Cold Regions Research and Engineering Laboratory, Hanover, NH

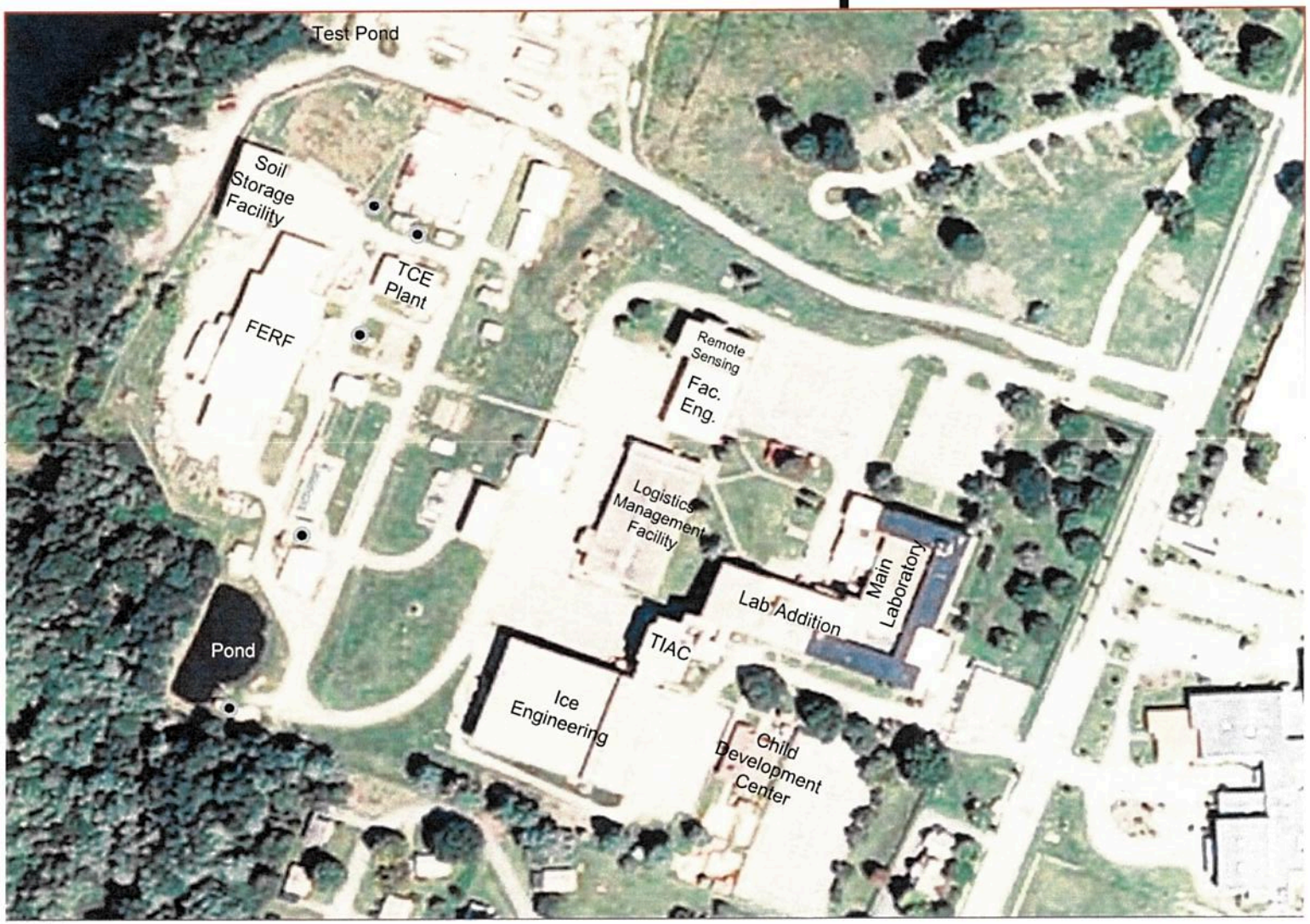
Vapor Intrusion
NHDES Site Visit
December 15, 2011

US Army Corps of Engineers
BUILDING STRONG®

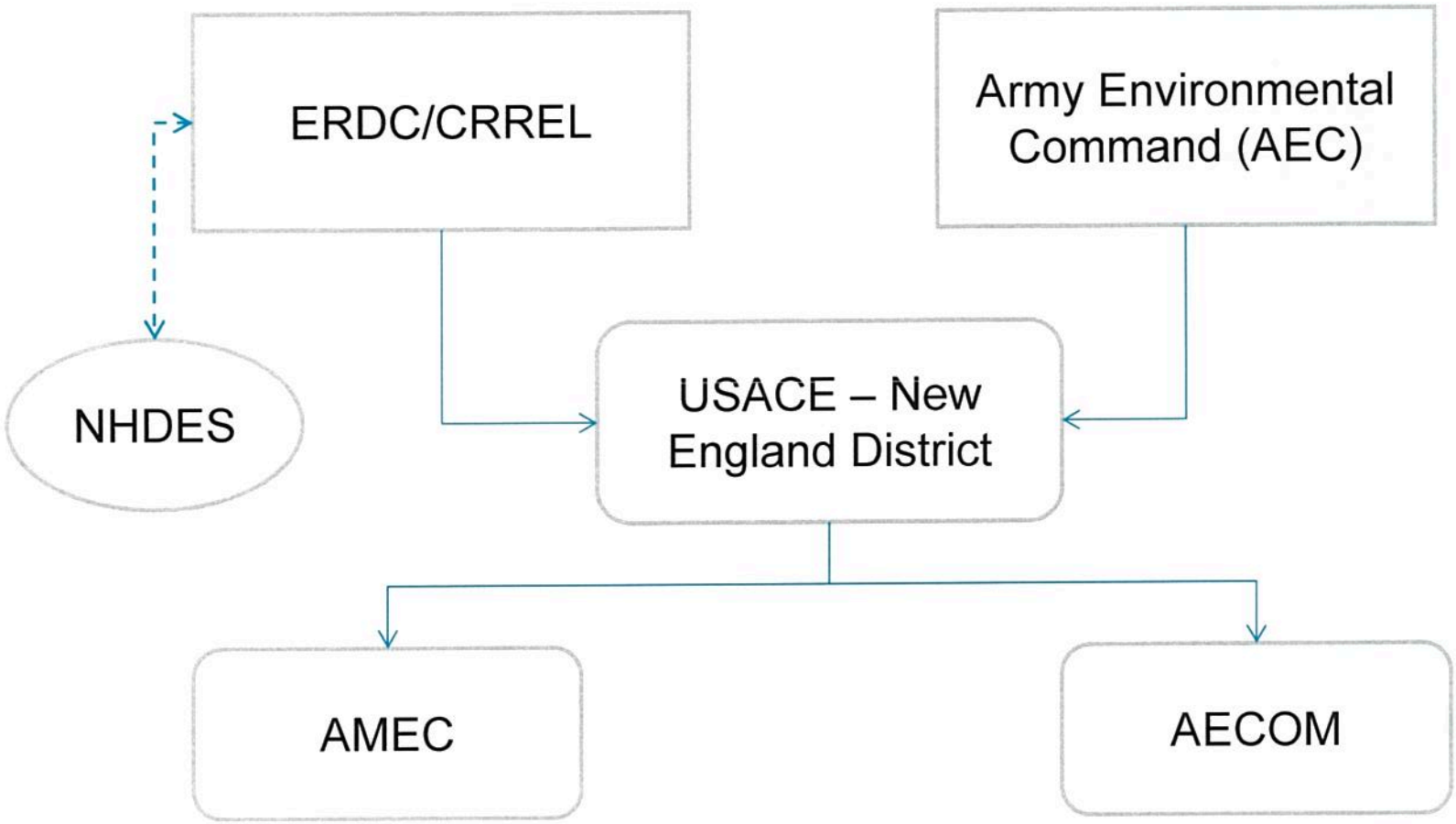
TODAY'S AGENDA

- Progress Regarding Vapor Intrusion - USACE
- Discuss Meeting Goals - NHDES
- Tour Areas of Interest - All
- Discuss Risk Evaluation - USACE

Site Map



Project Team Organization



Vapor Sampling Events

- March & June, 2010
- August 25-28, 2011
- October 2, 2011
- October 23, 2011

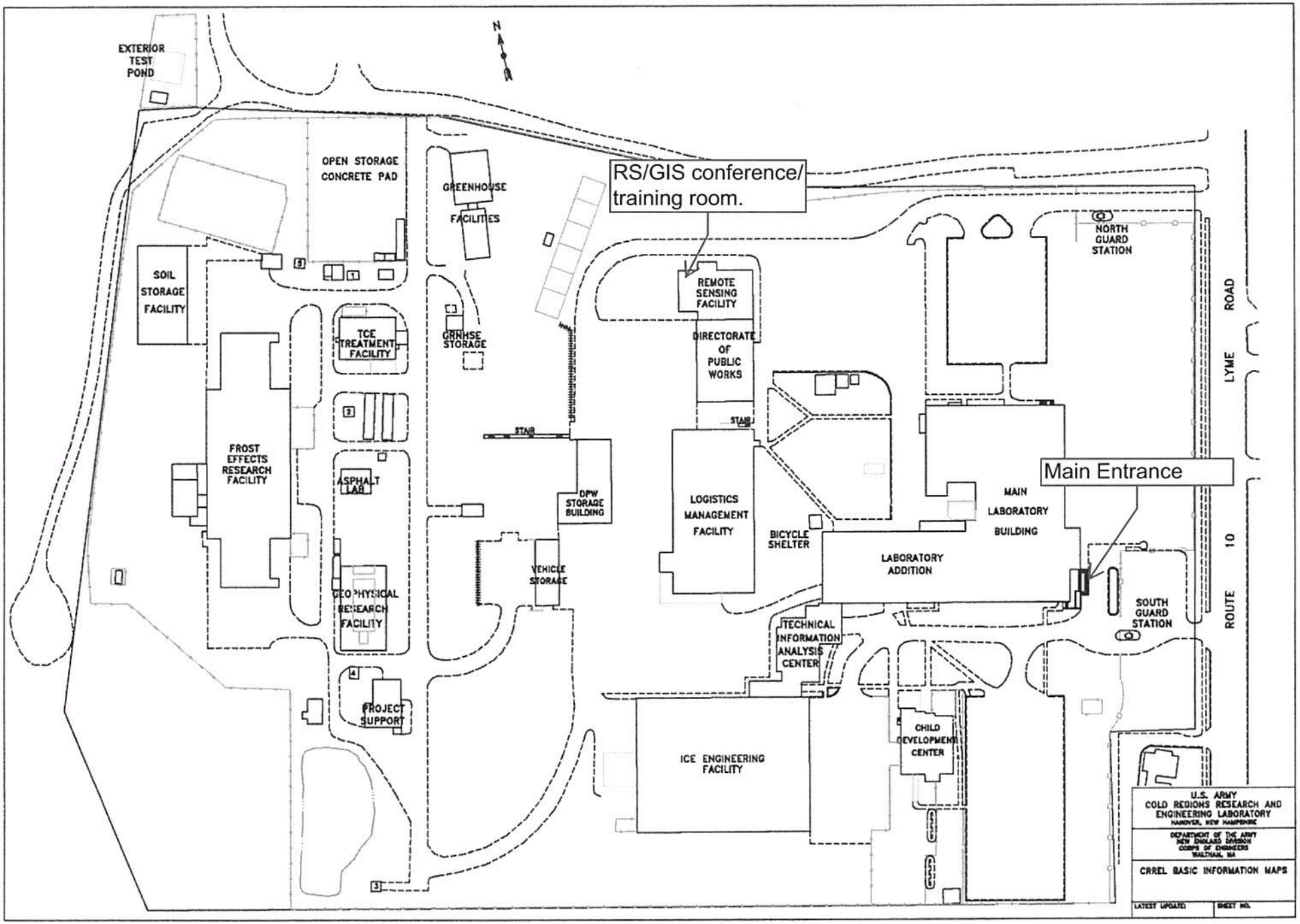
Path Forward

- VI Sampling Events
  - Winter Round - Jan/Feb
  - Summary Report
- Mitigation Measures where necessary
  - CDC – SSDS (Installed in Oct)
  - TIAC – SSDS piping(Installed Dec)
  - Main Lab – Communication testing, GPR survey

Path Forward (cont)

Supplemental Remedial Investigation

- ▶ RI Work Plan (In process)
  - VI Pathway Investigation
- ▶ RI Work Plan Implementation
- ▶ Remedial Investigation Report
- ▶ Feasibility Study Report
- ▶ Decision Document(s)
- ▶ Remedy Implementation


EXTERIOR TEST POND
N
OPEN STORAGE CONCRETE PAD
GREENHOUSE FACILITIES
RS/GIS conference/ training room.
NORTH GUARD STATION
SOIL STORAGE FACILITY
TCE TREATMENT FACILITY
GRNHSE STORAGE
REMOTE SENSING FACILITY
DIRECTORATE OF PUBLIC WORKS
LYME ROAD
STAIR
STAIR
FROST EFFECTS RESEARCH FACILITY
ASPHALT LAB
DPW STORAGE BUILDING
LOGISTICS MANAGEMENT FACILITY
BICYCLE SHELTER
MAIN LABORATORY BUILDING
Main Entrance
LABORATORY ADDITION
VEHICLE STORAGE
GEOPHYSICAL RESEARCH FACILITY
SOUTH GUARD STATION
ROUTE 10
TECHNICAL INFORMATION ANALYSIS CENTER
PROJECT SUPPORT
CHILD DEVELOPMENT CENTER
ICE ENGINEERING FACILITY
U.S. ARMY
COLD REGIONS RESEARCH AND ENGINEERING LABORATORY
HANOVER, NEW HAMPSHIRE
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MA
CRREL BASIC INFORMATION MAPS
LATEST UPDATED
SHEET NO.

USACE NAE Engineering/Planning Division Geo-Environmental Engineering Branch
Chronology of Vapor Intrusion Efforts at USACE ERDC CRREL Facility, Hanover, NH
November 2, 2011

Introduction

Staff at the Cold Regions Research and Engineering Laboratory (CRREL) in Hanover, NH has been remediating groundwater contaminated with trichloroethylene (TCE) since 1994, performing numerous investigations to characterize TCE contamination in soil and groundwater throughout the CRREL facility since 1991, and testing contaminant source treatment technologies. Per discussions in a draft Focused Feasibility Study (March 18, 2009) developed for CRREL via contract with the TSC Group, CRREL began a vapor intrusion (VI) investigation program. Investigations indicate that indoor air in several buildings has been affected by intrusion of TCE vapors.

VI Efforts to Date

The work associated with these VI investigations to date is as follows:

- March 10, 2010
  - U.S. Army Corps of Engineers (USACE), Baltimore District, contractor, AECOM, submitted a work plan to NHDES for VI investigation at CRREL.
  - NHDES approved the work plan prior to beginning field work
- March 13-14, 2010
  - Conducted winter sampling event
    - Collected sub-slab and indoor air samples from the Main Laboratory, Lab Addition Sub-Basement, and the Logistics Management Facility
- June 12-13, 2010
  - Conducted summer sampling event
    - Same locations as winter event - collected sub-slab and indoor air samples from the Main Laboratory, Lab Addition Sub-Basement, and the Logistics Management Facility
- August 11, 2010
  - CRREL held a meeting with employees to inform them of VI sampling findings from the previous winter and summer sampling events
- April 11, 2011
  - CRREL and U.S. Army Environmental Command (AEC) met with NHDES to discuss status of the project
- April 12-13, 2011
  - CRREL, USACE, New England District (NAE), and AEC held project planning meeting.
    - Decided to expand VI sampling to include additional buildings
- April 29, 2011
  - NAE submitted 2010 VI Data Report to NHDES
- June 2, 2011
  - NHDES provided comments on data report
- August 10, 2011
  - NAE submitted work plan for expanded summer and winter sampling effort to NHDES
- August 15, 2011
  - NHDES provided preliminary comments on work plan
    - Requested additional indoor air sampling in CDC

        - Requested identification of background vapor sources within buildings
        - Requested leak testing on sub-slab sampling points to ensure no short-circuiting
- August 22, 2011
    - NAE provided responses to comments to NHDES
        - Responses indicated concurrence and offered to make clarifications in the plan
- August 25-28, 2011
    - Performed expanded indoor air and sub-slab sampling effort in nine buildings:
        - Main Lab Building
        - Lab Addition Sub-Basement
        - TIAC Building
        - Ice Engineering
        - Logistics Management Building
        - DPW Building
        - Remote Sensing
        - Groundwater Treatment Facility Building
        - Child Development Center (CDC) Building
    - Criteria for building selection included proximity (within 100-ft vertically or laterally) to potential TCE vapor source (soil or groundwater) as well as proximity to utility trenches that may have been impacted by Areas of Concern (AOCs).
    - Also performed near slab subsurface vapor sampling outside the Laboratory Addition.
- September 21, 2011
    - NAE and CRREL received preliminary data from August sampling
- September 26, 2011
    - NAE verbally notified NHDES of preliminary data
- September 29, 2011
    - NAE forwarded preliminary data via email to NHDES. Email also outlined the following:
        - Immediate plans to install interim sub-slab depressurization system (SSDS) in CDC
        - Initial plans for employee and CDC family communication
        - Plans for re-sampling the CDC
    - NAE and NHDES (Scott Hilton) discussed the immediate path forward via phone.
    - Increased HVAC fresh air exchanges in CDC and Main Laboratory
- September 30, 2011
    - NAE and CRREL conferred with NHDES via teleconference, immediately following NHDES telephone request for discussion.
    - Completed installation of interim SSDS in CDC. Subsequently, vacuum and flow rates have been monitored daily.
- October 2, 2011

- Performed confirmatory re-sampling of CDC sub-slab and CDC indoor air, as well as sampling of outdoor background ambient air.
  - CDC HVAC system set at maximum air exchanges
  - CDC interim SSDS active
- Sampled SSDS discharge, pre- and post- vapor phase granular activated carbon (VGAC)
  - Uncontrolled mass emissions from the SSDS are substantially less than de minimis emission levels as specified in Env-A 1400, and therefore, typically would not require a permit
  - Regardless, as an added safety measure, vapors are currently being treated with VGAC
  - Should SSDS vapor TCE concentrations decline, removal of VGAC will be considered
  - Discharge from VGAC is non-detect for TCE
  - Plan being developed for routine monitoring pre and post VGAC

- October 3-4, 2011
  - ERDC/CRREL/NAE/U.S. Army Pubic Health Command held informative sessions with stakeholders:
    - USACE-ERDC-CRREL leadership
    - CDC Employees
    - USACE-ERDC-CRREL workers
    - CDC Patrons

- October 4, 2011
  - Performed risk calculations in accordance with new USEPA guidance using maximum detected concentrations from the August 28, 2011 sampling event.
    - Results indicated elevated levels at several occupied indoor locations---especially in the Main Lab and Laboratory Addition Sub-Basement
  - USEPA updated toxicity value for TCE
    - Recently (September 28, 2011) changed to more stringent values.
    - Includes methods for age-specific evaluations of children and adults.
    - Preliminary remediation goal calculated by NAE, now undergoing internal review.

- October 6, 2011
  - NAE Risk Assessor conferred with NHDES Risk Assessor, David Gordon, and the Environmental Health Program Section Leader, Dennis Pinski, via teleconference.

        - Call convened based on request of CRREL.
        - Purpose was to compare risk analyses prepared internally by NAE to those prepared internally by NHDES.

- October 11, 2011
    - NAE and CRREL received preliminary data from October 2, 2011 sampling event at CDC.

- October 23, 2011
    - Re-sampled indoor air in CDC, Main Lab, Lab Addition Sub-Basement, LMO, and DPW
    - Installed new sub-slab ports in four new locations in Main lab
    - Sampled new sub-slab ports and associated indoor air locations
    - Re-sampled sub-slab and indoor air in TIAC
    - Sampled elevator shaft in Main Lab
    - Ventilation within buildings was set for normal heating.
    - Preliminary data expected week of November 20, 2011

Path Forward

- Additional Sampling
    - Comprehensive winter round of sampling tentatively scheduled for January 2012.
        - Will follow the original August 10, 2011 work plan
        - May include additional locations based on analysis of the results of interim sampling.

- Reporting and Documentation of Sampling and Evaluation Efforts
    - Comprehensive report planned after results are obtained from winter sampling round.
    - Sample data compilation started, with updates as new data are received.
        - Will be shared with stakeholders (e.g., NHDES)
    - Information in report will include:
        - All available VI sample data.
            - Comparison of VI sample results from each round.
            - Comparison of VI sample results to site-specific screening criteria.
        - Human health risk estimates with available data and appropriate toxicity values.
        - Determination of need to remediate.
            - Near-term priorities for remedies accounting for activities in various spaces
        - Preliminary remediation goals.
        - Operational data of any preliminary mitigation systems

- Issues and efforts that may impact Vapor Intrusion Mitigation Measures
  - CDC
    - Continued evaluation of sub-slab depressurization system installed September 30, 2011.
    - Anticipated refurbishment of first floor for child gross motor skill development area.
  - TIAC
    - Anticipated refurbishment of basement for office space.
  - Main Lab
    - Existence of office spaces
    - Anticipated asbestos remediation
  - Iterative approach required
    - Evaluate vapor pathways into and within each building
    - Once pathways are better understood, evaluate alternative interim measures to reduce or eliminate VI pathway
    - Recommend alternatives, and implement
- Remedial Investigation/Feasibility Study (RI/FS)
  - The vapor intrusion study is intended to support a facility-wide Remedial Investigation and Feasibility Study. Tentative schedule includes:
    - Late Fall/Early Winter 2011 - Data Evaluation and Gaps Analysis performed.
      - To include identification and evaluation of potential preferential pathways and potential for offsite contaminant migration (e.g., groundwater, vapor)
    - Spring/Summer 2012 - Implementation of field effort for filling soil, groundwater, and/or vapor data gaps (if required).
    - Winter 2013 – Complete Remedial Investigation Report.
    - Summer 2013 – Complete Feasibility Study.
    - Winter 2014 – Complete Proposed Plan and Decision Document.

BG09	10/2/2011
TCE Indoor Air	0.21 U

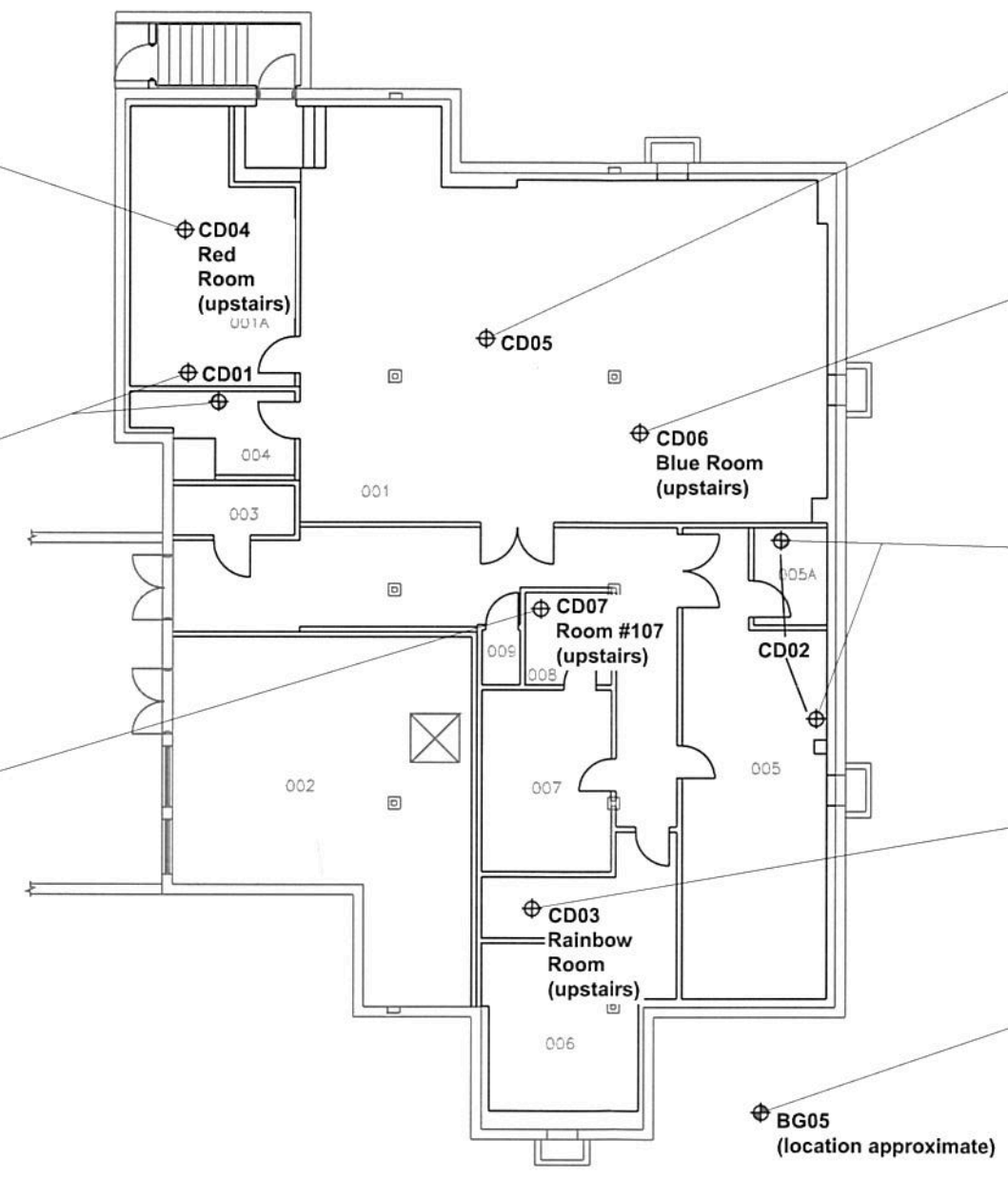
CD04	8/29/2011	10/2/2011	10/23/2011
TCE Indoor Air	5.9	0.23	0.24

CD01	8/29/2011	10/2/2011	10/23/2011
TCE Indoor Air	140 J	4.8	1
TCE Sub-Slab	11000 J	6400	2.6

CD07	10/2/2011	10/23/2011
TCE Indoor Air	0.21 U	0.21 U

Child Care Center

Basement Floor Plan



CD05	8/29/2011	10/2/2011	10/23/2011
TCE Indoor Air	7.2	1.6	0.62

CD06	10/2/2011	10/23/2011
TCE Indoor Air	0.21 U	0.21 U

CD02	8/29/2011	10/2/2011	10/23/2011
TCE Indoor Air	28	0.78	0.21 U
TCE Sub-Slab	47	1.4	0.21 U

CD03	8/29/2011	10/2/2011	10/23/2011
TCE Indoor Air	7.2	0.21 U	2.5

BG05	10/2/2011
TCE Indoor Air	0.21 U

Legend:

002 Room Number

CD01 Sample Location ID

⊕ Background Sample Location

⊕ Indoor Air Sampling Location

⊕ Sub-Slab Sampling Location

Notes:

1. CD03, CD04, CD06 and CD07 samples were collected one floor above basement, locations shown are approximate.
2. All concentrations are presented in ug/m³. Where duplicate samples were analyzed, the higher concentration is shown.

0' 7.5' 15'

1" = 15'

AECOM

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CRREL - Hanover, New Hampshire

Child Development Center (CDC)

Figure 1 - Sample Locations

BG02	3/14/2010	6/13/2010
TCE Indoor Air	0.7	0.53

LB11	6/13/2010	8/29/2011
TCE Indoor Air	16	0.25

LB02	3/14/2010	6/13/2010	8/29/2011
TCE Indoor Air	41	26	210
TCE Sub-Slab	1,200	13,000	85,000 J

HV08	8/29/2011
TCE Indoor Air	240

LB03	3/14/2010	6/13/2010	8/29/2011	10/23/2011
TCE Indoor Air	32	35	110	11
TCE Sub-Slab			51,000	

LB01	3/14/2010	6/13/2010	8/29/2011	10/23/2011
TCE Indoor Air	22	38	230	13
TCE Sub-Slab	110,000	100,000	91,000	

LB14	8/29/2011	10/23/2011
TCE Indoor Air	96	6.7
TCE Sub-Slab	60,000	

LB13	8/29/2011
TCE Indoor Air	61
TCE Sub-Slab	180,000

LB12	8/29/2011
TCE Indoor Air	85
TCE Sub-Slab	71,000

LB04	3/14/2010	6/13/2010	8/29/2011
TCE Indoor Air	31	20	79

LB06	3/14/2010	6/13/2010	8/29/2011	10/23/2011
TCE Indoor Air	20	15	88	32
TCE Sub-Slab			56,000	

LB05	3/14/2010	6/13/2010	8/29/2011	10/23/2011
TCE Indoor Air	38	33	200	19
TCE Sub-Slab			120,000	

LB20	8/29/2011
TCE Indoor Air	97
TCE Sub-Slab	27,000

LB19	8/29/2011	10/23/2011
TCE Indoor Air	180	8
TCE Sub-Slab	200,000	

BG01	3/14/2010	6/13/2010
TCE Indoor Air	3	4.9

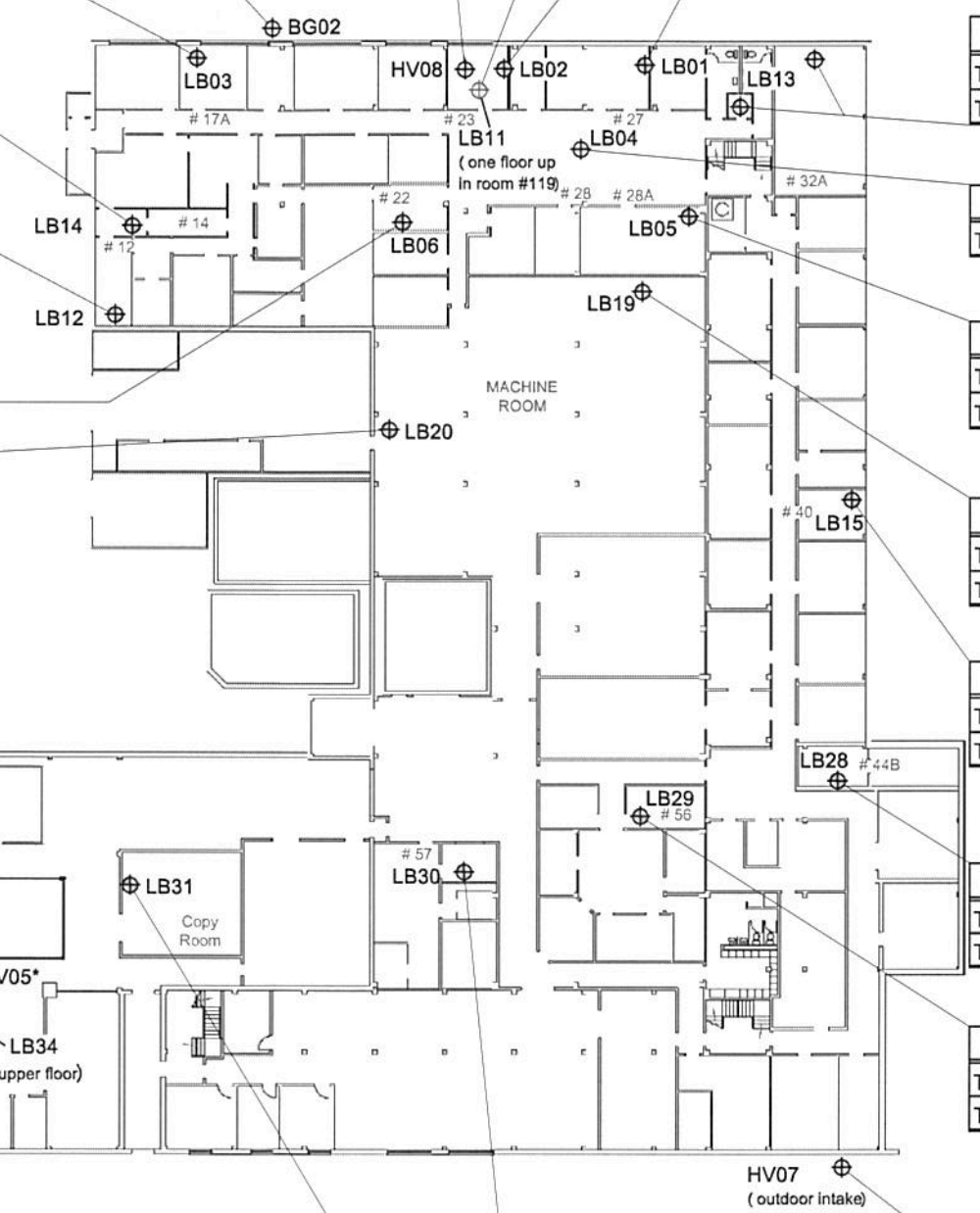
LB15	8/29/2011	10/23/2011
TCE Indoor Air	43	3.1
TCE Sub-Slab	16,000	

HV04	8/29/2011
TCE Indoor Air	79

LB28	10/23/2011
TCE Indoor Air	9.1
TCE Sub-Slab	9,700

HV03	8/29/2011
TCE Indoor Air	11

LB29	10/23/2011
TCE Indoor Air	3.1
TCE Sub-Slab	2,700



HV05	8/29/2011
TCE Indoor Air	320

LB34	10/23/2011
TCE Indoor Air	1.2

LB31	10/23/2011
TCE Indoor Air	3.2
TCE Sub-Slab	100

LB30	10/23/2011
TCE Indoor Air	3.3 J
TCE Sub-Slab	8,700

HV07	8/29/2011
TCE Indoor Air	19

Legend:

# 17A	Room Number
LB01	Sample Location ID
⊕	Indoor Air Sampling Location
⊕	Indoor Air (HVAC) Sampling Location*
⊕	Sub-Slab Sampling Location
⊕	Co-Located Sub-Slab/Indoor Air Sampling Location

Note:

1. *HV05 is an indoor air sample collected adjacent to the elevator, it is not an HVAC sample.
2. All concentrations are presented in ug/m³. Where duplicate samples were analyzed, the higher concentration is shown.

0' 20' 40'
1" = 40'

AECOM

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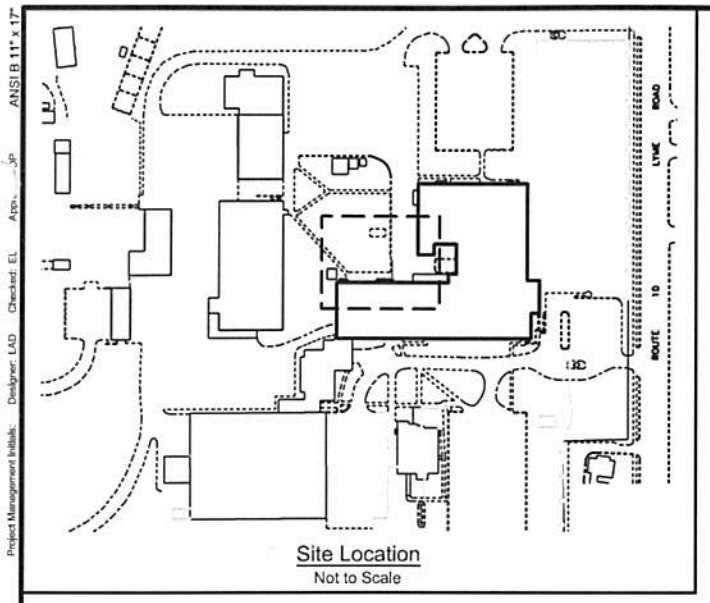
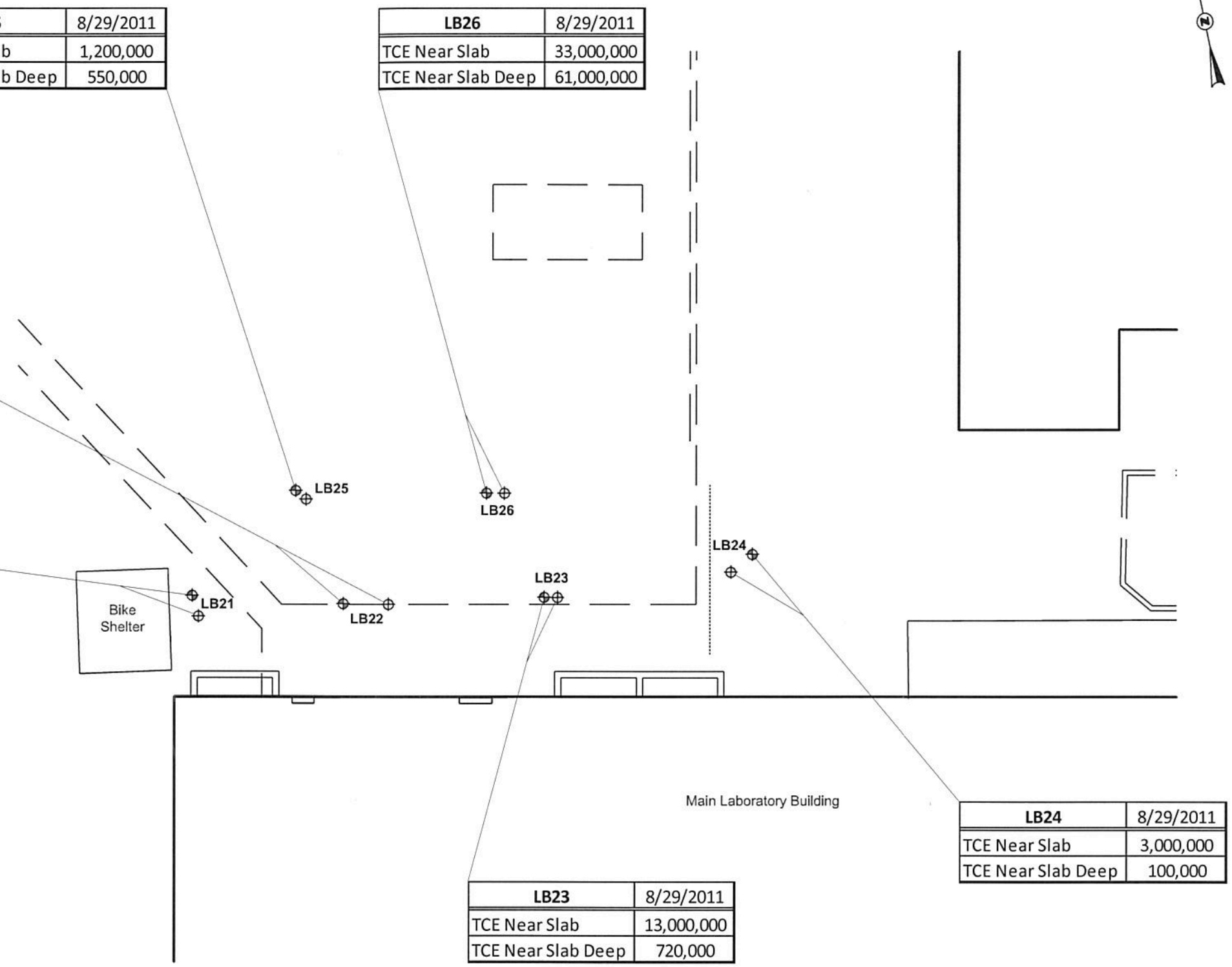
CRREL - Hanover, New Hampshire

Main Laboratory Building (LAB)

Figure 1 - Sample Locations





LB25	8/29/2011
TCE Near Slab	1,200,000
TCE Near Slab Deep	550,000

LB26	8/29/2011
TCE Near Slab	33,000,000
TCE Near Slab Deep	61,000,000

LB22	8/29/2011
TCE Near Slab	5,000,000
TCE Near Slab Deep	14,000,000

LB21	8/29/2011
TCE Near Slab	160,000
TCE Near Slab Deep	49000

LB24	8/29/2011
TCE Near Slab	3,000,000
TCE Near Slab Deep	100,000

LB23	8/29/2011
TCE Near Slab	13,000,000
TCE Near Slab Deep	720,000

Legend:

LB21 Sample Location ID

⊕ Near Slab Sample Location

⊕ Deep Near Slab Sampling Location

Note:

1. All concentrations are presented in ug/m³. Where duplicate samples were analyzed, the higher concentration is shown.

0' 10' 20'
1" = 20'

AECOM

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CRREL - Hanover, New Hampshire

Near Slab and Deep Near Slab

Figure 1 - Sample Locations

LB08	3/14/2010	6/13/2010	8/29/2011	10/23/2011
TCE Indoor Air	12	25	380	18
TCE Sub-Slab		1,900,000	4,500,000	
TCE Sub-Slab Deep			3,900,000	

LB27	8/29/2011	10/23/2011
TCE Indoor Air	16,000	12,000

HV01	8/29/2011
TCE Indoor Air	32

HV02	8/29/2011
TCE Indoor Air	19

LB07	3/14/2010	6/13/2010	8/29/2011
TCE Indoor Air	17	37	120
TCE Sub-Slab		5,900,000	470,000,000
TCE Sub-Slab Deep			3,800,000

LB16	8/29/2011
TCE Indoor Air	150
TCE Sub-Slab	2,400,000
TCE Sub-Slab Deep	5,800,000,000 J

LB17	8/29/2011	10/23/2011
TCE Indoor Air	160	2
TCE Sub-Slab	950,000	
TCE Sub-Slab Deep	1,300,000	

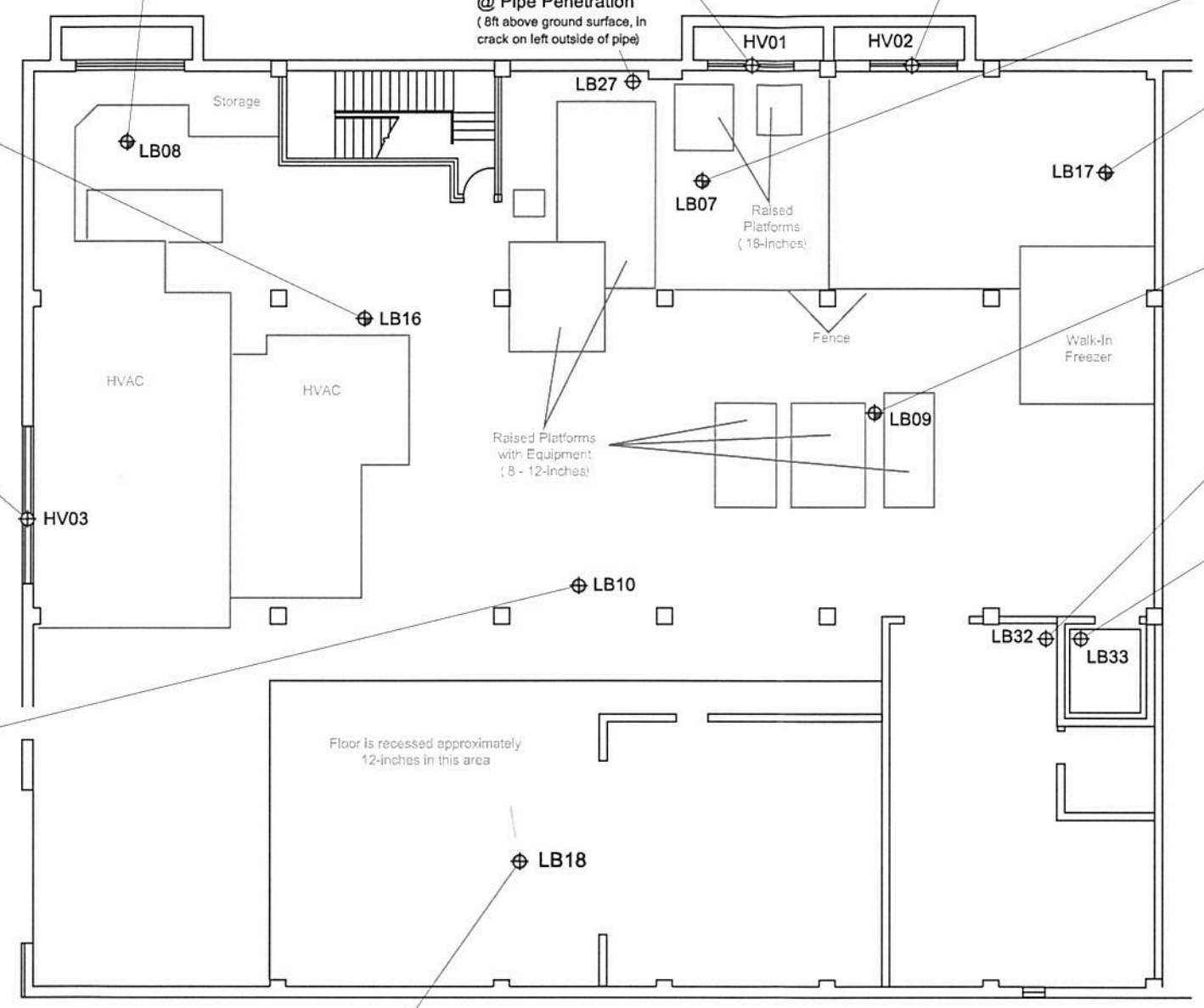
LB09	3/14/2010	6/13/2010	8/29/2011	10/23/2011
TCE Indoor Air	13	91	290	11
TCE Sub-Slab			900,000	
TCE Sub-Slab Deep			2,800,000	

HV03	8/29/2011
TCE Indoor Air	11

LB32	10/23/2011
TCE Indoor Air	3.5

LB33	10/23/2011
TCE Indoor Air	2.2

LB10	3/14/2010	6/13/2010	8/29/2011
TCE Indoor Air	11	34	170
TCE Sub-Slab			1,200,000



LB18	8/29/2011
TCE Indoor Air	140
TCE Sub-Slab	440,000

Legend:

Storage — Room Description

LB07 — Sample Location ID

⊕ — Indoor Air Sampling Location

⊕ — HVAC Sampling Location

⊕ — Combined Indoor Air and Sub-Slab Sampling Location (<1 ft below slab)

⊕ — Combined Indoor Air, Sub-Slab and Deep Sub-Slab Sampling Location (>5 ft below slab)

Note:

1. The sub-slab samples were collected from directly below the slab and the deep sub-slab samples were collected from > 5 ft below the slab.
2. All concentrations are presented in ug/m³. Where duplicate samples were analyzed, the higher concentration is shown.

0' 7.5' 15'
1" = 15'

AECOM

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CRREL - Hanover, New Hampshire

Lab Addition Sub-Basement

Figure 1 - Sample Locations

ANSI B 11" x 17"

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Logistics Management Facility

Basement Floor Plan

LM06	8/29/2011	10/23/2011
TCE Indoor Air	6.9	2.4
TCE Sub-Slab	290	

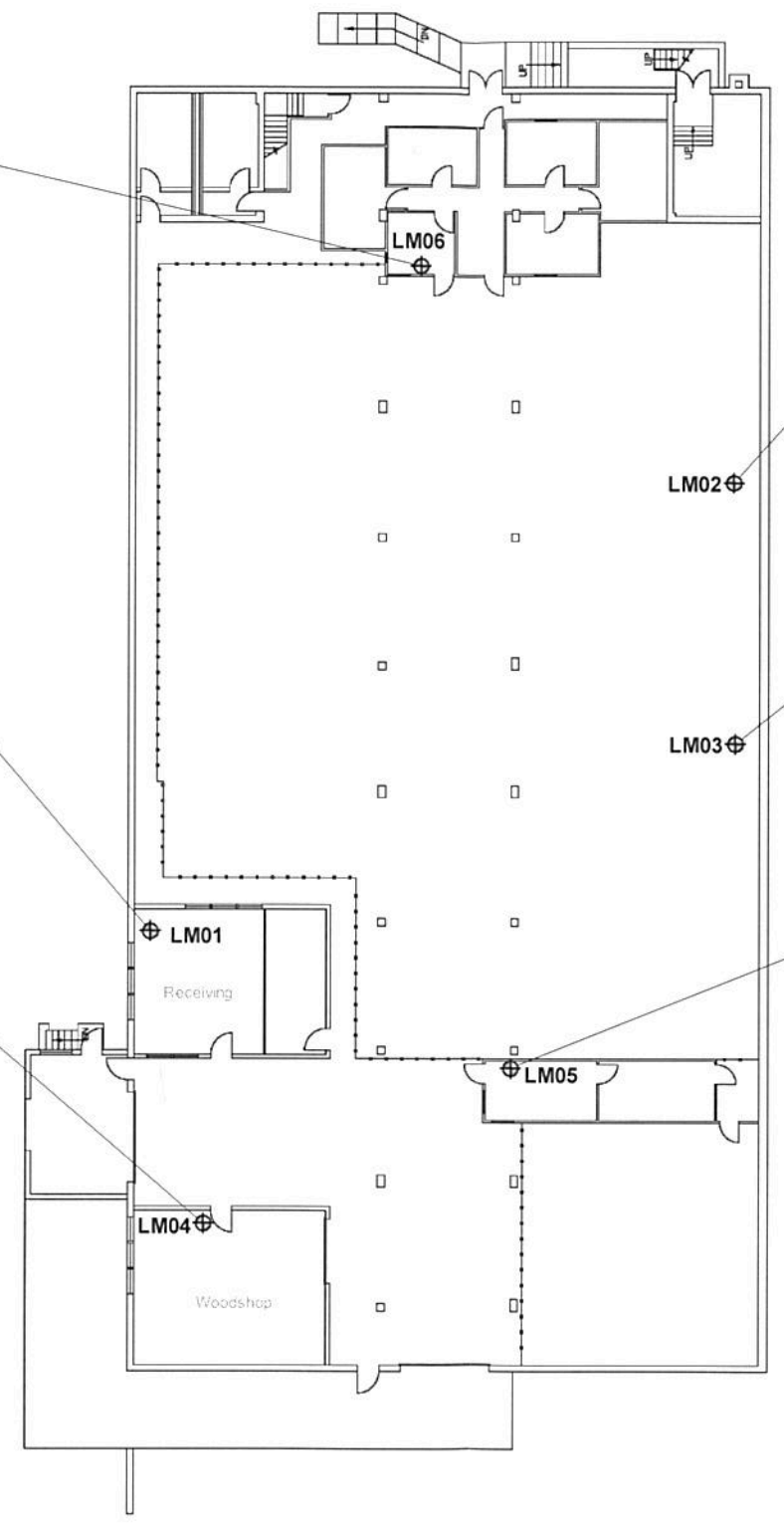
LM02	3/14/2010	6/13/2010
TCE Indoor Air	6.4	2.6
TCE Sub-Slab	26	50

LM01	3/14/2010	6/13/2010	8/29/2011
TCE Indoor Air	18	9.1	22
TCE Sub-Slab	910	2,800	8,400

LM03	3/14/2010	6/13/2010	8/29/2011
TCE Indoor Air	6.4	2.7	16
TCE Sub-Slab	19	18	89

LM04	3/14/2010	6/13/2010	8/29/2011	10/23/2011
TCE Indoor Air	6.4	3.9	14	3.2
TCE Sub-Slab			4,100	

LM05	8/29/2011	10/23/2011
TCE Indoor Air	24	2.2
TCE Sub-Slab	9.7	



Legend:

Receiving — Room Description

LM01 — Sample Location ID

⊕ — Co-Located Sub-Slab/Indoor Air Sampling Location

Note:

1. All concentrations are presented in ug/m ^{3}. Where duplicate samples were analyzed, the higher concentration is shown.

0' 15' 30'

1" = 30'

AECOM

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CRREL - Hanover, New Hampshire

Logistics Management Facility (LMO)

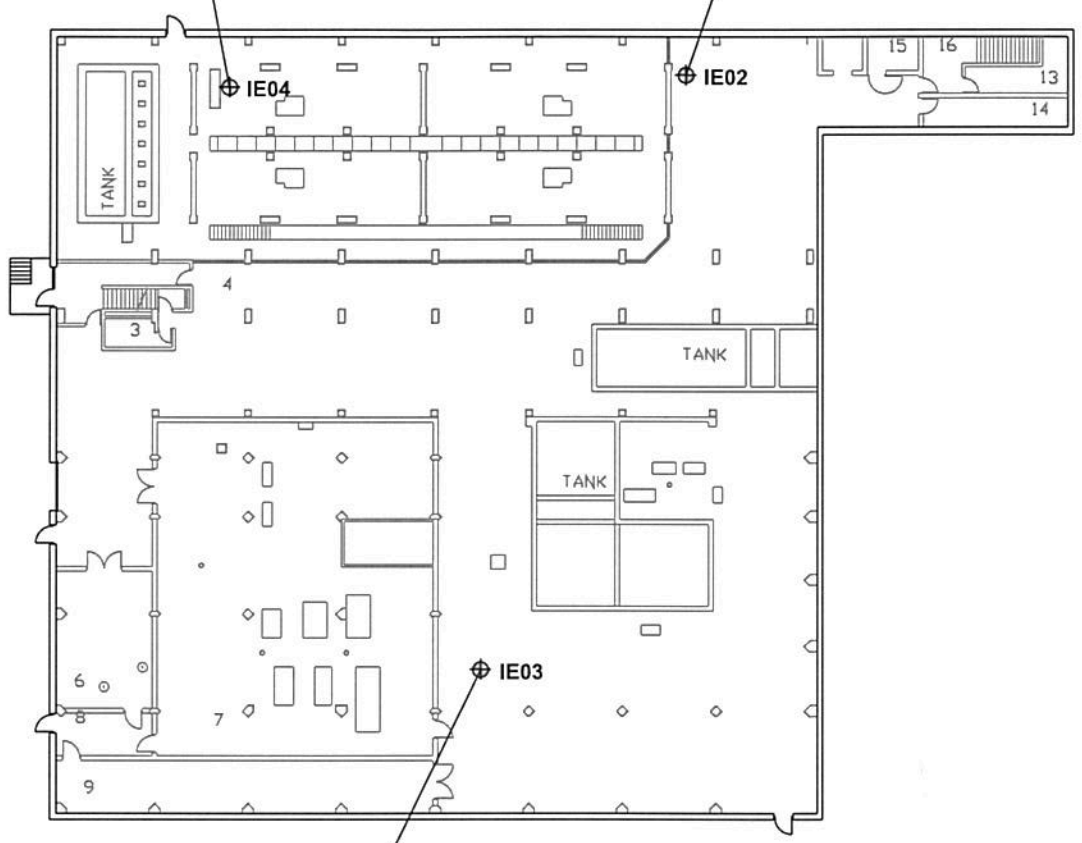
Figure 1 - Sample Locations

Ice Engineering Facility

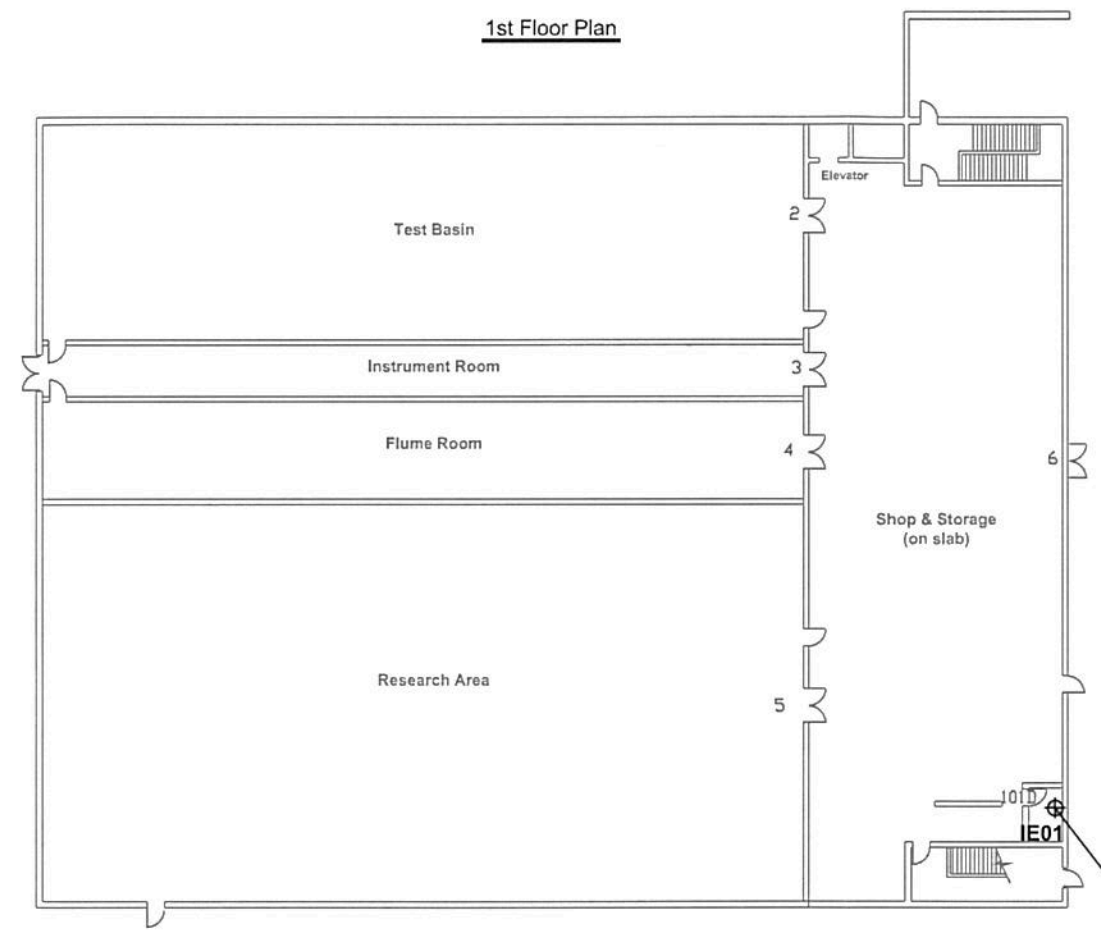
IE01	10/23/2011
TCE Indoor Air	2.7
TCE Sub-Slab	35

IE02	8/29/2011
TCE Indoor Air	1.6
TCE Sub-Slab	29

Ground Floor Plan



1st Floor Plan



IE03	8/29/2011
TCE Indoor Air	0.46
TCE Sub-Slab	14

IE04	8/29/2011
TCE Indoor Air	1.7
TCE Sub-Slab	760

Legend:

9 Room Number

IE01 Sample Location ID

⊕ Co-Located Sub-Slab/Indoor Air Sampling Location

Note:

1. Shop and Storage on 1st floor is located on the slab.
2. All concentrations are presented in ug/m³. Where duplicate samples were analyzed, the higher concentration is shown.

0' 20' 40'
1" = 40'

AECOM

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CRREL - Hanover, New Hampshire

Ice Engineering Facility (IE)

Figure 1 - Sample Locations

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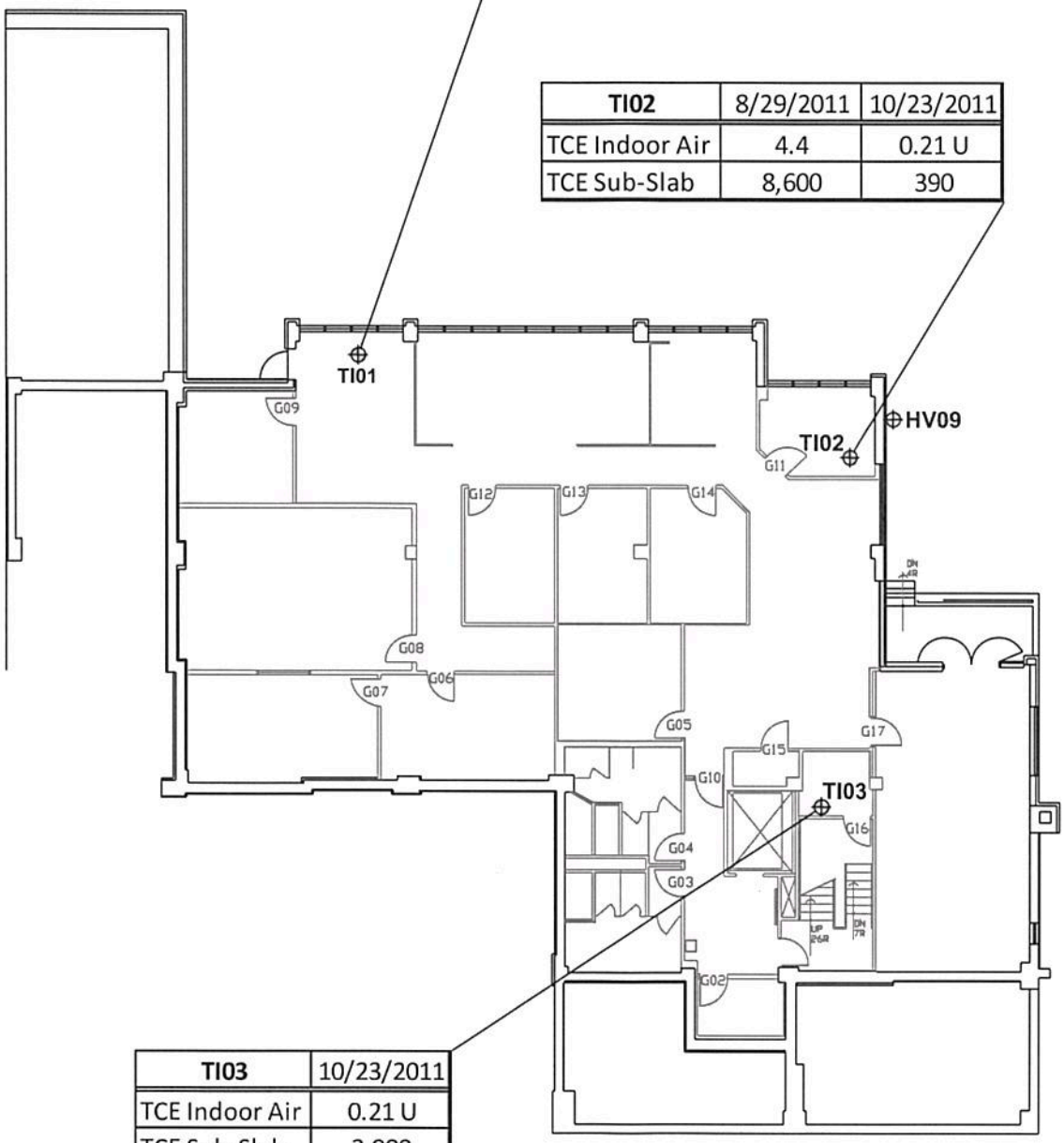
Technical Information Analysis Center

Ground Floor Plan

TI01	8/29/2011	10/23/2011
TCE Indoor Air	4	0.21 U
TCE Sub-Slab	110 U	54 U

TI02	8/29/2011	10/23/2011
TCE Indoor Air	4.4	0.21 U
TCE Sub-Slab	8,600	390



TI03	10/23/2011
TCE Indoor Air	0.21 U
TCE Sub-Slab	3,900

Legend:

G16 Room Number

TI01 Sample Location ID

⊕ Co-Located Sub-Slab/Indoor Air Sampling Location

⊕ HVAC Sampling Location

Note:

1. All concentrations are presented in ug/m³. Where duplicate samples were analyzed, the higher concentration is shown.

0' 10' 20'

1" = 20'

AECOM

W912DR-09-D-0019 0003

CRREL - Hanover, New Hampshire

Technical Information Analysis Center (TIAC)

Figure 1 - Sample Locations

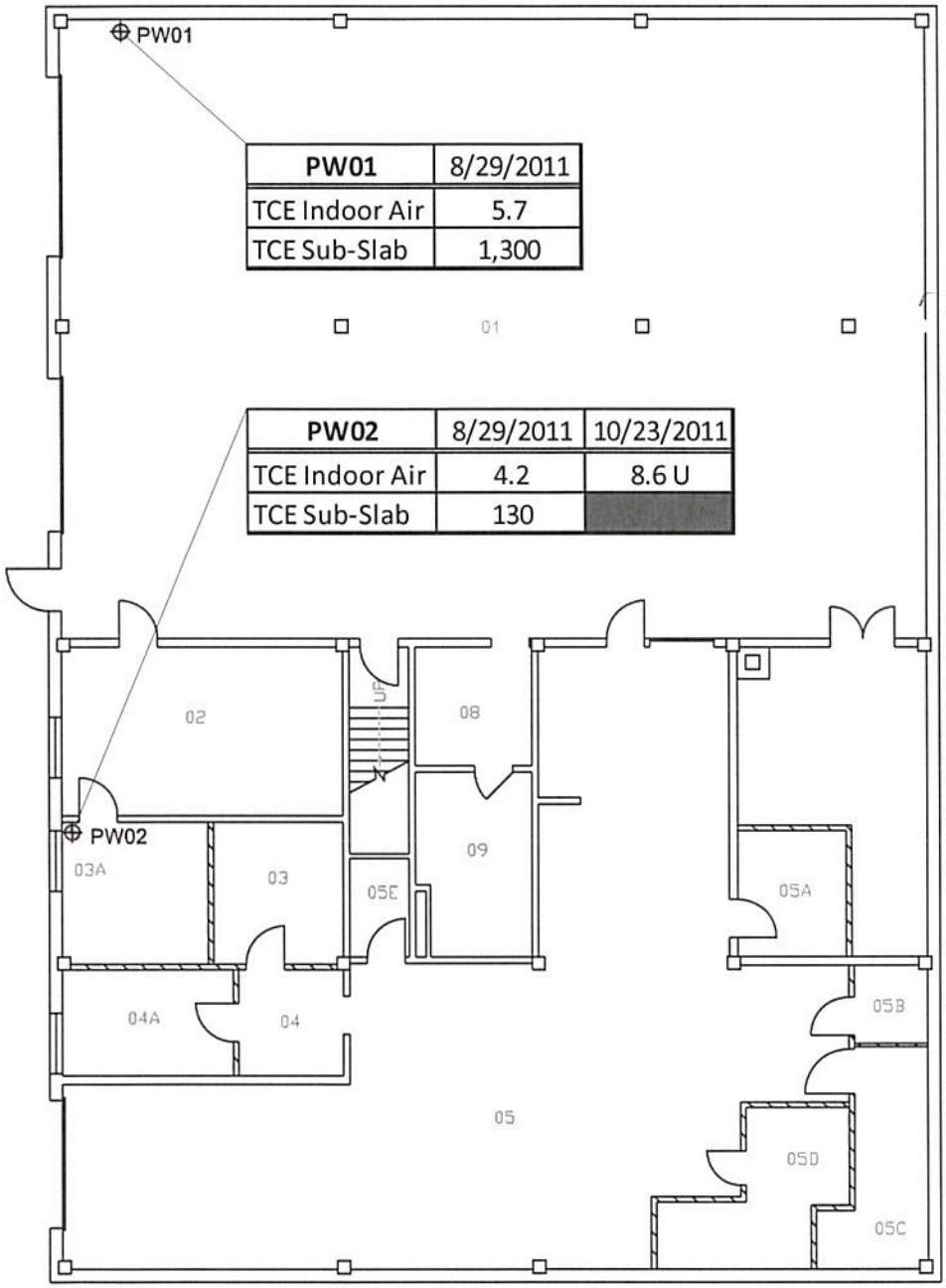
ANSI A 8.5" x 11"

Project Management Initials: Designer: LAD Checked: EL Approved:

Filename: C:\DOCUMENTS AN...INGS\DESKINSL\DESKTOP\DESKTOP\CRREL VAPOR INTRUSION\TIAC SAMPLING LOCATIONS.DWG Last saved by: DESKINSL Last Plotted: 12/12/2011 ...PM

Directorate of Public Works

Basement Floor Plan



PW01	8/29/2011
TCE Indoor Air	5.7
TCE Sub-Slab	1,300

PW02	8/29/2011	10/23/2011
TCE Indoor Air	4.2	8.6 U
TCE Sub-Slab	130	

Legend:

05 Room Number

PW01 Sample Location ID

⊕ Co-Located Sub-Slab/Indoor Air Sampling Location

Note:

1. All concentrations are presented in ug/m³. Where duplicate samples were analyzed, the higher concentration is shown.

0' 7.5' 15'

1" = 15'

AECOM

W912DR-09-D-0019 0003

CRREL - Hanover, New Hampshire

Directorate of Public Works (DPW)

Figure 1 - Sample Locations

ANSI A 8.5" x 11"

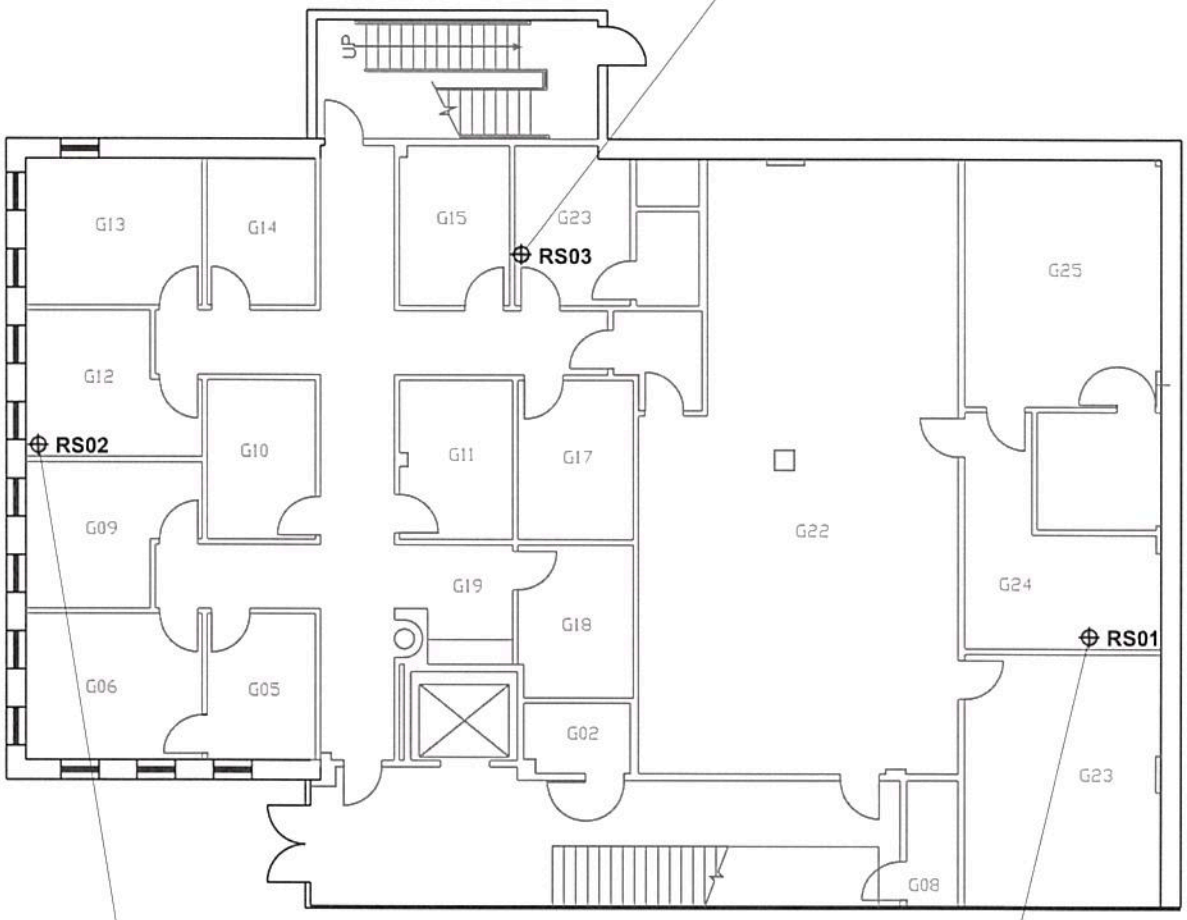
Project Management Initials: Designer: LAD Checked: EL Approved:

Filename: C:\DOCUMENTS AN...NGS\DESKINSL\DESKTOP\DESKTOP\CRREL VAPOR INTRUSION\DPW SAMPLING LOCATIONS.DWG Last saved by: DESKINSL Last Plotted: 12/13/2011

Remote Sensing Building

Ground Floor Plan

RS03	10/23/2011
TCE Indoor Air	0.38
TCE Sub-Slab	70



RS02	8/29/2011
TCE Indoor Air	1.5
TCE Sub-Slab	86

RS01	8/29/2011
TCE Indoor Air	0.32
TCE Sub-Slab	5.1

Legend:

G22 Room Number

RS01 Sample Location ID

⊕ Co-Located Sub-Slab/Indoor Air Sampling Location

Note:

1. All concentrations are presented in ug/m³. Where duplicate samples were analyzed, the higher concentration is shown.

0' 7.5' 15'

1" = 15'

AECOM

W912DR-09-D-0019 0003

CRREL - Hanover, New Hampshire

Remote Sensing Facility (RS)

Figure 1 - Sample Locations

ANSI A 8.5" x 11"

Approved:

Checked: EL

Designer: LAD

Project Management Initials:

Last Plotted: 12/13/2011 10:

Last saved by: DESKINSL

Filename: C:\DOCUMENTS AN...ING\DESKINSL\DESKTOP\DESKTOP\CRREL VAPOR INTRUSION\RS SAMPLING LOCATIONS.DWG

Action Levels for Chronic Exposures to TCE Vapor

Parameter	Receptor	Ages (yrs)	IUR $(mg/m^3)^{-1}$	ED (yrs)	RfC (mg/m^3)	Target Hazard Quotient	Target Cancer Risk	AT_{NC} (days)	AT_{CA} (days)	ET (hr/day)	CF (day/24 hrs)	EF (days/yr)	PRG Noncancer HQ = 1 (mg/m^3)	PRG Noncancer HQ = 1 $(\mu g/m^3)$	PRG Cancer Risk = 1×10^{-6} (mg/m^3)	PRG Cancer Risk = 1×10^{-6} $(\mu g/m^3)$
Trichloroethene	Child Daycare	0<2	1.3E-02	2	2.00E-03	1	1E-06	2,190	25,550	10	0.0417	250	0.0070	7.0	0.00485	4.8
		2<6	6.1E-03	4												
	Adult Worker	16-70	4.1E-03	25	2.00E-03	1	1E-06	9,125	25,550	8	0.0417	250	0.0088	8.8	0.0030	3.0
	Resident	0<2	1.3E-02	2	2.00E-03	1	1E-06	10,950	25,550	24	0.0417	350	0.0021	2.1	0.00043	0.43
		2<6	6.1E-03	4												
		6<16	6.1E-03	10												
		16-70	4.1E-03	14												

ATnc - Averaging time for noncancer effects
ATca -Averaging time for cancer effects
ET - Exposure time
CF - Conversion factor
EF - Exposure frequency
ED - Exposure duration
RfC - Reference concentration for noncancer effects
IUR - Inhalation unit risk for cancer effects

Derivation of IUR Protective of Sensitive Life Stages

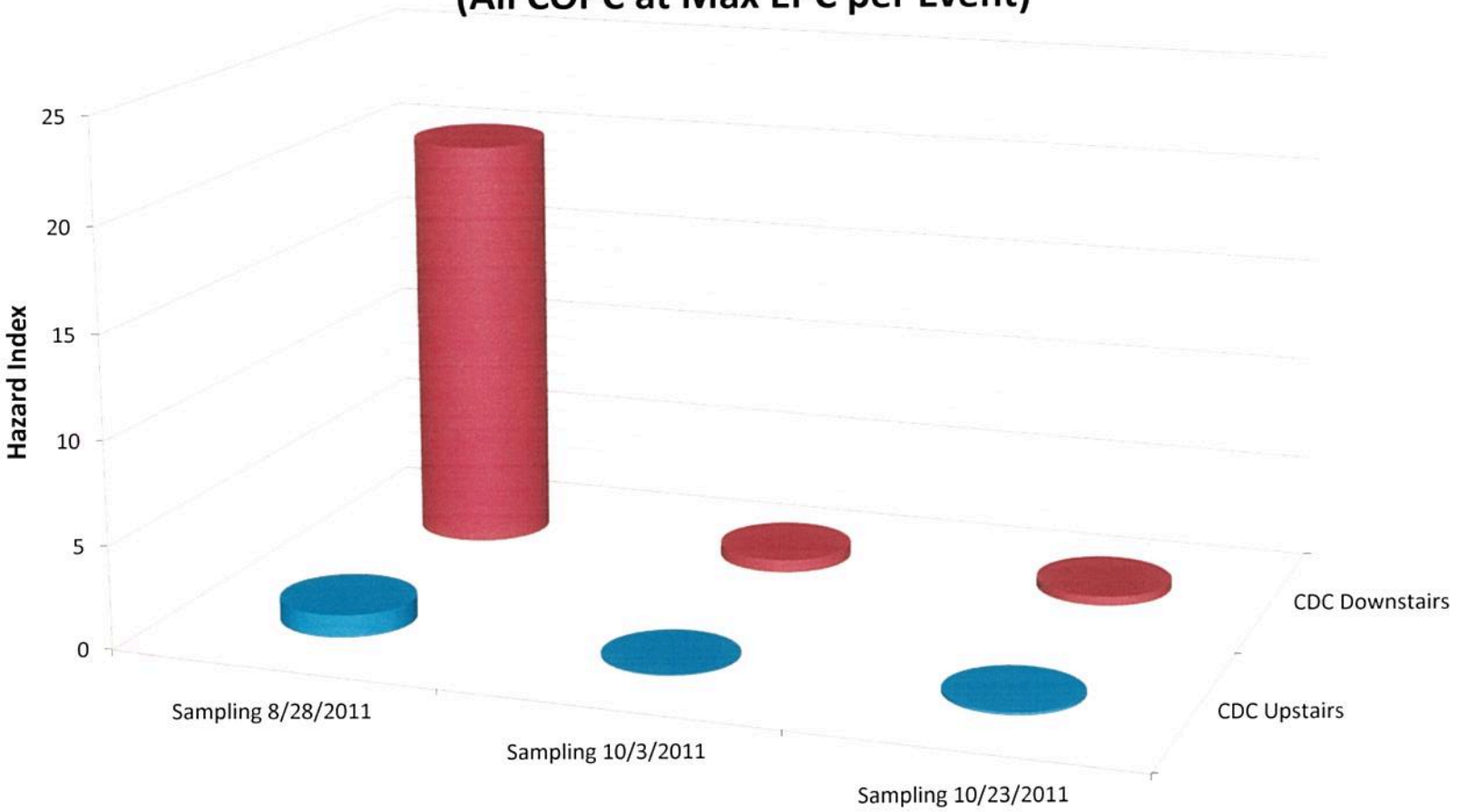
Parameter	Receptor	Ages (yrs)	Kidney			NHL+Liver	Kidney+NHL+Liver	
			IURU $(mg/m^3)^{-1}$	ADAF	IURA $(mg/m^3)^{-1}$	IURU $(mg/m^3)^{-1}$	IURU $(mg/m^3)^{-1}$	IURA $(mg/m^3)^{-1}$
Trichloroethene	Child Daycare	0<2	1.0E-03	10	1.0E-02	3.1E-03	4.1E-03	1.3E-02
		2<6	1.0E-03	3	3.0E-03	3.1E-03	4.1E-03	6.1E-03
	Adult Worker	16-70	1.0E-03	1	1.0E-03	3.1E-03	4.1E-03	4.1E-03
	Resident	0<2	1.0E-03	10	1.0E-02	3.1E-03	4.1E-03	1.3E-02
		2<6	1.0E-03	3	3.0E-03	3.1E-03	4.1E-03	6.1E-03
		6<16	1.0E-03	3	3.0E-03	3.1E-03	4.1E-03	6.1E-03
		16-70	1.0E-03	1	1.0E-03	3.1E-03	4.1E-03	4.1E-03

IUR - Inhalation unit risk for cancer effects
$IURU_{Kidney}$ is from (p 5-137 [5.2.2.1.4]); unadjusted with no ADAFs.
$IURA_{Kidney}$ is adjusted with ADAFs.
$IURU_{Kidney+NHL+Liver}$ is from (p 5-139 [5.2.2.2]); unadjusted with no ADAFs.
$IURU_{NHL+Liver} = IURUKidney+NHL+Liver - IURUKidney$
$IURA_{Kidney+NHL+Liver}$ is from (p 5-139 [5.2.2.2]); adjusted with ADAFs for only kidney effects.
PRG - Preliminary remediation goal
HQ - Hazard quotient for noncancer effects

Steps in the derivation

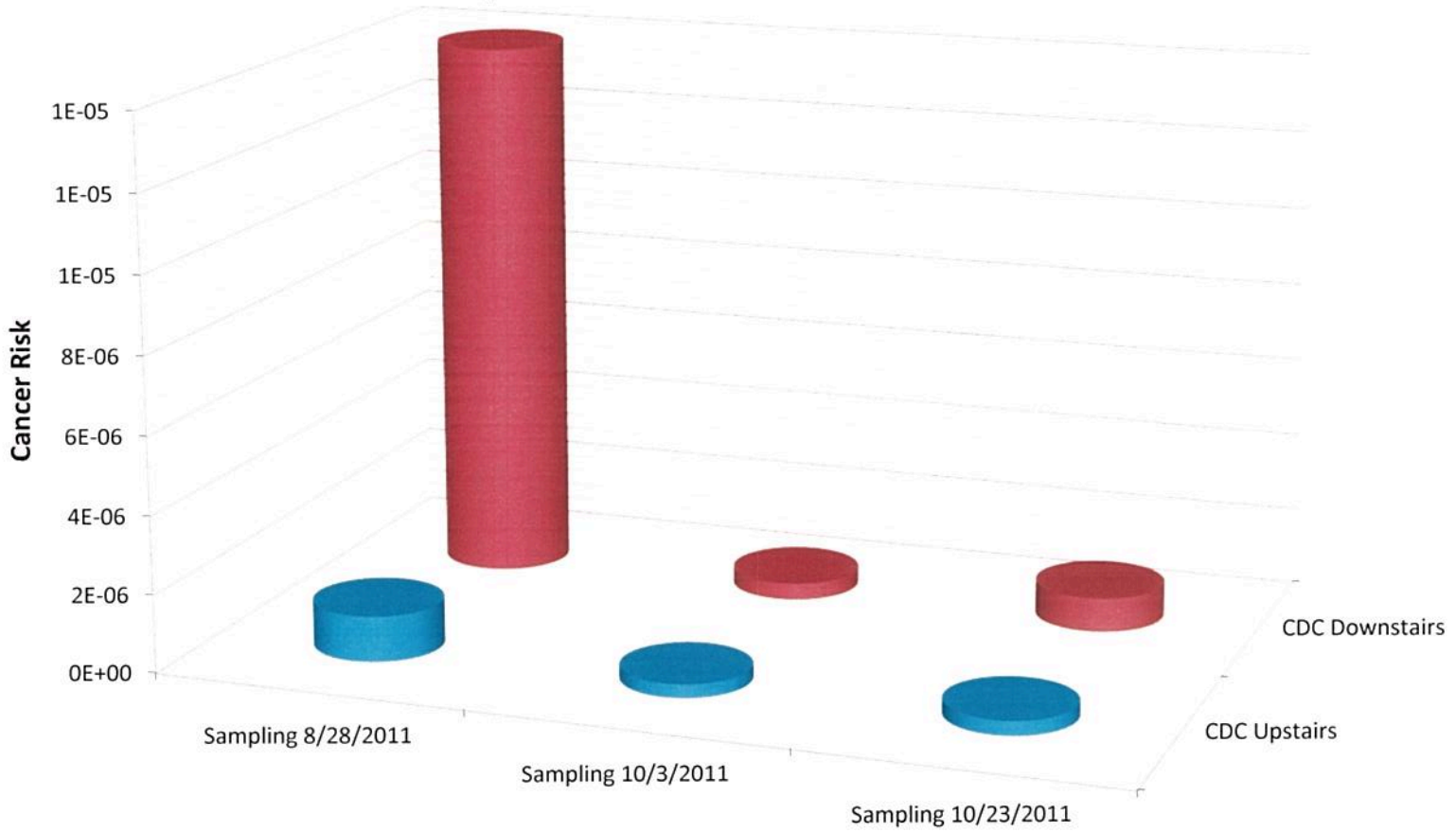
- Start with IURU for all three effects
- Subtract out IURU for kidney effects
- Adjust IURU for kidney effects with ADAFs
- Add adjusted IURA for kidney to unadjusted IURU for NHL and liver effects
- Result is specific IURs for each ADAF age group

Child's Hazard Index at CDC
(All COPC at Max EPC per Event)



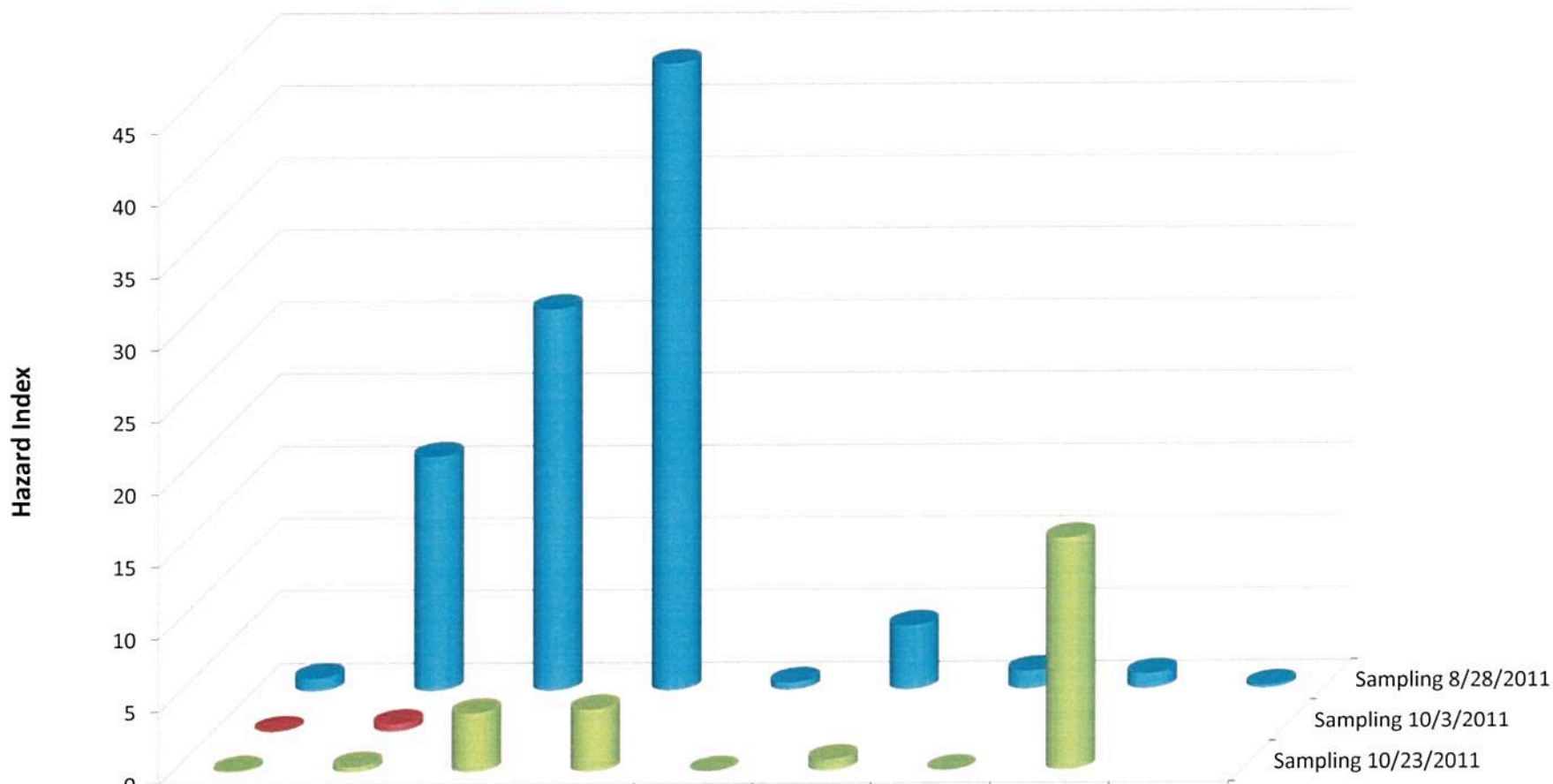
	Sampling 8/28/2011	Sampling 10/3/2011	Sampling 10/23/2011
CDC Upstairs	1	0.07	0.2
CDC Downstairs	20	0.6	0.5

Child's Cancer Risk at CDC
(All COPC at Max EPC per Event)



	Sampling 8/28/2011	Sampling 10/3/2011	Sampling 10/23/2011
CDC Upstairs	1E-06	4E-07	4E-07
CDC Downstairs	1E-05	4E-07	9E-07

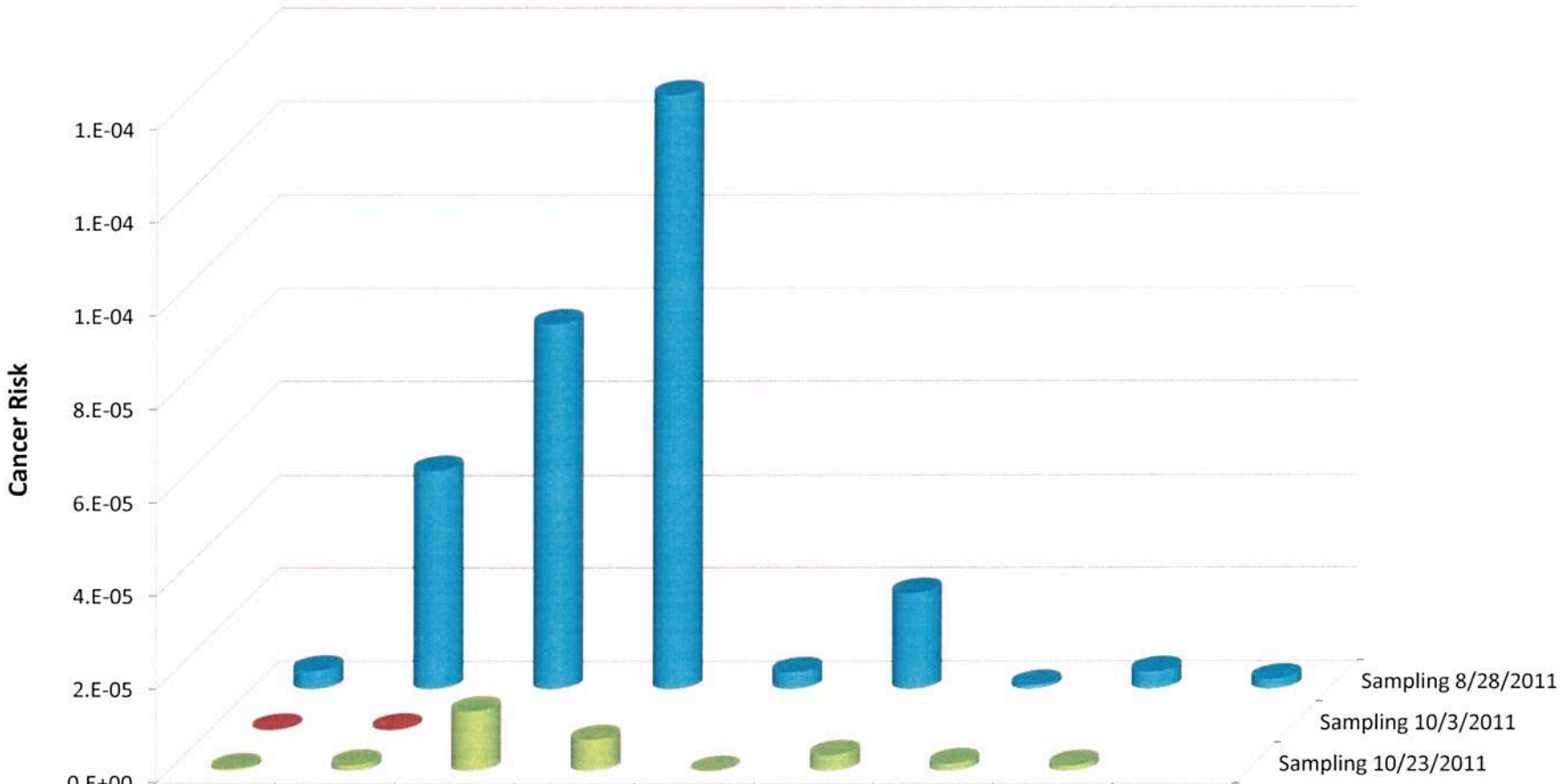
Adult Worker Hazard Index
(Max EPC per Sampling Event)



	CDC Upstairs	CDC Bsmt	Main Lab	Lab Add Sub-Bsmt	TIAC	LMO	Ice Eng	DPW	Remote Sens
Sampling 8/28/2011	0.9	16	26	43	0.5	4	1	1	0.2
Sampling 10/3/2011	0.06	0.5							
Sampling 10/23/2011	0.1	0.4	4	4	0.006	0.8	0.03	16	

Notes: Excluded soil wall sample for lab addition sub-basement.
DPW hazards are primarily due to fuel vapors (trimethylbenzenes).
No TCE 23OCT2011 at DPW, Ice Engineering, and TIAC subsequent to detections 28AUG2011.

Adult Worker Cancer Risk
(Max EPC per Sampling Event)



	CDC Upstairs	CDC Bsmt	Main Lab	Lab Add Sub-Bsmt	TIAC	LMO	Ice Eng	DPW	Remote Sens
Sampling 8/28/2011	4E-06	5E-05	8E-05	1E-04	4E-06	2E-05	9E-07	4E-06	2E-06
Sampling 10/3/2011	3E-07	4E-07							
Sampling 10/23/2011	6E-07	1E-06	1E-05	7E-06	1E-07	3E-06	2E-06	1E-06	

Notes: Excluded soil wall sample for lab addition sub-basement.
DPW hazards are primarily due to fuel vapors (trimethylbenzenes).
No TCE 23OCT2011 at DPW, Ice Engineering, and TIAC subsequent to detections 28AUG2011.

Summary of Risk Estimates for Vapor Intrusion Based on Maximum Detected Concentrations at Several CRREL Campus Locations

Location	Receptor											
	Child at Daycare						Adult Worker					
	Hazard Index			Cancer Risk			Hazard Index			Cancer Risk		
	Sampling 8/28/2011	Sampling 10/3/2011	Sampling 10/23/2011	Sampling 8/28/2011	Sampling 10/3/2011	Sampling 10/23/2011	Sampling 8/28/2011	Sampling 10/3/2011	Sampling 10/23/2011	Sampling 8/28/2011	Sampling 10/3/2011	Sampling 10/23/2011
CDC Upstairs	1	0.07	0.2	1E-06	4E-07	4E-07	0.9	0.06	0.1	4E-06	3E-07	6E-07
CDC Downstairs	20	0.6	0.5	1E-05	4E-07	9E-07	16	0.5	0.4	5E-05	4E-07	1E-06
Main Lab	NE	NE	NE	NE	NE	NE	26		4	8E-05		1E-05
Lab Add Sub-Bsmt	NE	NE	NE	NE	NE	NE	43		4	1E-04		7E-06
TIAC	NE	NE	NE	NE	NE	NE	0.5		0.006	4E-06		1E-07
LMO	NE	NE	NE	NE	NE	NE	4		0.8	2E-05		3E-06
Ice Eng	NE	NE	NE	NE	NE	NE	1		0.03	9E-07		2E-06
DPW	NE	NE	NE	NE	NE	NE	1		16	4E-06		1E-06
Remote Sens	NE	NE	NE	NE	NE	NE	0.2			2E-06		

All detected analytes are included at maximum detection anywhere for the noted location and sampling event.
Excluded soil wall sample for lab addition sub-basement.
No TCE 23OCT2011 at DPW, Ice Engineering, and TIAC subsequent to detections 28AUG2011.
NE - No Exposure
Shaded Cell - Not Sampled