BDL						
	03co3_6.dat	n/a	n/a	none	TNT	BDL						
	03co3_7.dat	n/a	n/a	none	TNT	BDL						
	03co3_8.dat	n/a	n/a	none	TNT	BDL						
	10tnt_1.dat	17	43	316	TNT	10						
	10tnt_2.dat	15	49	253	TNT	10						
	1ktnt.dat	25	63	1298	TNT	1000	BDL			4.27		

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03co4												
	03co4_1.dat	n/a	n/a	nothing	TNT	BDL						
	03co4_2.dat	n/a	n/a	nothing	TNT	BDL						
	03co4_3.dat	n/a	n/a	nothing	TNT	BDL						
	03co4_4.dat	n/a	n/a	nothing	TNT	BDL						
	03co4_5.dat	n/a	n/a	none	TNT	BDL						
	03co4_6.dat	n/a	n/a	none	TNT	BDL						
	03co4_7.dat	n/a	n/a	none	TNT	BDL						
	tnt100n.dat	38	86	1811	TNT	100ng.ml	BDL			BDL		
	tnt100n2.dat	n/a	n/a	none?	TNT	100ng/ml						
	tnt100n3.dat	33	115	467	TNT	100ng/ml						
	tnt100n4.dat	39	112	296	TNT	100ng/ml						
	tnt1000n.dat	33	172	2995	TNT	1000ng/ml						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03c08												
	03c08_1.dat	19	27	29	TNT	4.9						
	03c08_2.dat	16	28	63*	TNT	10.8						
	03c08_3.dat	18	27	38	TNT	6.5						
	03c08_4.dat	18	26	32	TNT	5.5						
	03c08_5.dat	11	30	161	TNT	27.5						
	03c08_6.dat	n/a	n/a	o respons	TNT	BDL						
	03c08_6.dat	18	32	99	TNT	16.9						
	03c08_7.dat	17	34	146	TNT	24.9						
	10tnt_7.dat	8	34	59	TNT	10						
	100tnt_1.dat	21	(1)43	230(1030)	TNT	100	13.9	9.4	68%	BDL		
	100tnt_2.dat	20	86	586	TNT	100 **						
	100tnt_3.dat	15	98	371	TNT	100						

* there was a sharp peak at the beginning

** Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03c09												
	03c09_1.dat (	n/a	n/a	none	TNT	BDL						
	03c09_2.dat (	n/a	n/a	none	TNT	BDL						
	03c09_3.dat (	n/a	n/a	none	TNT	BDL						
	03c09_4.dat (	n/a	n/a	none	TNT	BDL						
	03c09_5.dat (	n/a	n/a	none	TNT	BDL						
	03c09_6.dat(F	n/a	n/a	none	TNT	BDL						
	03c09_7.dat (	n/a	n/a	none	TNT	BDL						
	10tnt_7.dat	38	85	792	TNT	10						
	10tnt_8.dat (F	38	84	480	TNT	10						
	1ktnt_2.dat	39	111	11413	TNT	1000	BDL			BDL		

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03c10												
	03c10_1.dat	n/a	n/a	none	TNT	BDL						
	03c10_2.dat	n/a	n/a	none	TNT	BDL						
	03c10_3.dat	n/a	n/a	none	TNT	BDL						
	03c10_4.dat	n/a	n/a	none	TNT	BDL						
	03c10_5.dat	n/a	n/a	none	TNT	BDL						
	03c10_6.dat	n/a	n/a	none	TNT	BDL						
	03c10_7.dat	n/a	n/a	none	TNT	BDL						
	10tnt_8.dat	21	48	73	TNT	10						
	10tnt_9.dat	20	61	97	TNT	10						
	10tnt_10.dat	19	40	396	TNT	10						
	1ktnt_2.dat	18	87	3692	TNT	1000	BDL			BDL		

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03c12												
	03c12_1.dat	17	30	97*	TNT	5						
	03c12_2.dat	18	27	60	TNT	3.1						
	03c12_3.dat	16	27	85	TNT	4.4						
	03c12_4.dat	17	26	59	TNT	3						
	03c12_5.dat	17	28	109	TNT	5.6						
	03c12_6.dat	17	32	220	TNT	11.3						
	03c12_7.dat	18	32	208	TNT	10.7						
	10tnt_3.dat	17	46	194	TNT	10 **	6.2	3.4	55%	BDL		
	10tnt_4.dat	17	37	28(?)	TNT	10						
	10tnt_5.dat	18	26	10(?)	TNT	10						

** Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03c17												
	03c17_1.dat	36	50	108*	TNT	3.6						
	03c17_2.dat	35	53	297*	TNT	9.9						
	03c17_3.dat	34	50	255*	TNT	8.5						
	03c17_4.dat	33	47	100*	TNT	3						
	03c17_5.dat	n/a	n/a	none	TNT	BDL						
	03c17_6.dat	37	49	298*	TNT	9.1						
	03c17_7.dat	32	49	275*	TNT	9.1						
	tnt10n1	36	88	927	TNT	10						
	tntn3.dat	35	140	496	TNT	100						
	tnt100n1	39	101	3013	TNT	100 **	7.2	3.1	43%	21.5		
	tnt100n2	37	123	1092	TNT	100						

* there was a sharp peak at the beginning
** Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
03_34												
	03c17ns1.dat	43	56	298*	TNT	BDL						
	03c17ns2.dat	43	54	142*	TNT	BDL						
	03_34_1a.dat	n/a	n/a	none	TNT	BDL						
	03_34_2.dat	n/a	n/a	none	TNT	BDL						
	03_34_3.dat	n/a	n/a	none	TNT	BDL						
	03_34_4.dat	n/a	n/a	none	TNT	BDL						
	03_34_5.dat	n/a	n/a	none	TNT	BDL						
	03_34_6.dat	n/a	n/a	none	TNT	BDL						
	03_34_7.dat	n/a	n/a	none	TNT	BDL						
	03_34_1.dat(s	36	117	872	TNT	100ng/ml	BDL			BDL		
	tnt4.dat	37	97	3038	TNT	100ng/ml						
	tnt10n2.dat	34	91	764	TNT	10ng/ml						
	tnt100n4.dat	34	104	577	TNT	100ng/ml						
	tnt100n5.dat	35	103	707	TNT	100						

* there was a sharp peak at the beginning

10_ samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10_07												
	10_07_1.dat	n/a	n/a	none	TNT	BDL						
	10_07_2.dat	n/a	n/a	none	TNT	BDL						
	10_07_3.dat	n/a	n/a	none	TNT	BDL						
	10_07_4.dat	n/a	n/a	none	TNT	BDL						
	10_07_5.dat	n/a	n/a	none	TNT	BDL						
	10_07_6.dat	n/a	n/a	none	TNT	BDL						
	10_07_7.dat	n/a	n/a	none	TNT	BDL						
	tnt10n1.dat	35	80	83	TNT	10ng/ml						
	tnt100n1.dat	34	87	1739	TNT	100ng/ml	BDL			1.21		
	tnt100n2.dat	37	108	386	TNT	100ng/ml						
	tnt100n3.dat	n/a	n/a	none	TNT	100ng/ml						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10_8												
	10-8_1.dat	n/a	n/a	none	TNT	BDL						
	10-8_2.dat	14	26	42	TNT	1.5						
	10-8_3.dat	14	27	71	TNT	2.5						
	10-8_4.dat	17	29	111	TNT	4						
	10-8_5.dat	15	25	155	TNT	5.6						
	10-8_6.dat	18	32	200	TNT	7.2						
	10-8_7.dat	17	33	244	TNT	8.7						
	10tnt_11.dat	19	37	266	TNT	10	4.9	2.8	57%	0.98		
	10tnt_12.dat	20	37	191	TNT	10						
	10tnt_14.dat	20	53	279	TNT	10 **						

** Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10_17												
	10-17_1.dat	n/a	n/a	none	TNT	BDL						
	10-17_2.dat	n/a	n/a	none	TNT	BDL						
	10-17_3.dat	n/a	n/a	none	TNT	BDL						
	10-17_4.dat	n/a	n/a	none	TNT	BDL						
	10-17_5.dat	n/a	n/a	none	TNT	BDL						
	10tnt_1.dat	37	78	550	TNT	10ng/ml						
	10tnt_2.dat	41	76	277	TNT	10ng/ml						
	1ktnt_1.dat	39	117	12949	TNT	1000ng/ml	BDL			21.5		

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10c37												
	10c37_1.dat	n/a	n/a	none	TNT	BDL						
	10c37_2.dat	n/a	n/a	none	TNT	BDL						
	10c37_3.dat	n/a	n/a	none	TNT	BDL						
	10c37_4.dat	n/a	n/a	none	TNT	BDL						
	10c37_5.dat	n/a	n/a	none	TNT	BDL						
	10c37_6.dat	n/a	n/a	none	TNT	BDL						
	10c37_7.dat	n/a	n/a	none	TNT	BDL						
	10tnt_18.dat	21	56	86	TNT	10ng/ml						
	10tnt_17.dat	25	59	274	TNT	10ng/ml						
	1tnt_1.dat	-	-	BDL	TNT	1ng/ml						
	1tnt_2.dat	28	66	117	TNT	1ng/ml						
	1ktnt_3.dat	22	73	1227	TNT	-	BDL			BDL		

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10c55												
	10c55_1.dat	38	62	146	TNT	43						
	10c55_2.dat	36	65	159	TNT	46						
	10c55_3.dat	37	66	155	TNT	45						
	10c55_4.dat	35	64	123	TNT	34						
	10c55_5.dat	33	63	117	TNT	47						
	10c55_6.dat	31	70	161	TNT	47						
	10c55_7.dat	34	73	170	TNT	50						
	10tnt_3.dat	37	72	251	TNT	10	40.2	11.7	12%	50.8		
	10tnt_4.dat	37	77	241	TNT	36						
	10tnt_5.dat	40	71	152	TNT	44						
	10tnt_6.dat	38	69	148	TNT	10						
	100tnt_1.dat	39	98	343	TNT	100 **						

** Standard used for Quantitation

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10c55												
	10c55_1.dat (	n/a	n/a	none	TNT	-						
	10c55_2.dat (	n/a	n/a	none	TNT	-						
	10c55_3.dat	n/a	n/a	none	TNT	-						
	10c55_4.dat	n/a	n/a	none	TNT	-						
	10c55_5.dat	n/a	n/a	none	TNT	-						
	10tnt_14.dat	17	46	265	TNT	10	AD MEM					
	10tnt_15.dat	20	36	141	TNT	10						
	10tnt_16.dat	21	48	164	TNT	10						

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
10c57												
	10c57_1.dat	n/a	n/a	none	TNT	BDL						
	10c57_2.dat	n/a	n/a	none	TNT	BDL						
	10c57_3.dat	n/a	n/a	none	TNT	BDL						
	10c57_4.dat	n/a	n/a	none	TNT	BDL						
	10c57_5.dat	n/a	n/a	none	TNT	BDL						
	10c57_6.dat	n/a	n/a	none	TNT	BDL						
	10c57_7.dat	n/a	n/a	none	TNT	BDL						
	10tnt_9.dat (P2	35	84	487	TNT	10	BDL			BDL		
	10tnt_10.dat	36	84	491	TNT	10						
	10tnt_11.dat	36	93	453	TNT	10						
	10tnt_12.dat	38	84	271	TNT	10						

Spring samples

Sample	Injection #	Start	End	Integral	Analysis	RDX Conc. (ppb)	Mean	Std Dev	RSD	QST 8330 Conc. (ppb)	Fast 2000 Conc. (ppb)	RPD (%)
Spring												
	spr_1.dat	36	60	385	TNT	94.6						
	spr_2.dat	35	59	452	TNT	111						
	spr_3.dat	36	59	442	TNT	108.7						
	spr_4.dat	37	60	436	TNT	107						
	spr_5.dat	35	60	461	TNT	113.3						
	s1000.dat	38	102	1958	TNT	1000						
	spr_6.dat	36	62	569	TNT	139.8						
	spr_7.dat	35	62	539	TNT	132.4						
	tnt10_1.dat	38	98	505?	TNT	10	115	16	####	3.16		
	tnt100_1.dat	-	-	o respons	TNT	100						
	std100_3.dat	37	89	407	TNT	100**						
	tnt100_4.dat	39	74	212	TNT	100						
	st1000_1.dat	35	115	1687	TNT	1000						

** Standard used for Quantitation

Umatilla Army Depot, Flow, TNT, EW samples

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	TNT Conc. (ppb)	Mean	Stand. Dev.	RSD (%)	Q-Value	Reject (Y or N)	QST 8330 Conc. (ppb)	FAST 2000 Conc. (ppb)	RPD (%)
EW-1	_.1dat	33	81		309	11.4	8.25	3.55	43	0.11	N	126	8.25	-175%
	_.2dat	40	83		311	11.5								
	_.3dat	30	70		162	6								
	_.4dat	36	54		117	4.3								
	_.5dat	34	70		278	10.3								
	_.6dat	45	62		93	3.4								
	_.7dat	31	80		294	10.9								
TNT 10	_6.dat	39	70		269	10								

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	TNT Conc. (ppb)	Mean	Stand. Dev.	RSD (%)	Q-Value	Reject (Y or N)	QST 8330 Conc. (ppb)	FAST 2000 Conc. (ppb)	RPD (%)
EW-3	_.1dat	ND												
	_.2dat	36	225	644	12525	994	457			0.064	N	846	457	-60%
	_.3dat	37	90	626	1040	89.7								
	_.4dat	ND												
	_.5dat	35	209	450	8341	719								
	_.6dat	40	73	502	343	27.2								
	_.7dat	ND												
TNT 100	_6.dat	34	127	1259										

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	TNT Conc. (ppb)	Mean	Stand. Dev.	RSD (%)	Q-Value	Reject (Y or N)	QST 8330 Conc. (ppb)	FAST 2000 Conc. (ppb)	RPD (%)
EW-4	_.1dat	38	81	1370	3856	108	56	30.5	54	0.24	N	0.447	56	197%
	_.2dat	38	106	1070	3100	88								
	_.3dat	38	80	975	1594	45								
	_.4dat	36	82	875	2014	57								
	_.5dat	36	73	705	1343	38								
	_.6dat	35	75	650	1179	33								
	_.7dat	32	75	615	923	26								
TNT 100	_1.dat	37	127		3562									
	_2.dat	34	126		2908									

Umatilla Army Depot, Flow, TNT, SB samples

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	TNT Conc. (ppb)	Mean	Stand. Dev.	RSD (%)	Q-Value	Reject (Y or N)	QST 8330 Conc. (ppb)	FAST 2000 Conc. (ppb)	RPD (%)
SB-3	_.1dat	40	84	1300	3019	83	48	18.4	38	0.45	N	ND	48	ND
	_.2dat	40	74	1030	2123	58								
	_.3dat	40	73	900	1917	52								
	_.4dat	40	67	715	1009	28								
	_.5dat	39	78	660	1504	41								
	_.6dat	39	88	630	1244	34								
	_.7dat	40	78	565	1503	41								
TNT 100	_1.dat	38	79	3656										

Umatilla Army Depot, Flow, TNT, Combination samples

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	TNT Conc. (ppb)	Mean	Stand. Dev.	RSD (%)	Q-Value	Reject (Y or N)	QST 8330 Conc. (ppb)	FAST 2000 Conc. (ppb)	RPD (%)
Comb-1	_.1dat	34	81	555	2030	84	73	27.5	37.6	0.46	N	138	73	-62%
	_.2dat	33	106	515	1953	81								
	_.3dat	35	80	509	1132	47								
	_.4dat	37	82	470	998	41								
	_.5dat	35	73	305	885	80 (Used std. 2)								
	_.6dat	35	75	280	613	55 (Used Std. 2)								
	_.7dat	37	75	280	1340	121 (Used Std. 2)								
TNT 100	_1.dat	37	114	490	2414									
	_2.dat	37	99	250	1108									

Sample	Injection #	Peak Start	Peak End	Fluor. Bkgd.	Integral	TNT Conc. (ppb)	Mean	Stand. Dev.	RSD (%)	Q-Value	Reject (Y or N)	QST 8330 Conc. (ppb)	FAST 2000 Conc. (ppb)	RPD (%)
Comb-2	_.1dat	45	133	580	1321	167	190	29.6	15.5	0.25	N	133	190	35%
	_.2dat	44	135	515	1253	158								
	_.3dat	44	142	540	1741	220								
	_.4dat	44	141	540	1911	241								
	_.5dat	45	144	520	1408	178								
	_.6dat	44	143	550	1447	182								
	_.7dat	45	143	540	1471	185								
TNT 100	_1.dat	41	114	530	791									

Bangor Field Trial (June 23-26)
Fiber, TNT and RDX, FLS samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS - 1	0.0	0.0	NA	JL				
1 ppb TNT	0.0	0.0	NA	JL				
	0.0	0.0	NA	JL				
	0.0	0.0	NA	JL				
	0.0	0.0	NA	SVB				
	9.7	4.1	NA	SVB				
	11.5	5.5	NA	SVB				
	16.4	9.2	NA	SVB				
Average	4.7	2.3						
St. Dev.	6.7	3.5						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-15	40.9	35.6	NA	SVB				
100 ppb TNT,	42.7	38.6	NA	SVB				
2,4DNT	44.3	41.6	NA	SVB				
	45.4	43.7	NA	SVB				
	34.4	26.4	NA	JL				
	33.7	25.6	NA	JL				
	37.9	31.1	NA	JL				
	32.8	24.5	NA	JL				
Average	39.0	33.4						
St. Dev.	5.0	7.6						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS - 2	18.5	10.9	NA	JL				
10 ppb TNT	15.9	8.8	NA	JL				
	20.5	12.5	NA	JL				
	18.3	10.7	NA	JL				
	10.8	4.9	NA	SVB				
	6.7	1.6	NA	SVB				
	10.9	5.0	NA	SVB				
	17.7	10.2	NA	SVB				
Average	14.9	8.1						
St. Dev.	4.9	3.8						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-16	53.7	65.8	NA	SVB				
100 ppb TNT,	48.7	51.1	NA	SVB				
2amino	42.5	38.3	NA	SVB				
	40.5	35.0	NA	SVB				
	32.8	24.5	NA	JL				
	35.3	27.6	NA	JL				
	38.0	31.2	NA	JL				
	38.8	32.4	NA	JL				
Average	41.3	38.2						
St. Dev.	6.9	13.7						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS - 3	16.2	9.1	NA	JL				
100 ppb TNT	47.3	47.8	NA	JL				
	29.7	21.1	NA	JL				
	41.4	36.4	NA	JL				
	41.7	36.9	NA	SVB				
	38.5	31.9	NA	SVB				
	48.9	51.6	NA	SVB				
	54.9	70.2	NA	SVB				
Average	39.8	38.1						
St. Dev.	12.2	18.8						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-17	46.2	45.4	NA	SVB				
100 ppb TNT,TNB,	45.1	43.1	NA	SVB				
2,4DNT	49.5	53.1	NA	SVB				
	50.5	55.8	NA	SVB				
	46.5	46.0	NA	JL				
	44.7	42.4	NA	JL				
	49.2	52.4	NA	JL				
	49.1	52.1	NA	JL				
Average	47.6	48.8						
St. Dev.	2.2	5.1						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS - 4	78.6	#NUM!	NA	JL				
1000 ppb TNT	85.9	#NUM!	NA	JL				
	82.5	#NUM!	NA	JL				
	84.9	#NUM!	NA	JL				
	79.9	#NUM!	NA	SVB				
	75.8	#NUM!	NA	SVB				
	83.3	#NUM!	NA	SVB				
	85.6	#NUM!	NA	SVB				
Average	82.1	#NUM!						
St. Dev.	3.6	#NUM!						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-18	47.9	49.2	NA	SVB				
100 ppb TNT,TNB,	48.7	51.1	NA	SVB				
2aDNT	51.5	58.7	NA	SVB				
	53.3	64.4	NA	SVB				
	34.3	26.3	NA	JL				
	36.0	28.5	NA	JL				
	43.9	40.8	NA	JL				
	40.0	34.2	NA	JL				
Average	44.5	44.2						
St. Dev.	7.1	14.0						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS - 5	90.0	#NUM!	NA	SVB				
5000 ppb TNT	81.8	#NUM!	NA	SVB				
	90.5	#NUM!	NA	SVB				
	88.8	#NUM!	NA	SVB				
	80.4	#NUM!	NA	JL				
	89.5	#NUM!	NA	JL				
	80.7	#NUM!	NA	JL				
*=mixed fibers	84.6	#NUM!	NA	JL				
Average	85.8	#NUM!						
St. Dev.	4.4	#NUM!						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-19	-3.5	0.0	NA	SVB				
100 ppb HMX	-2.2	0.0	NA	SVB				
	0.5	0.0	NA	SVB				
	1.6	0.0	NA	SVB				
	-3.6	0.0	NA	JL				
	-9.2	0.0	NA	JL				
	-2.8	0.0	NA	JL				
	-3.2	0.0	NA	JL				
Average	-2.8	0.0						
St. Dev.	3.2	0.0						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-6	3.6	0.0	NA	SVB	-0.6	0.0	NA	SVB
1ppb RDX	5.9	0.9	NA	SVB	-5.7	0.0	NA	SVB
	3.9	0.0	NA	SVB	-5.7	0.0	NA	SVB
	3.4	0.0	NA	SVB	22.8	13.1	NA	SVB
	4.5	0.0	NA	JL				
	-0.6	0.0	NA	JL				
	6.3	1.2	NA	JL				
	7.1	2.0	NA	JL				
Average	4.3	0.5			2.7	3.3		
St. Dev.	2.4	0.8			13.6	6.5		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-20	15.2	8.3	NA	SVB				
100 ppb HMX,	8.9	3.5	NA	SVB				
RDX	22.5	14.2	NA	SVB				
	23.5	15.1	NA	SVB				
	22.6	14.3	NA	JL				
	0.3	0.0	NA	JL				
	24.1	15.6	NA	JL				
	26.3	17.7	NA	JL				
Average	17.9	11.1						
St. Dev.	9.1	6.4						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-7	-13.8	0.0	NA	SVB	26.9	16.3	NA	SVB
10 ppb RDX	-15.4	0.0	NA	SVB	24.7	14.6	NA	SVB
	-12.3	0.0	NA	SVB	26.5	16.0	NA	SVB
	-8.6	0.0	NA	SVB	18.6	9.9	NA	SVB
	47.6	48.5	NA	JL	16.4	8.3	NA	JL
	33.4	25.2	NA	JL	16.1	8.1	NA	JL
	48.6	50.9	NA	JL	16.7	8.5	NA	JL
	12.1	5.9	NA	JL	16.5	8.4	NA	JL
Average	11.5	16.3			20.3	11.2		
St. Dev.	28.0	22.3			4.8	3.7		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-21	37.8	30.9	NA	SVB				
100 ppb RDX,	36.1	28.6	NA	SVB				
TNT	45.2	43.3	NA	SVB				
	45.0	42.9	NA	SVB				
	71.4	332.2	NA	JL				
	79.2	#NUM!	NA	JL				
	60.9	101.5	NA	JL				
	69.2	225.4	NA	JL				
Average	55.6	#NUM!						
St. Dev.	16.6	#NUM!						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-8	-7.8	0.0	NA	JL	57.2	49.4	NA	SVB
100 ppb RDX	-1.5	0.0	NA	JL	58.1	50.9	NA	SVB
	4.8	0.0	NA	JL	63.1	60.3	NA	SVB
	-2.5	0.0	NA	JL	78.4	110.1	NA	JL
	2.7	0.0	NA	SVB	78.6	111.2	NA	JL
	1.9	0.0	NA	SVB	82.4	135.2	NA	JL
	2.7	0.0	NA	SVB	83.8	146.6	NA	JL
	3.3	0.0	NA	SVB				
Average	0.4	0.0			71.7	94.8		
St. Dev.	4.1	0.0			11.7	40.8		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-22	38.8	32.4	NA	SVB				
100 ppb HMX,	39.4	33.3	NA	SVB				
RDX,TNT	43.3	39.7	NA	SVB				
	44.9	42.7	NA	SVB				
	27.9	19.2	NA	JL				
	27.5	18.9	NA	JL				
	35.3	27.6	NA	JL				
	19.3	11.5	NA	JL				
Average	34.6	28.2						
St. Dev.	8.9	10.9						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-9	58.9	88.8	NA	JL	98.5	2953.6	NA	JL
1000 ppb RDX	46.1	45.2	NA	JL	100.0	#NUM!	NA	JL
	53.2	64.1	NA	JL	100.0	#NUM!	NA	JL
	54.0	66.9	NA	JL	100.0	#NUM!	NA	JL
	27.7	19.0	NA	SVB	99.8	#NUM!	NA	SVB
	28.7	20.1	NA	SVB	99.3	#NUM!	NA	SVB
	28.1	19.4	NA	SVB	98.7	5960.2	NA	SVB
	31.7	23.3	NA	SVB				
Average	41.1	43.3			99.5	#NUM!		
St. Dev.	13.3	27.2			0.6	#NUM!		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-10	6.9	1.8	NA	SVB	100.0	#NUM!	NA	SVB
5000 ppb RDX	5.6	0.5	NA	SVB	100.0	#NUM!	NA	SVB
	10.3	4.5	NA	SVB	100.0	#NUM!	NA	SVB
	7.6	2.4	NA	SVB	100.0	#NUM!	NA	JL
	2.5	0.0	NA	JL	100.0	#NUM!	NA	JL
	0.9	0.0	NA	JL	100.0	#NUM!	NA	JL
	3.8	0.0	NA	JL	100.0	#NUM!	NA	JL
	7.1	2.0	NA	JL				
Average	5.6	1.4			100.0	#NUM!		
St. Dev.	3.0	1.6			0.0	#NUM!		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-11	25.7	17.1	NA	SVB				
100 ppb TNB	28.5	19.9	NA	SVB				
	30.7	22.2	NA	SVB				
	33.8	25.7	NA	SVB				
	12.1	5.9	NA	JL				
	19.0	11.3	NA	JL				
	11.0	5.1	NA	JL				
	2.3	0.0	NA	JL				
Average	20.4	13.4						
St. Dev.	11.1	9.2						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-12	4.2	0.0	NA	JL				
100 ppb 2,4DNT	5.5	0.4	NA	JL				
	4.0	0.0	NA	JL				
	2.1	0.0	NA	JL				
	8.1	2.8	NA	SVB				
	8.0	2.7	NA	SVB				
	8.5	3.1	NA	SVB				
	8.9	3.5	NA	SVB				
Average	6.2	1.6						
St. Dev.	2.6	1.6						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-13	6.3	1.2	NA	JL				
100 ppb 2amDNT	20.1	12.2	NA	JL				
	13.3	6.8	NA	JL				
	18.6	11.0	NA	JL				
	12.2	6.0	NA	SVB				
	13.3	6.8	NA	SVB				
	15.0	8.1	NA	SVB				
	14.9	8.1	NA	SVB				
Average	14.2	7.5						
St. Dev.	4.2	3.3						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
FLS-14	50.2	55.0	NA	JL				
100 ppb TNT,	46.2	45.4	NA	JL				
TNB	52.6	62.1	NA	JL				
	60.5	98.7	NA	JL				
	47.5	48.3	NA	SVB				
	49.2	52.4	NA	SVB				
	50.0	54.5	NA	SVB				
	52.3	61.1	NA	SVB				
Average	51.1	59.7						
St. Dev.	4.4	16.8						

Effluent and Influent samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EFF1	0.0	0.0	NA	JL	100.0	#NUM!	NA	SM
	0.0	0.0	NA	JL	100.0	#NUM!	NA	SM
	0.0	0.0	NA	JL	0.0	0.0	NA	CR*
	23.7	15.3	NA	JL	0.0	0.0	NA	CR*
	0.0	0.0	NA	SVB	0.0	0.0	NA	LA*
	0.0	0.0	NA	SVB	15.0	7.2	NA	AZ
	0.0	0.0	NA	SVB	2.0	0.0	NA	AZ
	1.2	0.0	NA	SVB	1.0	0.0	NA	AZ
	2.6	0.0	NA	CR*	0.0	0.0	NA	AZ
	0.0	0.0	NA	CR*				
	0.0	0.0	NA	LA*				
	4.0	0.0	NA	LA*				
	7.0	1.9	NA	SM				
*=mixed fibers	27.0	18.4	NA	SM				
Average	4.7	2.5			24.2	#NUM!		
St. Dev.	9.0	6.1			43.2	#NUM!		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
INF1	11.0	5.1	NA	SM	73.9	90.3	NA	CR*
	3.0	0.0	NA	SM	89.7	225.5	NA	CR*
	1.9	0.0	NA	CR*	85.0	157.9	NA	LA*
	0.0	0.0	NA	CR*	85.0	157.9	NA	AZ
	0.0	0.0	NA	LA*	92.0	286.3	NA	AZ
*=mixed fibers	0.0	0.0	NA	LA*	92.0	286.3	NA	AZ
					92.0	286.3	NA	AZ
Average	2.7	0.8			87.1	212.9		
St. Dev.	4.3	2.1			6.6	79.0		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
INF2	0.0	0.0	NA	LA*	93.0	325.4	NA	LA*
	0.0	0.0	NA	LA*	88.0	195.2	NA	LA*
	4.2	0.0	NA	CR*	100.0	#NUM!	NA	AZ
	3.6	0.0	NA	CR*	100.0	#NUM!	NA	AZ
	0.0	0.0	NA	SM	97.0	804.6	NA	AZ
	0.0	0.0	NA	SM	97.0	804.6	NA	AZ
	0.0	0.0	NA	SM	97.0	804.6	NA	CR*
*=mixed fibers	0.0	0.0	NA	SM	95.0	454.0	NA	CR*
Average	1.0	0.0			95.9	#NUM!		
St. Dev.	1.8	0.0			3.9	#NUM!		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
INF 1					36.8	24.7	1:10	IB
					31.2	19.8	1:10	IB
					29.1	18.1	1:10	IB
					25.9	15.5	1:10	IB
					55.5	46.7	1:10	IB
					49	37.7	1:10	IB
					50.7	39.9	1:10	IB
*=mixed fibers					41.2	29	1:10	IB
Average					39.9	28.9		
St. Dev.					11.0	11.4		

Bangor SUBASE, Fiber, TNT and RDX, EW samples

Undiluted

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW2	20.0	12.1	NA	LA*	82.0	132.2	NA	LA*
	13.0	6.6	NA	LA*	63.9	62.0	NA	LA*
	22.0	13.8	NA	AZ*	90.0	231.8	NA	AZ*
	26.0	17.4	NA	AZ*	93.0	325.4	NA	AZ*
	46.1	45.2	NA	CR*	96.7	716.0	NA	CR*
	37.8	30.9	NA	CR*	89.3	217.5	NA	CR*
	11.9	5.8	NA	SVB	67.2	69.7	NA	JL
	8.1	2.8	NA	SVB	72.6	85.6	NA	JL
	15.3	8.4	NA	SVB	68.1	72.1	NA	JL
*=mixed fibers	17.8	10.3	NA	SVB	80.5	122.1	NA	NN
	24.5	16.0	NA	JL	59.5	53.4	NA	NN
	27.7	19.0	NA	JL	67.9	71.5	NA	NN
	30.1	21.5	NA	JL	47.0	35.3	NA	SM
	27.0	18.4	NA	JL				
Average	23.4	16.3			75.2	168.8		
St. Dev.	10.3	11.1			14.8	185.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW3	63.0	118.5	NA	SM	100.0	#NUM!	NA	LA*
	66.0	154.3	NA	SM	94.0	378.1	NA	LA*
	72.0	383.1	NA	SM	66.8	68.7	NA	CR*
	73.0	520.8	NA	LA*	86.5	174.6	NA	CR*
	73.0	520.8	NA	LA*				
	68.2	197.0	NA	CR*				
*=mixed fibers	69.5	235.6	NA	CR*				
Average	69.2	304.3			86.8	#NUM!		
St. Dev.	3.8	169.9			14.4	#NUM!		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW4	10.0	4.3	NA	LA*	85.0	157.9	NA	LA*
	20.0	12.1	NA	LA*	88.0	195.2	NA	LA*
	9.5	3.9	NA	SM	87.9	193.7	NA	CR*
	0.0	0.0	NA	SM	76.7	101.9	NA	CR*
	0.0	0.0	NA	SM	89.0	211.9	NA	AZ
	0.0	0.0	NA	CR*	89.0	211.9	NA	AZ
	0.0	0.0	NA	CR*				
	35.5	27.8	NA	SVB				
	33.9	25.8	NA	SVB				
*=mixed fibers	33.2	25.0	NA	SVB				
	32.2	23.8	NA	SVB				
	26.0	17.4	NA	JL				
	30.5	21.9	NA	JL				
	26.4	17.8	NA	JL				
	27.4	18.8	NA	JL				
Average	19.0	13.2			85.9	178.8		
St. Dev.	14.1	10.8			4.8	42.5		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW5	0.0	0.0	NA	CR*	74.8	93.8	NA	CR*
	0.0	0.0	NA	CR*	81.0	125.4	NA	LA*
	0.0	0.0	NA	LA*	78.0	108.1	NA	LA*
	9.0	3.5	NA	LA*	90.0	231.8	NA	AZ
	32.0	23.6	NA	SM	90.0	231.8	NA	AZ
	0.0	0.0	NA	SM	85.0	157.9	NA	AZ
	0.0	0.0	NA	SM	87.0	181.0	NA	AZ
*=mixed fibers	2.0	0.0	NA	SM				
Average	5.4	3.4			83.7	161.4		
St. Dev.	11.2	8.3			5.9	56.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW6	1.0	0.0	NA	LA*	34.0	22.2	NA	SM*
	10.0	4.3	NA	LA*	40.0	27.8	NA	SM*
	0.0	0.0	NA	CR*	94.0	378.1	NA	LA*
	3.8	0.0	NA	CR*	97.0	804.6	NA	LA*
					87.7	190.7	NA	CR*
					88.0	195.2	NA	CR*
					100.0	#NUM!	NA	AZ
					100.0	#NUM!	NA	AZ
					100.0	#NUM!	NA	AZ
*=mixed fibers					79.0	113.4	NA	AZ
Average	3.7	1.1			82.0	#NUM!		
St. Dev.	4.5	2.2			24.7	#NUM!		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW7	84.0	#NUM!	NA	AZ*	69.8	76.8	NA	JL
	87.0	#NUM!	NA	AZ*	89.5	221.4	NA	JL
	17.2	9.9	NA	LA*	79.5	116.2	NA	JL
	16.6	9.4	NA	LA*	68.5	73.1	NA	JL
	57.0	79.1	NA	SM*	67.6	70.7	NA	SVB
					69.2	75.1	NA	SVB
					70.6	79.2	NA	SVB
					76.2	99.6	NA	SVB
					63.0	60.1	NA	AZ*
					55.0	46.0	NA	AZ*
					11.1	4.1	NA	LA*
*=mixed fibers					42.0	29.8	NA	SM*
Average	52.4	#NUM!			63.5	79.3		
St. Dev.	34.4	#NUM!			20.3	53.7		

Diluted

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW3	50.5	55.9	1:50	SVB	0.0	0.0	1:50	JL
	34.5	26.6	1:50	SVB	4.2	0.0	1:50	JL
	16.0	8.9	1:50	SVB	0.0	0.0	1:50	JL
	31.7	23.3	1:50	SVB	13.3	5.9	1:50	JL
	0.0	0.0	1:50	JL	9.0	2.3	1:50	SVB
	17.0	9.7	1:50	JL	11.1	4.1	1:50	SVB
	0.0	0.0	1:50	JL	18.8	10.1	1:50	SVB
*=mixed fibers	0.0	0.0	1:50	JL	30.5	19.2	1:50	SVB
Average	18.7	15.5			10.9	5.2		
St. Dev.	18.9	19.3			10.3	6.7		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW4	2.0	0.0	1:150	LA*	11.0	4.1	1:150	LA*
	2.0	0.0	1:150	LA*	11.0	4.1	1:150	LA*
	0.0	0.0	1:150	CR*	4.2	0.0	1:150	CR*
	1.7	0.0	1:150	CR*	4.2	0.0	1:150	CR*
	0.0	0.0	1:150	SM	5.0	0.0	1:150	AZ
	0.0	0.0	1:150	SM	5.0	0.0	1:150	AZ
	0.0	0.0	1:150	SM	0.0	0.0	1:150	AZ
*=mixed fibers	0.0	0.0	1:150	SM	6.0	0.0	1:150	AZ
Average	0.7	0.0			5.8	1.0		
St. Dev.	1.0	0.0			3.7	1.9		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW5					27.7	16.9	1:10	IB
					22.3	12.7	1:10	IB
					22.4	12.8	1:10	IB
					24.9	14.7	1:10	IB
					29.8	18.6	1:10	IB
					28.9	17.8	1:10	IB
					26.7	16.1	1:10	IB
					23.4	13.6	1:10	IB
Average					25.8	15.4		
St. Dev.					2.9	2.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW6					48.4	37.0	1:10	IB
					40.7	28.5	1:10	IB
					47.2	35.6	1:10	IB
					54.7	45.6	1:10	IB
					56.5	48.3	1:10	IB
					56.7	48.6	1:10	IB
					52.3	42.1	1:10	IB
					46.2	34.4	1:10	IB
Average					50.3	40.0		
St. Dev.					5.7	7.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW7	84.8	#NUM!	1:2	CR*	94.1	384.4	1:2	CR*
	90.5	#NUM!	1:2	CR*	63.2	60.5	1:2	CR*
	75.0	3337.7	1:2	SM	70.0	77.4	1:2	AZ
	74.0	847.3	1:2	SM	68.0	71.8	1:2	AZ
	71.0	305.4	1:2	SM	67.0	69.2	1:2	AZ
	77.0	#NUM!	1:2	SM	71.0	80.4	1:2	AZ
	86.0	#NUM!	1:2	LA*	61.0	56.1	1:2	LA*
*=mixed fibers	85.0	#NUM!	1:2	LA*	55.0	46.0	1:2	LA*
Average	80.4	#NUM!			68.7	105.7		
St. Dev.	7.0	#NUM!			11.5	113.2		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW9	13.0	6.6	1:2	SM	21.4	12.0	1:200	JL
	0.0	0.0	1:2	SM	27.3	16.6	1:200	JL
	0.0	0.0	1:2	SM	36.5	24.4	1:200	JL
	0.0	0.0	1:2	SM	28.4	17.5	1:200	JL
	0.1	0.0	1:2	CR*	0.0	0.0	1:200	SVB
	2.2	0.0	1:2	CR*	0.0	0.0	1:200	SVB
*=mixed fibers					0.0	0.0	1:200	SVB
Average	2.6	1.1			16.2	10.1		
St. Dev.	5.2	2.7			15.8	10.1		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW10	0.0	0.0	1:10	CR*	66.0	66.8	1:10	CR*
	0.0	0.0	1:10	CR*	59.0	52.5	1:10	CR*
	0.0	0.0	1:10	SM	96.0	574.9	1:10	AZ
	0.0	0.0	1:10	SM	96.0	574.9	1:10	AZ
	0.0	0.0	1:10	SM	96.0	574.9	1:10	AZ
	0.0	0.0	1:10	SM	95.0	454.0	1:10	AZ
	0.0	0.0	1:10	CR*	55.6	46.9	1:10	CR*
*=mixed fibers	0.0	0.0	1:10	CR*	57.6	50.1	1:10	CR*
Average	0.0	0.0			77.7	299.4		
St. Dev.	0.0	0.0			19.6	265.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW8	30.0	21.4	NA	LA*	79.5	116.2	NA	SVB
	28.0	19.3	NA	LA*	92.2	293.3	NA	SVB
	100.0	#NUM!	NA	SM	93.0	325.4	NA	SVB
	12.0	5.8	NA	SM	86.2	171.0	NA	SVB
	0.0	0.0	NA	SM	85.0	157.9	NA	LA*
	31.0	22.5	NA	SM	83.0	139.9	NA	LA*
	9.4	3.8	NA	CR*	96.0	574.9	NA	AZ
	12.9	6.5	NA	CR*	98.0	1470.2	NA	AZ
	0.0	0.0	NA	JL	81.0	125.4	NA	AZ
	0.0	0.0	NA	JL	98.0	1470.2	NA	AZ
	0.0	0.0	NA	JL	92.7	312.5	NA	CR*
	0.0	0.0	NA	JL	80.9	124.7	NA	CR*
	0.0	0.0	NA	SVB	94.9	444.9	NA	JL
	2.3	0.0	NA	SVB	89	211.9	NA	JL
	2.6	0.0	NA	SVB	81.0	125.4	NA	JL
*=mixed fibers	14.1	7.4	NA	SVB				
Average	15.1	#NUM!			88.7	404.2		
St. Dev.	25.3	#NUM!			6.7	452.7		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW9	0.0	0.0	NA	AZ*	0.0	0.0	NA	SM*
	0.0	0.0	NA	AZ*	75.0	94.6	NA	AZ*
	10.0	4.3	NA	LA*	67.0	69.2	NA	AZ*
	13.0	6.6	NA	LA*	85.0	157.9	NA	LA*
	35.9	28.3	NA	SVB				
	34.0	26.0	NA	SVB				
	32.6	24.3	NA	SVB				
	35.3	27.6	NA	SVB				
	5.0	0.0	NA	JL				
*=mixed fibers	0.0	0.0	NA	JL				
	4.6	0.0	NA	JL				
	2.8	0.0	NA	JL				
Average	14.4	9.8			56.8	80.4		
St. Dev.	15.3	12.6			38.5	65.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW10	2.2	0.0	NA	LA*	98.5	2953.6	NA	LA*
	3.8	0.0	NA	LA*	98.0	1470.2	NA	AZ*
	2.0	0.0	NA	AZ*	88.0	195.2	NA	AZ*
	4.0	0.0	NA	AZ*	98.1	1620.6	NA	SM*
	0.0	0.0	NA	SM*	100.0	#NUM!	NA	SM*
*=mixed fibers	0.0	0.0	NA	SM*				
Average	2.0	0.0			96.5	#NUM!		
St. Dev.	1.7	0.0			4.8	#NUM!		

Diluted

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW3					41.7	29.5	1:10	IB
					39.9	27.6	1:10	IB
					36.9	24.8	1:10	IB
					39.2	27.0	1:10	IB
					51	40.3	1:10	IB
					50.9	40.2	1:10	IB
					48.9	37.6	1:10	IB
					45.7	33.9	1:10	IB
Average					44.3	32.6		
St. Dev.					5.6	6.2		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW4					23.0	13.2	1:100	JL
					25.7	15.3	1:100	JL
					26.4	15.9	1:100	JL
					27.5	16.7	1:100	JL
					46.0	34.2	1:100	SVB
					50.7	39.9	1:100	SVB
					51.6	41.1	1:100	SVB
*=mixed fibers					50.9	40.2	1:100	SVB
Average					37.7	27.1		
St. Dev.					13.1	12.8		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW6					17.9	9.4	1:150	SVB
					4.8	0.0	1:150	SVB
					12.8	5.5	1:150	SVB
					96.2	608.5	1:150	SVB
					94.5	412.2	1:150	JL
					14.0	6.5	1:150	JL
					5.2	0.0	1:150	JL
*=mixed fibers					27.4	16.7	1:150	JL
Average					34.1	132.3		
St. Dev.					38.5	239.2		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW7	21.4	13.3	1:50	SVB				
	24.0	15.6	1:50	SVB				
	24.3	15.8	1:50	SVB				
	15.8	8.8	1:50	SVB				
	22.0	13.8	1:50	JL				
	30.4	21.8	1:50	JL				
	44.8	42.5	1:50	JL				
*=mixed fibers	26.3	17.7	1:50	JL				
Average	26.1	18.7						
St. Dev.	8.6	10.3						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW9	0.0	0.0	1:100	LA*	19.0	10.2	1:100	LA*
	0.0		1:100	LA*	13.0	5.7	1:100	LA*
	0.0		1:100	CR*	20.9	11.7	1:100	CR*
	0.0		1:100	CR*	20.5	11.4	1:100	CR*
					72.0	83.6	1:100	AZ
					76.0	98.7	1:100	AZ
					72.0	83.6	1:100	AZ
*=mixed fibers					68.0	71.8	1:100	AZ
Average	0.0				45.2	47.1		
St. Dev.	0.0				28.9	40.6		

SUBASE Bangor, Fiber, TNT and RDX, BTW samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
BTW1	6.0	0.9	NA	CR*	8.7	2.0	NA	CR*
	6.4	1.3	NA	CR*	7.6	0.7	NA	CR*
	1.0	0.0	NA	LA*	25.0	14.8	NA	LA*
	0.0	0.0	NA	LA*	10.0	3.2	NA	LA*
	0.0	0.0	NA	SM	34.0	22.2	NA	AZ
	17.0	9.7	NA	SM	27.0	16.3	NA	AZ
	13.0	6.6	NA	SM	32.0	20.4	NA	AZ
*=mixed fibers					45.0	33.0	NA	AZ
Average	6.2	2.7			23.7	14.1		
St. Dev.	6.7	3.9			13.7	11.4		

SUBASE Bangor, Fiber, TNT and RDX, Standards

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TNT 100	61.4	105.1	NA	AZ *	20.9	11.7	NA	AZ*
	68.0	192.2	NA	AZ *	0.0	0.0	NA	AZ*
	49.0	51.9	NA	LA *	18.0	9.5	NA	LA*
	49.0	51.9	NA	LA *	0.0	0.0	NA	CR*
	0.0	0.0	NA	CR *	6.0	0.0	NA	SM*
	23.8	15.4	NA	SM *	0.0	0.0	NA	SM*
*=mixed fibers	0.0	0.0	NA	AZ *				
Average	35.9	59.5			7.5	3.5		
St. Dev.	28.1	69.3			9.6	5.5		

SUBASE Bangor, Fiber, TNT and RDX, Blanks

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
BLANK 1	0.0	0.0	NA	SM	0.0	0.0	NA	AZ
	0.0	0.0	NA	SM	0.0	0.0	NA	AZ
	0.0	0.0	NA	LA*	0.0	0.0	NA	AZ
	0.0	0.0	NA	LA*	0.0	0.0	NA	AZ
	3.4	0.0	NA	CR*	4.0	0.0	NA	LA*
	0.0	0.0	NA	CR*	9.0	2.3	NA	LA*
					0.0	0.0	NA	CR*
*=mixed fibers					0.0	0.0	NA	CR*
Average	0.6	0.0			1.6	0.3		
St. Dev.	1.4	0.0			3.3	0.8		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
BLANK 2	3.0	0.0	NA	LA*	0.0	0.0	NA	AZ
	1.0	0.0	NA	LA*	0.0	0.0	NA	AZ
	0.0	0.0	NA	CR*	22.0	12.5	NA	AZ
	0.0	0.0	NA	CR*	0.0	0.0	NA	AZ
	0.0	0.0	NA	SM	8.0	1.2	NA	LA*
	0.0	0.0	NA	SM	2.0	0.0	NA	LA*
					6.0	0.0	NA	CR*
*=mixed fibers					0.0	0.0	NA	CR*
Average	0.7	0.0			4.8	1.7		
St. Dev.	1.2	0.0			7.6	4.4		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
BLANK 3	0.0	0.0	NA	CR*	6.0	0.0	NA	CR*
	0.3	0.0	NA	CR*	1.3	0.0	NA	CR*
	0.0	0.0	NA	LA*	0.0	0.0	NA	LA*
	0.0	0.0	NA	LA*	0.0	0.0	NA	LA*
	0.0	0.0	NA	SM	0.0	0.0	NA	AZ
	0.0	0.0	NA	SM	5.0	0.0	NA	AZ
	0.0	0.0	NA	SM	8.0	1.2	NA	AZ
*=mixed fibers	0.0	0.0	NA	SM	5.0	0.0	NA	AZ
Average	0.0	0.0			3.2	0.2		
St. Dev.	0.1	0.0			3.2	0.4		

Crane Field Trial (September 8-12, 1997)
Fiber, TNT and RDX, Numbered samples

03C samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03C03P2	-24.5	0.0	NA	KD	102.0	#NUM!	NA	LA
	-11.6	0.0	NA	KD	95.0	454.0	NA	LA
	4.3	0.0	NA	KD	89.2	215.6	NA	IB
	-3.4	0.0	NA	KD	75.0	94.6	NA	IB
	-59.0	0.0	NA	KD	72.4	84.9	NA	IB
	-65.0	0.0	NA	KD	72.0	83.6	NA	IB
	-96.0	0.0	NA	KD				
Average	-36.5	0.0			84.3	#NUM!		
St. Dev.	37.4	0.0			12.9	#NUM!		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03C03P2					58.4	51.5	NA	LA
					46.0	34.2	NA	LA
					44.4	32.4	NA	IB
					52.5	42.4	NA	IB
Average					50.3	40.1		
St. Dev.					6.4	8.7		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03C04	-176.7	0.0	NA	KD	-9.0	0.0	NA	TM
	-168	0.0	NA	KD	-4.0	0.0	NA	TM
	-68.6	0.0	NA	KD	4.0	0.0	NA	KD
	22.0	13.8	NA	LA	6.5	0.0	NA	KD
	12.0	5.8	NA	LA	3.7	0.0	NA	KD
	34.0	26.0	NA	LA	16.7	8.5	NA	KD
	1.0	0.0	NA	TM	-70.0	0.0	NA	IB
	-69.3	0.0	NA	TM	-100.0	0.0	NA	IB
	-7.2	0.0	NA	TM	-88.0	0.0	NA	IB
	-53.2	0.0	NA	TM	-92.0	0.0	NA	IB
	12.1	5.9	NA	TM	-83.9	0.0	NA	SVB
	-46.9	0.0	NA	TM				
	-7.7	0.0	NA	TM				
	-40.2	0.0	NA	TM				
	15.9	8.8	NA	TM				
Average	-10.6	5.0			-37.8	0.9		
St. Dev.	33.6	8.0			47.8	2.7		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03C08AP2	5.6	0.5	NA	TM	47.3	35.7	NA	TM
	11.9	5.8	NA	TM	48.0	36.5	NA	TM
	9.6	4.0	NA	TM	70.8	79.8	NA	LSL
	10.8	4.9	NA	TM	80.5	122.1	NA	LSL
	-11.2	0.0	NA	KD	71.0	80.4	NA	LSL
	2.4	0.0	NA	KD	59.9	54.1	NA	SVB
	-11.7	0.0	NA	KD	53.0	43.1	NA	SVB
	-30.2	0.0	NA	TM	38.3	26.1	NA	SVB
	-18.7	0.0	NA	TM	43.8	31.7	NA	SVB
	-20.7	0.0	NA	TM				
	-7.3	0.0	NA	TM				
Average	-5.4	1.4			57.0	56.6		
St. Dev.	14.4	2.3			14.4	31.6		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03C09P2					47.0	35.3	NA	IB
					59.0	52.5	NA	IB
					63.2	60.5	NA	SVB
					53.4	43.6		
					51.5	41.0		
					46.0	34.2		
					53.3	43.5		
Average					53.3	44.4		
St. Dev.					6.1	9.4		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03C10	12.0	5.8	NA	LA	44.0	31.9	NA	KD
	-35.0	0.0	NA	LA	74.0	90.7	NA	KD
	-28.0	0.0	NA	LA	67.0	69.2	NA	KD
	20.1	12.2	NA	TM	48.0	36.5	NA	KD
	-24.7	0.0	NA	TM	74.9	94.2	NA	TM
	-11.2	0.0	NA	TM	60.3	54.8	NA	TM
	-32.1	0.0	NA	TM	51.2	40.6	NA	LA
					48.4	37.0	NA	IB
					25.0	14.8	NA	IB
					57.6	50.1	NA	IB
					59.7	53.7	NA	IB
					33.8	22.0	NA	SVB
Average	-14.1	2.6			53.7	49.6		
St. Dev.	22.1	4.8			15.1	24.9		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03C12	16.7	9.5	NA	TM				
	-60.9	0.0	NA	TM				
	-39.9	0.0	NA	TM				
	-103.7	0.0	NA	TM				
	-161.0	0.0	NA	KD				
	-142.0	0.0	NA	KD				
	-109.0	0.0	NA	KD				
	-55.0	0.0	NA	KD				
Average	-81.9	1.2						
St. Dev.	58.2	3.3						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03C17	-70.8	0.0	NA	TM	-19.0	0.0	NA	IB
	-15.7	0.0	NA	TM	16.4	8.3	NA	SVB
	-64.4	0.0	NA	TM	6.2	0.0	NA	SVB
	14.0	7.4	NA	TM	4.3	0.0	NA	IB
	-50.5	0.0	NA	KD	-3.2	0.0	NA	IB
	-51.5	0.0	NA	KD	14.6	6.9	NA	IB
	-57.4	0.0	NA	KD				
	-54.5	0.0	NA	KD				
Average	-43.9	0.9			3.2	2.5		
St. Dev.	28.5	2.6			13.0	3.9		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
03-34	-92.0	0.0	NA	KD	-0.8	0.0	NA	IB
	-99.0	0.0	NA	KD	-0.3	0.0	NA	IB
	-27.1	0.0	NA	TM	-0.6	0.0	NA	IB
	14.9	8.1	NA	TM	6.3	0.0	NA	IB
	-13.6	0.0	NA	TM				
	23.2	14.8	NA	TM				
	-73.0	0.0	NA	JL				
	-135.0	0.0	NA	JL				
	-71.0	0.0	NA	JL				
Average	-52.5	2.5			1.2	0.0		
St. Dev.	54.5	5.3			3.4	0.0		

10- samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10-07	-75.4	0.0	NA	KD	14.0	6.5	NA	IB
	-88.4	0.0	NA	KD	24.0	14.0	NA	IB
	-36.9	0.0	NA	KD	29.9	18.7	NA	SVB
	-45.0	0.0	NA	KD				
	-41.0	0.0	NA	KD				
	-38.2	0.0	NA	KD				
	19.6	11.8	NA	TM				
	17.8	10.3	NA	TM				
	21.0	12.9	NA	TM				
	0.0	0.0	NA	TM				
Average	-26.7	3.5			22.6	13.1		
St. Dev.	39.5	5.7			8.0	6.2		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10-08	14.9	8.1	NA	TM	-12.0	0.0	NA	IB
	-11.6	0.0	NA	TM	-0.9	0.0	NA	IB
	0.7	0.0	NA	TM	-1.6	0.0	NA	IB
	-41.9	0.0	NA	TM	-1.0	0.0	NA	IB
	-170.9	0.0	NA	KD	-55.6	0.0	NA	SVB
	-129.7	0.0	NA	KD				
	-116.9	0.0	NA	KD				
	-174.0	0.0	NA	KD				
	0.0	0.0	NA	LA				
	0.0	0.0	NA	LA				
	-60.0	0.0	NA	LA				
Average	-62.7	0.7			-14.2	0.0		
St. Dev.	72.4	2.4			23.6	0.0		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10-17	30.5	21.9	NA	TM	-18.0	0.0	NA	LSL
	32.0	23.6	NA	TM	40.0	27.8	NA	LSL
	31.5	23.0	NA	TM	33.0	21.3	NA	LSL
	21.6	13.5	NA	TM	8.0	1.2	NA	LSL
	19.0	11.3	NA	TM	34.0	22.2	NA	SVB
	44.1	41.2	NA	TM	20.0	11.0	NA	SVB
	29.5	20.9	NA	TM	-23.0	0.0	NA	IB
	53.7	65.8	NA	TM	-87.0	0.0	NA	IB
	32.0	23.6	NA	KD	-27.0	0.0	NA	IB
	23.6	15.2	NA	KD	14.7	7.0	NA	SVB
	31.6	23.2	NA	KD				
	26.5	17.9	NA	KD				
Average	31.3	25.1			-0.5	9.0		
St. Dev.	9.5	14.9			39.0	10.9		

10C samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10C37	-53.3	0.0	NA	KD	-50.0	0.0	NA	IB
	-82.2	0.0	NA	KD	-39.0	0.0	NA	IB
	-48.7	0.0	NA	KD	-69.0	0.0	NA	IB
	-50.7	0.0	NA	TM	-38.0	0.0	NA	IB
	3.0	0.0	NA	TM	-122.4	0.0	NA	SVB
	-41.5	0.0	NA	TM	-56.0	0.0	NA	IB
	16.8	9.5	NA	TM	-51.0	0.0	NA	IB
					-56.0	0.0	NA	IB
					-47.0	0.0	NA	IB
Average	-36.7	1.4			-58.7	0.0		
St. Dev.	34.5	3.6			25.7	0.0		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10C55	8.5	3.1	NA	LA	68.0	71.8	NA	IB
	0.0	0.0	NA	LA	59.4	53.2	NA	SVB
	5.0	0.0	NA	LA	59.4	53.2	NA	SVB
	25.0	16.5	NA	LA	56.0	47.5	NA	IB
	28.0	19.3	NA	LA	71.0	80.4	NA	IB
	9.0	3.5	NA	LA	86.0	168.7	NA	IB
	0.0	0.0	NA	LA	79.0	113.4	NA	IB
	-60.0	0.0	NA	LA				
	-32.4	0.0	NA	KD				
	-15.0	0.0	NA	KD				
	6.6	1.5	NA	KD				
	-25.2	0.0	NA	KD				
Average	-4.2	3.7			68.4	84.0		
St. Dev.	25.1	6.8			11.1	43.6		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10C55P2	24.1	15.6	NA	KD	30.6	19.3	NA	IB
	10.0	4.3	NA	LA	29.0	18.0	NA	IB
	10.0	4.3	NA	LA	27.0	16.3	NA	SVB
	1.0	0.0	NA	LA	13.3	5.9	NA	IB
	-26.0	0.0	NA	LA	7.9	1.1	NA	IB
					-6.0	0.0	NA	IB
					31.9	20.4	NA	IB
Average	3.8	4.9			19.1	11.6		
St. Dev.	18.6	6.4			14.4	8.9		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10C57	-10.0	0.0	NA	LA	0.4	0.0	NA	IB
	-40.0	0.0	NA	LA	0.0	0.0	NA	SVB
	-30.0	0.0	NA	LA	-0.3	0.0	NA	SVB
	-30.0	0.0	NA	LA				
	-103.3	0.0	NA	KD				
	-142.4	0.0	NA	KD				
	-122.9	0.0	NA	KD				
Average	-68.4	0.0			0.0	0.0		
St. Dev.	53.0	0.0			0.3	0.0		

1x ppb TNT samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
1 ppb TNT	-0.5	0.0	NA	KD	-4.6	0.0	NA	IB
(new)	-13.2	0.0	NA	KD	-2.2	0.0	NA	IB
	-42.3	0.0	NA	KD	3.9	0.0	NA	IB
	-23.8	0.0	NA	KD	-16.0	0.0	NA	IB
	-30.0	0.0	NA	JSL				
	-44.0	0.0	NA	JSL				
	-29.0	0.0	NA	JSL				
	-25.0	0.0	NA	JSL				
Average	-26.0	0.0						
St. Dev.	14.3	0.0						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10 ppb TNT	-4.0	0.0	NA	LSL				
(old)	-4.0	0.0	NA	LSL				
	10.0	4.3	NA	LSL				
	14.0	7.4	NA	LSL				
	21.0	12.9	NA	KD				
	10.2	4.5	NA	KD				
	13.0	6.6	NA	KD				
	8.1	2.8	NA	KD				
Average	8.5	4.8						
St. Dev.	8.7	4.3						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10 ppb TNT	53.9	66.5	NA	KD				
(new)	50.8	56.7	NA	KD				
	71.0	305.4	NA	KD				
	55.5	72.6	NA	KD				
	33.0	24.8	NA	JSL				
	32.0	23.6	NA	JSL				
	29.0	20.4	NA	JSL				
	-17.0	0.0	NA	TM				
	-11.7	0.0	NA	TM				
	-14.5	0.0	NA	TM				
	25.9	17.3	NA	TM				
	43.3	39.7	NA	KD				
	42.9	39.0	NA	KD				
	39.9	34.0	NA	KD				
	47.6	48.5	NA	KD				
	30.0	21.4	NA	LA				
	13.0	6.6	NA	LA				
	-10.0	0.0	NA	LA				
	-80.0	0.0	NA	LA				
Average	22.9	40.9						
St. Dev.	35.8	68.1						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
100 ppb TNT	54.2	67.6	NA	TM	-0.1	0.0	NA	IB
(new)	65.3	144.2	NA	TM	4.5	0.0	NA	IB
	62.0	109.8	NA	TM	4.6	0.0	NA	IB
	64.4	133.0	NA	TM	0.4	0.0	NA	IB
	71.2	318.2	NA	TM				
	68.2	197.0	NA	TM				
	68.4	202.1	NA	TM				
	55.4	72.2	NA	TM				
	50.1	54.7	NA	TM				
	43.0	39.2	NA	TM				
	39.8	33.9	NA	TM				
	33.6	25.5	NA	TM				
Average	56.3	116.4			2.4	0.0		
St. Dev.	12.4	87.8			2.5	0.0		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
1000 ppb TNT	39.5	33.4	1:10	KD	-2.6	0.0	NA	IB
(new)	45.4	43.7	1:10	KD	1.2	0.0	NA	IB
	51.3	58.1	1:10	KD	-1.7	0.0	NA	IB
	36.4	29.0	1:10	KD	-4.6	0.0	NA	IB
	39.0	32.7	1:10	JSL				
	31.0	22.5	1:10	JSL				
	40.0	34.2	1:10	JSL				
	49.0	51.9	1:10	JSL				
Average	41.5	38.2			-1.9	0.0		
St. Dev.	6.7	12.0			2.4	0.0		

1x ppb RDX samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
10 ppb RDX					27.9	17.1	NA	TM
					-98.7	0.0	NA	TM
Average					-35.4	8.5		
St. Dev.					89.5	12.1		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
100 ppb RDX					57.0	49.1	NA	LA
					39.0	26.8	NA	LA
					69.0	74.5	NA	KD
					77.0	103.2	NA	KD
					70.3	78.3	NA	KD
Average					62.5	66.4		
St. Dev.					15.0	29.3		

Spring samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
Spring	5.0	0.0	NA	LSL	31.0	19.6	NA	LA
	9.0	3.5	NA	LSL	62.0	58.1	NA	LA
	18.0	10.5	NA	LSL	64.0	62.2	NA	LA
	25.0	16.5	NA	LSL	39.0	26.8	NA	IB
	-21.0	0.0	NA	LSL	36.0	24.0	NA	IB
	-25.0	0.0	NA	LSL	35.0	23.1	NA	IB
	2.0	0.0	NA	LSL				
	13.0	6.6	NA	LSL				
	-6.0	0.0	NA	JL				
	1.3	0.0	NA	JL				
	20.2	12.3	NA	JL				
	28.4	19.8	NA	JL				
	11.0	5.1	NA	KD				
	-19.0	0.0	NA	KD				
	30.2	21.6	NA	KD				
	24.3	15.8	NA	KD				
Average	7.3	7.0			44.5	35.6		
St. Dev.	17.7	7.9			14.6	19.2		

Soil Studies - FOB
TNT and RDX

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ001	-0.4	1.3	20	SVB	62.5	59.1	20	LCS
	-0.6	1.2	20	SVB	58.0	50.8	20	LCS
	-4.8	0.2	20	SVB	63.8	61.8	20	LCS
	-2.1	0.8	20	SVB	56.9	49.0	20	LCS
	-1.9	0.8	20	LCS	64.4	63.1	20	SVB
	-1.2	1.0	20	LCS	56.9	49.0	20	SVB
	5.0	3.4	20	LCS	62.1	58.3	20	SVB
	-6.7	0.0	20	LCS	60.8	55.8	20	SVB
Average	-1.6	1.1			60.7	55.8		
St. Dev.	3.4	1.0			3.0	5.7		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ002	18.6	12.9	20	SVB	32.9	21.2	20	LCS
	15.1	9.8	20	SVB	30.0	18.8	20	LCS
	11.2	6.9	20	SVB	33.5	21.7	20	LCS
	18.7	13.0	20	SVB	28	17.1	20	LCS
	32.2	31.5	20	LCS	41.4	29.2	20	SVB
	27.6	23.8	20	LCS	30.8	19.4	20	SVB
	32.4	31.9	20	LCS	34.8	22.9	20	SVB
	28.8	25.7	20	LCS	34.0	22.2	20	SVB
	17.8	12.2	20	LCS				
	18.0	12.4	20	LCS				
	19	13.3	20	LCS				
Average	22.0	18.0			33.2	21.6		
St. Dev.	7.5	9.3			4.0	3.6		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ003	32.8	32.7	20000	LCS	10.2	3.4	20	LCS
	27.8	24.1	20000	LCS	10.9	4.0	20	LCS
	31.5	30.3	20000	LCS	7.5	0.6	20	LCS
	33.5	34.1	20000	LCS	11.6	4.6	20	LCS
	39.7	48.6	20000	SVB	6.1	0.0	20	LCS
	43.2	59.1	20000	SVB	2.7	0.0	20	LCS
	45.1	65.8	20000	SVB	2.8	0.0	20	LCS
	38.6	45.7	20000	SVB	8.2	1.5	20	LCS
Average	36.5	42.5			7.5	1.7		
St. Dev.	6.1	14.7			3.4	1.9		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ004	45.7	68.0	640	SVB	2.0	0.0	20	LCS
	43.4	59.8	640	SVB	1.6	0.0	20	LCS
	40.2	50.0	640	SVB	1.5	0.0	20	LCS
	43.9	61.5	640	SVB	5.8	0.0	20	LCS
	44.3	62.9	640	SVB	-10.7	0.0	20	LCS
	49.6	84.7	640	SVB	6.4	0.0	20	LCS
	47.0	73.2	640	SVB	4.7	0.0	20	LCS
	44.2	62.5	640	SVB	1.1	0.0	20	LCS
Average	44.8	65.3			1.6	0.0		
St. Dev.	2.8	10.3			5.4	0.0		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ005	38.9	46.4	2000	SVB	49.8	38.8	20	LCS
	42.8	57.8	2000	SVB	55.7	47.1	21	LCS
	42.7	57.5	2000	SVB	55.7	47.1	22	LCS
	38.3	44.9	2000	SVB	54.5	45.2	23	LCS
	39.4	47.8	2000	SVB	52.2	41.9	24	SVB
	40.9	52.0	2000	SVB	49.8	38.8	25	SVB
	42.6	57.2	2000	SVB	54.8	45.7	26	SVB
	38.7	45.9	2000	SVB	51.6	41.1	27	SVB
Average	40.5	51.2			53.0	43.2		
St. Dev.	1.9	5.6			2.5	3.5		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ006	32.3	31.7	1000	SVB	35.8	23.8	4000	LCS
	29.0	26.0	1000	SVB	40.0	27.8	4000	LCS
	30.6	28.7	1000	SVB	37.4	25.3	4000	LCS
	30.4	28.3	1000	SVB	39.1	26.9	4000	LCS
	34.8	36.7	1000	SVB	59.5	53.4	4000	SVB
	32.5	32.1	1000	SVB	54.3	44.9	4000	SVB
	31.5	30.3	1000	SVB	58.5	51.6	4000	SVB
	26.1	21.7	1000	SVB	56.3	48.0	4000	SVB
					60.1	54.5	4000	LCS
					61.7	57.5	4000	LCS
					59.2	52.8	4000	LCS
					60.4	55.0	4000	LCS
					37.2	25.1	4000	LCS
					58.5	51.6	4000	LCS
					54.3	44.9	4000	LCS
					62.9	59.9	4000	LCS
Average	30.9	29.4			51.5	43.9		
St. Dev.	2.6	4.5			10.2	13.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ007	38.1	44.4	1000	SVB	22.7	13.0	200	LCS
	38.7	45.9	1000	SVB	31.7	20.2	200	LCS
	36.0	39.4	1000	SVB	37.5	25.4	200	LCS
	37.7	43.4	1000	SVB	33.7	21.9	200	LCS
	40.2	50.0	1000	SVB	42.2	30.0	200	LCS
	43.5	60.1	1000	SVB	23.8	13.9	200	LCS
	44.5	63.6	1000	SVB	50.0	39.0	200	LCS
	39.3	47.5	1000	SVB	39.0	26.8	200	LCS
					58.7	52.0	200	SVB
					58.3	51.3	200	SVB
					58.6	51.8	200	SVB
					53.2	43.3	200	SVB
					54.8	45.7	200	LCS
					58.5	51.6	200	LCS
					56.1	47.7	200	LCS
					55.2	46.3	200	LCS
Average	39.8	49.3			45.9	36.2		
St. Dev.	2.9	8.4			12.9	14.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ008	38.3	44.9	20	SVB	36.8	24.7	4000	SVB
	39.4	47.8	20	SVB	44.6	32.6	4000	SVB
	37.2	42.2	20	SVB	40.1	27.9	4000	SVB
	37.1	41.9	20	SVB	39.2	27.0	4000	SVB
	40.3	50.3	20	LCS	41.5	29.3	4000	SVB
	39.0	46.7	20	LCS	43.9	31.8	4000	SVB
	38.6	45.7	20	LCS	41.9	29.7	4000	SVB
	39.6	48.3	20	LCS	40.4	28.2	4000	SVB
Average	38.7	46.0			41.1	28.9		
St. Dev.	1.1	2.9			2.5	2.6		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ009	14.2	9.1	20	SVB	37.9	25.7	20	SVB
	10.6	6.5	20	SVB	40.6	28.4	20	SVB
	7.2	4.5	20	SVB	40.0	27.8	20	SVB
	11.0	6.8	20	SVB	38.8	26.6	20	SVB
	11.0	6.8	20	LCS	43.3	31.2	20	SVB
	14.2	9.1	20	LCS	39.1	26.9	20	SVB
	8.9	5.5	20	LCS	36.5	24.4	20	SVB
	9.6	5.9	20	LCS	40.5	28.3	20	SVB
Average	10.8	6.8			39.6	27.4		
St. Dev.	2.4	1.6			2.0	2.0		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
TJ010	49.2	82.8	40	SVB	49.1	37.9	60	SVB
	48.3	78.7	40	SVB	57.0	49.1	60	SVB
	47.1	73.6	40	SVB	49.0	37.8	60	SVB
	49.0	81.9	40	SVB	53.1	43.2	60	SVB
	51.4	93.8	40	LCS	51.8	41.4	60	LCS
	48.6	80.1	40	LCS	38.3	26.1	60	LCS
	47.2	74.0	40	LCS	52.7	42.6	60	LCS
	50.1	87.1	40	LCS	46.7	35.0	60	LCS
Average	48.9	81.5			49.7	39.1		
St. Dev.	1.4	6.7			5.6	6.8		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
G51-L1-A	41.4	53.5	20	SVB	61.2	56.5	40	LCS
	34.5	36.1	20	SVB	58.5	51.6	40	LCS
	40.9	52.0	20	SVB	60.1	54.5	40	LCS
	39.2	47.2	20	SVB	57.5	49.9	40	LCS
	40.1	49.7	20	SVB	57.4	49.8	40	LCS
	39.7	48.6	20	SVB	61.9	57.9	40	LCS
	31.5	30.3	20	SVB	56.9	49.0	40	LCS
					58.7	52.0	40	LCS
Average	38.2	45.3			59.0	52.6		
St. Dev.	3.7	8.7			1.9	3.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
G16-L2-A	23.6	18.4	100	LCS	46.4	34.6	400	LCS
	14.7	9.5	100	LCS	52.9	42.9	400	LCS
	22.9	17.6	100	LCS	47.6	36.0	400	LCS
	36.1	39.6	100	LCS	47.5	35.9	400	LCS
	39.7	48.6	100	SVB	59.8	53.9	400	LCS
	41.0	52.3	100	SVB	58.4	51.5	400	LCS
	35.7	38.7	100	SVB	60.0	54.3	400	LCS
	33.2	33.5	100	LCS	51.8	41.4	400	LCS
	33.3	33.7	100	LCS				
	34.5	36.1	100	LCS				
Average	31.5	32.4			53.1	43.8		
St. Dev.	8.4	14.5			5.7	8.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
G55-X-A	15.0	9.7	2000	LCS	57.4	49.8	4000	LCS
	5.2	3.5	2000	LCS	59.1	52.7	4000	LCS
	13.7	8.7	2000	LCS	62.0	58.1	4000	LCS
	31.9	31.0	2000	LCS	60.1	54.5	4000	LCS
	36.9	41.4	2000	SVB	51.2	40.6	4000	LCS
	39.1	47.0	2000	SVB	57.1	49.3	4000	LCS
	31.5	30.3	2000	SVB	52.7	42.6	4000	LCS
	22.7	17.3	2000	LCS	53.5	43.8	4000	LCS
	23.8	18.7	2000	LCS				
	26	21.5	2000	LCS				
Average	24.6	23.1			56.6	48.9		
St. Dev.	10.8	15.2			3.8	6.2		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
G18-L3-A	29.2	26.3	40	LCS	55.6	46.9	200	SVB
	17.0	11.4	40	LCS	58.4	51.5	200	SVB
	26.1	21.7	40	LCS	63.1	60.3	200	SVB
	36.1	39.6	40	LCS	56.3	48.0	200	SVB
	40.5	50.8	40	SVB	47.4	35.8	200	LCS
	40.9	52.0	40	SVB	35.5	23.5	200	LCS
	36.0	39.4	40	SVB	46.5	34.7	200	LCS
	15.0	9.7	40	SVB	44.8	32.8	200	LCS
	18.2	12.5	40	LCS				
	17.8	12.2	40	LCS				
Average	27.7	27.6			51.0	41.7		
St. Dev.	10.3	16.7			9.0	12.0		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
G18-L1-A	40.5	50.8	200	LCS	62.7	59.5	400	LCS
	29.1	26.2	200	LCS	62.3	58.7	400	LCS
	38.9	46.4	200	LCS	62.1	58.3	400	LCS
	34.5	36.1	200	LCS	62.1	58.3	400	LCS
	40.5	50.8	200	SVB	58.7	52.0	400	LCS
	40.3	50.3	200	SVB	66.4	67.7	400	LCS
	33.5	34.1	200	SVB	66.1	67.0	401	LCS
					61.0	56.1	400	LCS
Average	36.8	42.1			62.7	59.7		
St. Dev.	4.5	9.9			2.5	5.3		

Umatilla Field Trial (August 4-8, 1997)
Fiber, TNT and RDX, Numbered samples

4-x samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-2	23.3	14.9	NA	JL	-1.6	0.0	NA	SVB
	1.4	0.0	NA	JL	-12.8	0.0	NA	SVB
	-6.0	0.0	NA	JL	-45.1	0.0	NA	SVB
	-27.1	0.0	NA	SVB	-35.6	0.0	NA	SVB
	-7.7	0.0	NA	SVB	-59.2	0.0	NA	SVB
	26.1	17.5	NA	SVB	-36.8	0.0	NA	SVB
	-23.6	0.0	NA	KD	-71.9	0.0	NA	SVB
	-12.6	0.0	NA	KD	-64.2	0.0	NA	SVB
	-19.4	0.0	NA	KD	8.5	1.8	NA	SVB
	-10.3	0.0	NA	KD	-32.0	0.0	NA	LA
	4.0	0.0	NA	LA	-51.0	0.0	NA	LA
	-9.0	0.0	NA	LA				
	4.0	0.0	NA	LA				
	-16.0	0.0	NA	LA				
Average	-5.2	2.3			-36.5	0.2		
St. Dev.	15.8	5.9			25.8	0.5		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-3	17.2	9.9	NA	JL	21.0	11.7	1:10	KD
	17.6	10.2	NA	JL	33.1	21.4	1:10	KD
	21.7	13.5	NA	JL	29.7	18.5	1:10	KD
	20.2	12.3	NA	JL	19.2	10.4	1:10	KD
	28.1	19.4	NA	SVB	32.6	21.0	1:10	GF
	26.6	18.0	NA	SVB	28.8	17.8	1:10	GF
	35.9	28.3	NA	SVB	30.1	18.9	1:10	GF
	26.5	17.9	NA	SVB				
	-11.0	0.0	NA	GF				
	-10.0	0.0	NA	GF				
	-7.0	0.0	NA	GF				
	-10.0	0.0	NA	GF				
	20.0	12.1	NA	KD				
	12.0	5.8	NA	KD				
	0.0	0.0	NA	KD				
	0.0	0.0	NA	KD				
Average	11.7	9.2				17.1		
St. Dev.	15.7	8.9				4.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-7					-13.2	0.0	1:50	SVB
					10.5	3.6	1:50	SVB
					9.1	2.4	1:50	SVB
					13.4	6.0	1:50	SVB
					-26.8	0.0	1:50	SVB
					-34.0	0.0	1:50	SVB
					-9.8	0.0	1:50	SVB
					-5.1	0.0	1:50	SVB
Average					-7.0	1.5		
St. Dev.					17.5	2.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-7	25.4	16.8	NA	SVB	89.5	221.4	NA	GF
	32.8	24.5	NA	SVB	87.7	190.7	NA	GF
	31.4	22.9	NA	SVB	79.5	116.2	NA	GF
	40.2	34.5	NA	SVB	87.3	185.0	NA	GF
	11.3	5.3	NA	SVB	95.0	454.0	NA	LA
	20.2	12.3	NA	SVB	98.4	2418.6	NA	LA
	21.4	13.3	NA	SVB	91.8	279.7	NA	LA
	30.0	21.4	NA	SVB	97.9	1348.6	NA	LA
	-1.6	0.0	NA	GF				
	-14.0	0.0	NA	GF				
	-20.0	0.0	NA	GF				
	-7.0	0.0	NA	GF				
	1.0	0.0	NA	LA				
	14.0	7.4	NA	LA				
	6.0	0.9	NA	LA				
	40.0	34.2	NA	LA				
Average	14.4	12.1			90.9	651.8		
St. Dev.	18.9	12.4			6.3	818.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-7					21.5	12.1	1:10	IB
					31.5	20.0	1:10	IB
					18.6	9.9	1:10	IB
					20.3	11.2	1:10	IB
					28.3	17.4	1:10	IB
					32.1	20.5	1:10	IB
					23.2	13.4	1:10	IB
					29.3	18.2	1:10	IB
Average					25.6	15.3		
St. Dev.					5.3	4.2		

4- 1xx samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-102	66.5	162.3	NA	GF				
	66.0	154.3	NA	GF				
	71.6	347.5	NA	GF				
	73.3	586.4	NA	GF				
	79.2	#NUM!	NA	LA				
	74.1	907.9	NA	LA				
	82.4	#NUM!	NA	LA				
	68.5	204.7	NA	LA				
Average	72.7	#NUM!						
St. Dev.	5.9	#NUM!						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-102	27.7	19.0	1:10	SVB	49.3	38.1	1:10	GF
	19.2	11.5	1:10	SVB	47.2	35.6	1:10	GF
	27.1	18.5	1:10	SVB	38.3	26.1	1:10	GF
	29.2	20.6	1:10	SVB	35.0	23.1	1:10	LA
	27.1	18.5	1:10	SVB	34.0	22.2	1:10	LA
	30.4	21.8	1:10	SVB	41.0	28.8	1:10	LA
					51.0	40.3	1:10	LA
Average	26.8	18.3			42.3	30.6		
St. Dev.	3.9	3.6			6.9	7.4		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-111	58.0	84.0	NA	AZ	-39.0	0.0	1:50	LA*
	46.0	45.0	NA	AZ	36.0	24.0	1:50	LA*
	50.0	54.5	NA	AZ	3.2	0.0	1:50	LA*
	61.0	102.2	NA	AZ	9.1	2.4	1:50	LA*
	54.9	70.2	NA	GF	3.7	0.0	1:50	GF
	55.4	72.2	NA	GF	-11.0	0.0	1:50	GF
	60.0	95.4	NA	GF	29.4	18.3	1:50	GF
	58.2	85.0	NA	GF	-5.0	0.0	1:50	GF
					-6.8	0.0	1:50	SVB
					10.4	3.6	1:50	SVB
					13.3	5.9	1:50	SVB
					7.1	0.0	1:50	SVB
					-0.6	0.0	1:50	SVB
					12.1	5.0	1:50	SVB
					12.4	5.2	1:50	SVB
					16.9	8.7	1:50	SVB
Average	55.4	76.1			5.7	4.6		
St. Dev.	5.1	19.6			17.1	7.1		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-112	80.8	#NUM!	NA	SVB	28.3	17.4	NA	GF
	87.0	#NUM!	NA	SVB	38.5	26.3	NA	GF
	85.9	#NUM!	NA	SVB	30.1	18.9	NA	GF
	86.2	#NUM!	NA	SVB	43.9	31.8	NA	GF
	100.0	#NUM!	NA	KD/AZ	36.0	24.0	NA	KD
	47.1	47.4	NA	KD/AZ	26.9	16.3	NA	KD
	26.4	17.8	NA	KD/AZ	28.4	17.5	NA	KD
	41.0	35.8	NA	AZ	24.7	14.6	NA	KD
	65.0	140.3	NA	AZ				
	58.0	84.0	NA	AZ				
	24.0	15.6	NA	AZ				
Average	63.8	#NUM!			32.1	20.8		
St. Dev.	26.4	#NUM!			6.6	5.9		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-112	38.5	31.9	1:10	SVB				
	40.8	35.4	1:10	SVB				
	38.3	31.6	1:10	SVB				
	28.9	20.3	1:10	SVB				
	49.2	52.4	1:10	JL				
	44.0	41.0	1:10	JL				
	42.7	38.6	1:10	JL				
	44.4	41.8	1:10	JL				
Average	40.9	36.6						
St. Dev.	6.0	9.4						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-112	-7.0	0.0	1:50	GF				
	-13.0	0.0	1:50	GF				
	-2.0	0.0	1:50	GF				
	-6.0	0.0	1:50	GF				
Average	-7.0	0.0						
St. Dev.	4.5	0.0						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-113	68.0	192.2	NA	KD	-53.6	0.0	NA	SVB
	66.0	154.3	NA	KD	-46.1	0.0	NA	SVB
	62.0	109.8	NA	KD	-0.4	0.0	NA	SVB
	60.0	95.4	NA	LA	-7.0	0.0	NA	SVB
	59.0	89.4	NA	LA	-8.0	0.0	NA	AZ
	62.0	109.8	NA	LA	-6.0	0.0	NA	AZ
	54.0	66.9	NA	LA	-4.0	0.0	NA	AZ
					-4.0	0.0	NA	AZ
					42.1	29.9	NA	GF
					37.8	25.6	NA	GF
					44.5	32.5	NA	GF
					34.7	22.8	NA	GF
Average	61.6	116.8			2.5	9.2		
St. Dev.	4.6	42.6			32.3	13.8		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-24	12.4	6.2	NA	SVB	64.4	63.1	NA	GF
	8.1	2.8	NA	SVB	71.0	80.4	NA	GF
	0.5	0.0	NA	SVB	59.7	53.7	NA	GF
	-30.2	0.0	NA	SVB	62.0	58.1	NA	GF
	-19.8	0.0	NA	SVB	72.0	83.6	NA	LA
	-16.0	0.0	NA	SVB	70.9	80.1	NA	LA
	-22.5	0.0	NA	SVB	77.4	105.1	NA	LA
	-13.0	0.0	NA	LA	74.1	91.0	NA	LA
	-6.0	0.0	NA	LA				
	-24.0	0.0	NA	LA				
	-4.0	0.0	NA	LA				
	-11.4	0.0	NA	SVB				
	9.2	3.7	NA	SVB				
	-8.6	0.0	NA	SVB				
Average	-9.0	0.9			68.9	76.9		
St. Dev.	13.2	1.9			6.2	17.5		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-25	9.4	3.8	NA	GF	36.8	24.7	NA	GF
	9.6	4.0	NA	GF	40.0	27.8	NA	GF
	0.9	0.0	NA	GF	46.5	34.7	NA	GF
	3.6	0.0	NA	GF	53.4	43.6	NA	GF
	19.0	11.3	NA	LA	36.0	24.0	NA	KD
	26.0	17.4	NA	LA	27.4	16.7	NA	KD
	24.0	15.6	NA	LA	32.4	20.8	NA	KD
	28.0	19.3	NA	LA	32.9	21.2	NA	KD
Average	15.1	8.9			38.2	26.7		
St. Dev.	10.5	7.9			8.4	8.7		

SB, 009 samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
SB-3	-20.4	0.0	NA	SVB	4.1	0.0	NA	SVB
	-12.8	0.0	NA	SVB	27.4	16.7	NA	SVB
	-7.5	0.0	NA	SVB	-5.7	0.0	NA	SVB
	-10.1	0.0	NA	SVB	6.2	0.0	NA	SVB
	-11.3	0.0	NA	KD	9.7	2.9	NA	SVB
	-4.2	0.0	NA	KD	-6.8	0.0	NA	SVB
	-34.9	0.0	NA	KD	-6.3	0.0	NA	SVB
	-4.5	0.0	NA	KD	-14.0	0.0	NA	AZ
	-9.0	0.0	NA	GF	13.0	5.7	NA	AZ
	-9.0	0.0	NA	GF	-19.0	0.0	NA	AZ
	-5.0	0.0	NA	GF	24.0	14.0	NA	AZ
	1.0	0.0	NA	GF	39.8	27.6	NA	LA
					31.5	20.0	NA	LA
					33.5	21.7	NA	LA
					33.2	21.5	NA	LA
Average	-10.6	0.0			11.4	8.7		
St. Dev.	9.3	0.0			19.2	10.3		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
009	66.8	167.5	NA	GF				
	64.6	135.4	NA	GF				
	64.6	135.4	NA	GF				
	65.9	152.8	NA	GF				
	51.0	57.2	NA	KD				
	55.0	70.6	NA	KD				
	55.0	70.6	NA	KD				
	63.0	118.5	NA	KD				
Average	60.7	113.5						
St. Dev.	6.1	41.9						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
009	21.4	13.3	1:50	SVB	19.2	10.4	1:50	GF
	36.2	28.7	1:50	SVB	16.1	8.1	1:50	GF
	36.6	29.3	1:50	SVB	28.1	17.2	1:50	GF
	43.2	39.5	1:50	SVB	10.4	3.6	1:50	KD
					6.4	0.0	1:50	KD
					17.2	8.9	1:50	KD
					20.7	11.5	1:50	KD
Average	34.4	27.7			16.9	8.5		
St. Dev.	9.2	10.8			7.1	5.6		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-113	6.0	0.9	1:50	LA				
	4.0	0.0	1:50	LA				
	2.0	0.0	1:50	LA				
	-9.0	0.0	1:50	LA				
	-21.0	0.0	1:50	GF				
	-27.0	0.0	1:50	GF				
	-18.0	0.0	1:50	GF				
	-15.0	0.0	1:50	GF				
Average	-9.8	0.1						
St. Dev.	12.5	0.3						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-114	50.2	55.0	NA	SVB	19.6	10.7	NA	SVB
	65.1	141.6	NA	SVB	-15.1	0.0	NA	SVB
	61.5	105.9	NA	SVB	1.0	0.0	NA	SVB
	32.8	24.5	NA	SVB	29.5	18.4	NA	SVB
	33.6	25.5	NA	SVB	-1.7	0.0	NA	SVB
	27.8	19.1	NA	SVB	-9.8	0.0	NA	SVB
	28.9	20.3	NA	SVB	17.0	8.7	NA	SVB
	26.0	17.4	NA	JL	16.7	8.5	NA	SVB
	60.3	97.4	NA	JL	37.5	25.4	NA	GF
	49.8	53.9	NA	JL	25.4	15.1	NA	GF
	57.3	80.5	NA	JL	28.9	17.9	NA	GF
					24.9	14.7	NA	GF
					-2.0	0.0	NA	LA
					-12.0	0.0	NA	LA
					10.2	3.4	NA	LA
					-24.0	0.0	NA	LA
Average	44.8	58.3			9.1	7.7		
St. Dev.	15.2	42.6			18.5	8.5		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-114	-26.0	0.0	1:50	LA				
	-37.0	0.0	1:50	LA				
	-8.0	0.0	1:50	LA				
	-123.0	0.0	1:50	LA				
	9.0	3.5	1:50	LA				
	4.0	0.0	1:50	LA				
	12.0	5.8	1:50	LA				
	0.0	0.0	1:50	LA				
Average	-21.1	1.2						
St. Dev.	44.6	2.3						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-114D	42.6	38.5	1:50	KD	7.0	0.0	1:50	KD
	57.6	82.0	1:50	KD	8.4	1.7	1:50	KD
	54.0	66.9	1:50	KD	13.0	5.7	1:50	KD
	49.0	51.9	1:50	LA	-9.8	0.0	1:50	KD
	50.0	54.5	1:50	LA	37.0	24.9	1:50	AZ
	50.0	54.5	1:50	LA	30.0	18.8	1:50	AZ
	45.0	42.9	1:50	LA	36.0	24.0	1:50	AZ
Average	49.7	55.9			17.4	10.7		
St. Dev.	5.1	14.7			17.5	11.4		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
4-117	46.3	45.6	NA	?	43.0	30.8	1:10	LA
	68.3	199.5	NA	?	35.0	23.1	1:10	LA
	68.4	202.1	NA	?	44.0	31.9	1:10	LA
	66.2	157.4	NA	?	32.0	20.4	1:10	LA
	36.5	29.1	NA	SVB	6.9	0.0	1:10	KD
	49.8	53.9	NA	SVB	37.6	25.4	1:10	KD
	51.3	58.1	NA	SVB	34.4	22.5	1:10	KD
	62.4	113.1	NA	SVB				
	0.0	0.0	NA	AZ/KD				
	19.0	11.3	NA	AZ/KD				
	0.0	0.0	NA	AZ/KD				
	9.0	3.5	NA	GF				
	7.0	1.9	NA	GF				
	9.0	3.5	NA	GF				
	0.0	0.0	NA	GF				
Average	32.9	58.6			33.3	22.0		
St. Dev.	27.5	73.7			12.4	10.6		

Umatilla, Fiber, TNT and RDX, EW samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW-1	63.4	122.3	NA	SVB	25.7	15.3	1:50	GF/AZ
	80.4	#NUM!	NA	SVB	27.3	16.6	1:50	GF/AZ
	75.6	#NUM!	NA	SVB	29.2	18.1	1:50	GF/AZ
	80.4	#NUM!	NA	SVB	27.7	16.9	1:50	GF/AZ
	54.7	69.4	NA	SVB	21.9	12.4	1:50	LA
	74.6	1460.0	NA	SVB	19.0	10.2	1:50	LA
	77.3	#NUM!	NA	SVB	16.3	8.2	1:50	LA
	74.6	1460.0	NA	SVB				
	44.8	42.5	NA	SVB				
	6.0	0.9	NA	SVB				
	39.9	34.0	NA	SVB				
Average	61.1	#NUM!			23.9	14.0		
St. Dev.	23.2	#NUM!			4.9	3.7		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW-3	68.4	202.1	NA	LA				
	72.0	383.1	NA	LA				
	84.0	#NUM!	NA	LA				
	70.0	254.9	NA	LA				
Average	73.6	#NUM!						
St. Dev.	7.1	#NUM!						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW-3	69.0	219.1	1:50	GF	7.0	0.0	1:50	LA
	74.0	847.3	1:50	GF	12.0	4.9	1:50	LA
	81.0	#NUM!	1:50	GF	-15.0	0.0	1:50	LA
	83.0	#NUM!	1:50	GF	-31.0	0.0	1:50	AZ
					-4.0	0.0	1:50	AZ
Average	76.8	#NUM!			-6.2	1.0		
St. Dev.	6.4	#NUM!			17.3	2.2		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW-3	8.9	3.5	1:100	SVB				
	8.8	3.4	1:100	SVB				
	16.9	9.6	1:100	SVB				
	17.8	10.3	1:100	SVB				
	48.5	50.6	1:100	SVB				
	27.4	18.8	1:100	SVB				
	29.1	20.5	1:100	SVB				
Average	22.5	16.7						
St. Dev.	14.0	16.4						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW-4	-94.9	0.0	NA	SVB				
	-57.3	0.0	NA	SVB				
	-12.0	0.0	NA	SVB				
	-6.0	0.0	NA	SVB				
	31.1	22.6	NA	SVB				
	32.1	23.7	NA	SVB				
	29.4	20.8	NA	SVB				
	2.0	0.0	NA	SVB				
	-3.9	0.0	NA	SVB				
	-0.2	0.0	NA	SVB				
	-17.0	0.0	NA	SVB				
	-13.0	0.0	NA	SVB				
	-5.0	0.0	NA	SVB				
	-17.0	0.0	NA	SVB				
Average	-9.4	4.8						
St. Dev.	33.8	9.5						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
EW-4					81.0	125.4	1:50	LA
					84.0	148.4	1:50	LA
					74.0	90.7	1:50	LA
					91.0	256.1	1:50	LA
					-21.0	0.0	1:50	AZ
					33.0	21.3	1:50	AZ
					-10.0	0.0	1:50	AZ
Average					47.4	91.7		
St. Dev.					47.0	94.1		

Umatilla, Fiber, RDX and TNT, WO samples

Sample Nam	TNT Inhib.	TNT(ppb)	TNT Dilutior	OPER	RDX Inhib.	RDX(ppb)	RDX Dilutior	OPER
WO-21	13.0	6.6	NA	KD	89.0	211.9	NA	AZ
	6.0	0.9	NA	KD	99.0	#NUM!	NA	AZ
	0.0	0.0	NA	KD	100.0	#NUM!	NA	AZ
	0.0	0.0	NA	KD	94.4	404.9	NA	KD
	11.7	5.6	NA	GF	95.1	463.5	NA	KD
	16.5	9.3	NA	GF	93.9	372.0	NA	KD
	12.2	6.0	NA	GF	91.7	276.5	NA	KD
	7.4	2.2	NA	GF				
Average	8.4	3.8			94.7	#NUM!		
St. Dev.	6.1	3.5			3.9	#NUM!		

Sample Nam	TNT Inhib.	TNT(ppb)	TNT Dilutior	OPER	RDX Inhib.	RDX(ppb)	RDX Dilutior	OPER
WO-21					40.8	28.6	1:10	IB
					49.6	38.6	1:10	IB
					41.1	28.8	1:10	IB
					38.3	26.1	1:10	IB
					36.0	23.9	1:10	IB
					37.1	25.0	1:10	IB
					31.2	19.8	1:10	IB
					42.1	29.9	1:10	IB
Average					39.5	27.6		
St. Dev.					5.4	5.5		

Sample Nam	TNT Inhib.	TNT(ppb)	TNT Dilutior	OPER	RDX Inhib.	RDX(ppb)	RDX Dilutior	OPER
WO22	81.5	#NUM!	NA	GF	9.0	2.3	NA	SVB
	77.5	#NUM!	NA	GF	0.7	0.0	NA	SVB
	80.0	#NUM!	NA	GF	21.6	12.2	NA	SVB
	82.6	#NUM!	NA	GF	-8.9	0.0	NA	SVB
	59.3	91.1	NA	LA*est	24.0	14.0	NA	SVB
	57.0	79.1	NA	LA*est	-2.5	0.0	NA	SVB
	66.0	154.3	NA	LA*est	-1.5	0.0	NA	SVB
	66.0	154.3	NA	LA*est	22.4	12.8	NA	SVB
					54.7	45.5	NA	KD
					39.8	27.6	NA	KD
					44.8	32.8	NA	KD
					29.4	18.3	NA	KD
Average	71.2	#NUM!			19.5	13.8		
St. Dev.	10.4	#NUM!			20.5	15.0		

Sample Nam	TNT Inhib.	TNT(ppb)	TNT Dilutior	OPER	RDX Inhib.	RDX(ppb)	RDX Dilutior	OPER
WO22	36.5	29.1	1:10	SVB				
	27.7	19.0	1:10	SVB				
	31.0	22.5	1:10	SVB				
	31.9	23.5	1:10	SVB				
	-3.0	0.0	1:10	JL				
	-4.0	0.0	1:10	JL				
	0.0	0.0	1:10	JL				
	-4.5	0.0	1:10	JL				
Average	14.5	11.8						
St. Dev.	18.7	12.9						

Sample Nam	TNT Inhib.	TNT(ppb)	TNT Dilutior	OPER	RDX Inhib.	RDX(ppb)	RDX Dilutior	OPER
WO24	15.5	8.5	NA	SVB	94.0	378.1	NA	AZ
	33.7	25.6	NA	SVB	99.0	#NUM!	NA	AZ
	30.7	22.2	NA	SVB	54.0	44.5	NA	AZ
	40.9	35.6	NA	SVB	92.6	308.4	NA	KD
	30.5	21.9	NA	JL	91.5	270.3	NA	KD
	32.6	24.3	NA	JL	96.9	772.4	NA	KD
	35.2	27.4	NA	JL	90.7	248.3	NA	KD
	34.2	26.2	NA	JL				
	35.8	28.2	NA	GL				
	26.8	18.2	NA	GL				
	31.7	23.3	NA	GL				
	31.1	22.6	NA	GL				
	6.8	1.7	NA	KD				
	18.6	11.0	NA	KD				
	-12.7	0.0	NA	KD				
	-26.3	0.0	NA	KD				
Average	22.8	18.5			88.4	#NUM!		
St. Dev.	18.8	10.9			15.4	#NUM!		

Sample Nam	TNT Inhib.	TNT(ppb)	TNT Dilutior	OPER	RDX Inhib.	RDX(ppb)	RDX Dilutior	OPER
WO-24					-2.4	0.0	1:50	SVB
					18.2	9.6	1:50	SVB
					16.0	8.0	1:50	SVB
					16.2	8.1	1:50	SVB
					20.5	11.4	1:50	SVB
					26.6	16.0	1:50	SVB
					16.7	8.5	1:50	SVB
Average					16.0	8.8		
St. Dev.					8.9	4.8		

Umatilla, Fiber, RDX and TNT, Combine samples

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
COMBINE 1					67.3	70.0	1:10	GF
					65.5	65.6	1:10	GF
					59.4	53.2	1:10	GF
					59.5	53.4	1:10	SVB
					62.8	59.7	1:10	SVB
					69.6	76.2	1:10	SVB
					51.4	40.9	1:10	SVB
Average					62.2	59.8		
St. Dev.					6.1	11.9		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
COMBINE 1	54.1	67.2	1:50	GF	30.0	18.8	1:50	LA*
	48.3	50.1	1:50	GF	-2.0	0.0	1:50	GF
	49.7	53.7	1:50	GF	-3.0	0.0	1:50	GF
	54.4	68.3	1:50	GF	51.0	40.3	1:50	SVB
	26.0	17.4	1:50	KD/AZ				
	19.0	11.3	1:50	KD/AZ				
	31.0	22.5	1:50	KD/AZ				
	12.0	5.8	1:50	KD/AZ				
Average	36.8	37.0			19.0	14.8		
St. Dev.	16.9	25.5			26.3	19.2		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
COMBINE 2	57.0	79.1	1:50	LA	-30.2	0.0	1:50	KD
	59.0	89.4	1:50	LA	-4.7	0.0	1:50	KD
	56.0	74.7	1:50	LA	12.6	5.4	1:50	KD
	59.0	89.4	1:50	LA	7.6	0.7	1:50	KD
	45.0	42.9	1:50	KD				
	45.0	42.9	1:50	KD				
	54.0	66.9	1:50	KD				
	49.0	51.9	1:50	KD				
Average	53.0	67.1			-3.7	1.5		
St. Dev.	5.9	19.3			19.1	2.6		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
COMBINE 2					55.7	47.1	1:10	SVB
					56.8	48.8	1:10	SVB
					60.9	56.0	1:10	SVB
					45.4	33.5	1:10	SVB
					78.0	108.1	1:10	GF
					82.5	136.0	1:10	GF
					68.6	73.4	1:10	GF
Average					64.0	71.8		
St. Dev.					13.1	37.2		

Umatilla, Fiber, TNT and RDX, Standards

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
STD-2	42.6	38.5	NA	JSL				
	33.4	25.2	NA	JSL				
	17.8	10.3	NA	JSL				
	17.4	10.0	NA	JSL				
	5.3	0.1	NA	SVB				
	-3.1	0.0	NA	SVB				
	-1.3	0.0	NA	SVB				
	-18.9	0.0	NA	SVB				
	3.0	0.0	NA	LA				
	12.0	5.8	NA	LA				
	12.0	5.8	NA	LA				
	-39.0	0.0	NA	LA				
	58.0	84.0	NA	KD				
	49.0	51.9	NA	KD				
	31.0	22.5	NA	KD				
	35.0	27.2	NA	KD				
Average	15.9	17.6						
St. Dev.	25.4	23.7						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
STD-3	42.2	37.8	NA	?				
	41.9	37.3	NA	?				
	36.5	29.1	NA	?				
	46.2	45.4	NA	?				
	40.0	34.2	NA	SVB				
	41.3	36.3	NA	SVB				
	37.0	29.8	NA	SVB				
	25.8	17.2	NA	GF				
	29.9	21.3	NA	GF				
	31.0	22.5	NA	KD				
	42.0	37.4	NA	KD				
	40.0	34.2	NA	KD				
Average	37.8	31.9						
St. Dev.	6.0	8.2						

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
STD-7					-10.1	0.0	NA	SVB*
					-1.5	0.0	NA	SVB*
					32.5	20.9	NA	SVB*
					69.6	76.2	NA	SVB*
					14.4	6.8	NA	SVB
					18.3	9.7	NA	SVB
					6.0	0.0	NA	SVB
					27.1	16.4	NA	SVB
					11.9	4.8	NA	GF
					21.0	11.7	NA	GF
					4.0	0.0	NA	GF
					22.8	13.1	NA	GF
					20.0	11.0	NA	KD
					51.0	40.3	NA	KD
					56.0	47.5	NA	KD
* = mixed fibers					52.0	41.7	NA	KD
Average					24.7	18.8		
St. Dev.					22.4	21.8		

Sample Name	TNT Inhib.	TNT(ppb)	TNT Dilution	OPER	RDX Inhib.	RDX(ppb)	RDX Dilution	OPER
STD-8					88.0	195.2	NA	LA
					82.0	132.2	NA	LA
					78.0	108.1	NA	LA
					76.0	98.7	NA	LA
					53.0	43.1	NA	GF
					55.0	46.0	NA	GF
					46.0	34.2	NA	GF
					54.0	44.5	NA	GF
Average					66.5	87.8		
St. Dev.					16.1	56.8		