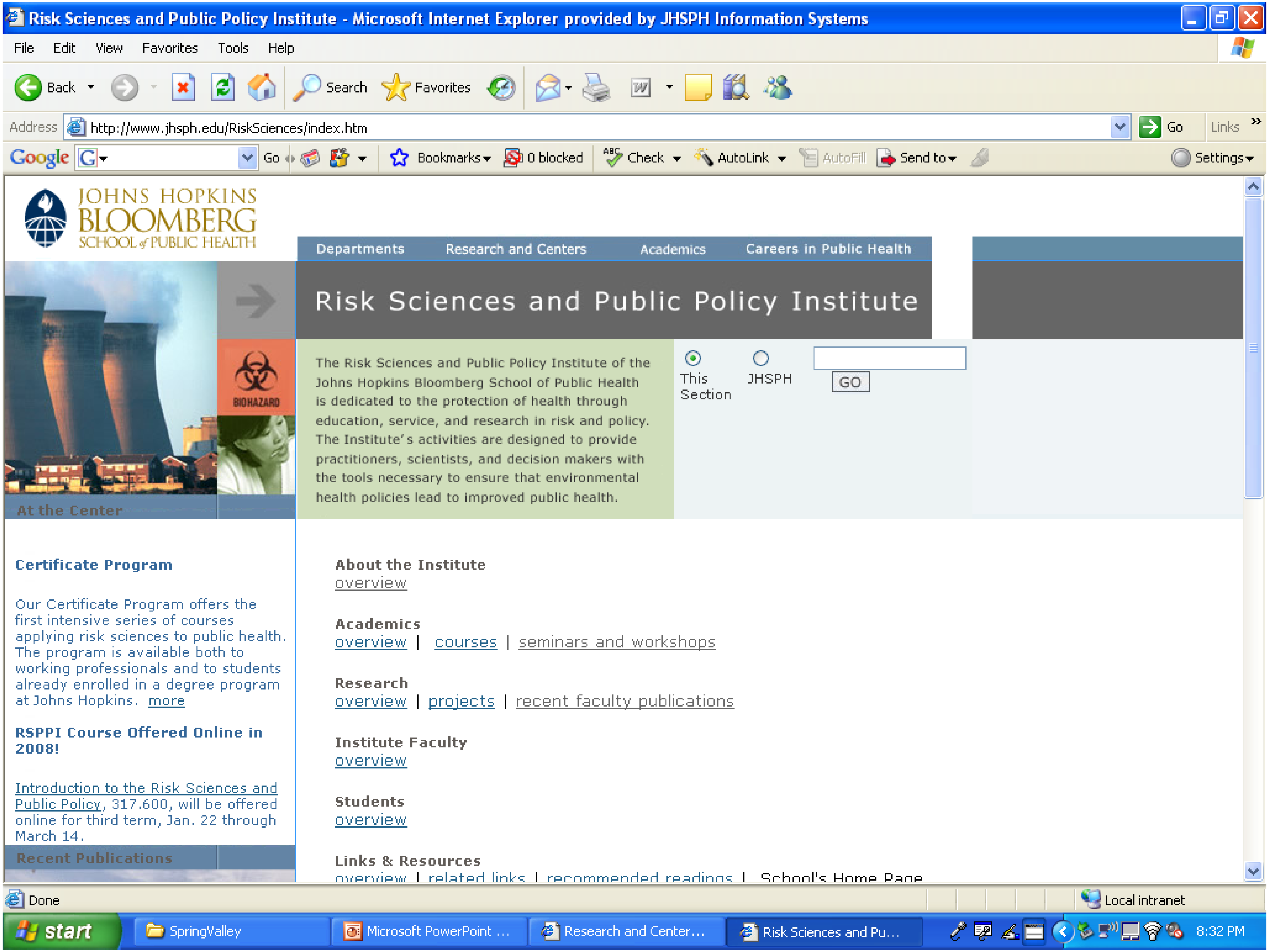
Spring Valley Public Health Scoping Study

Mary A. Fox, PhD, MPH

Risk Forum

October 16, 2007

Courtesy of the U.S. Army Corps of Engineers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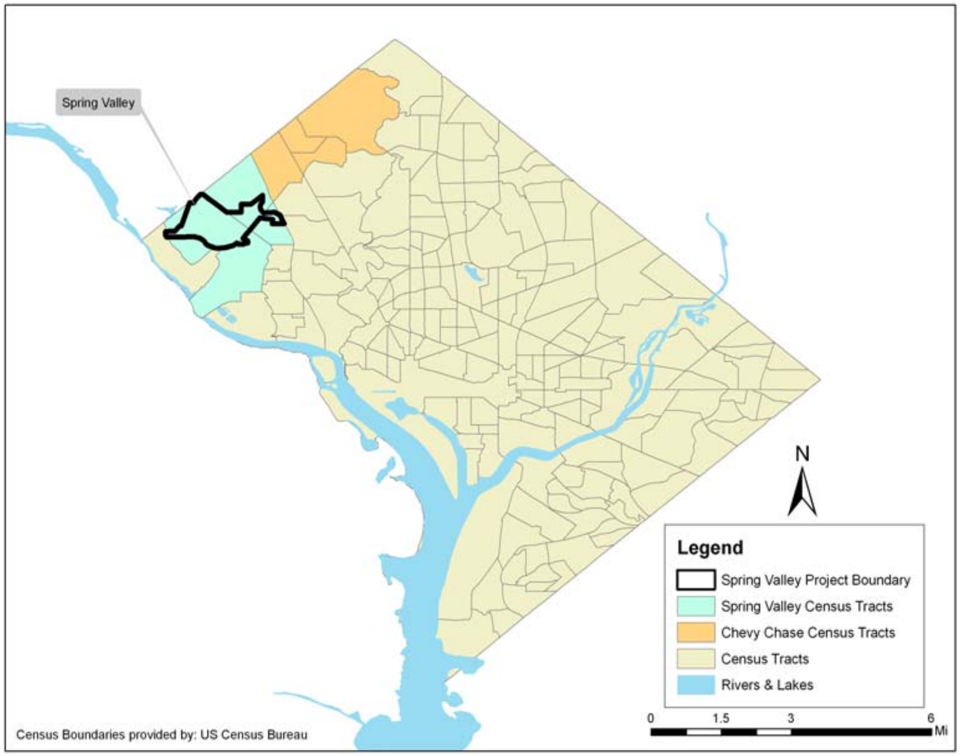
American University Experiment Station - Birthplace of Army Chemical Corps

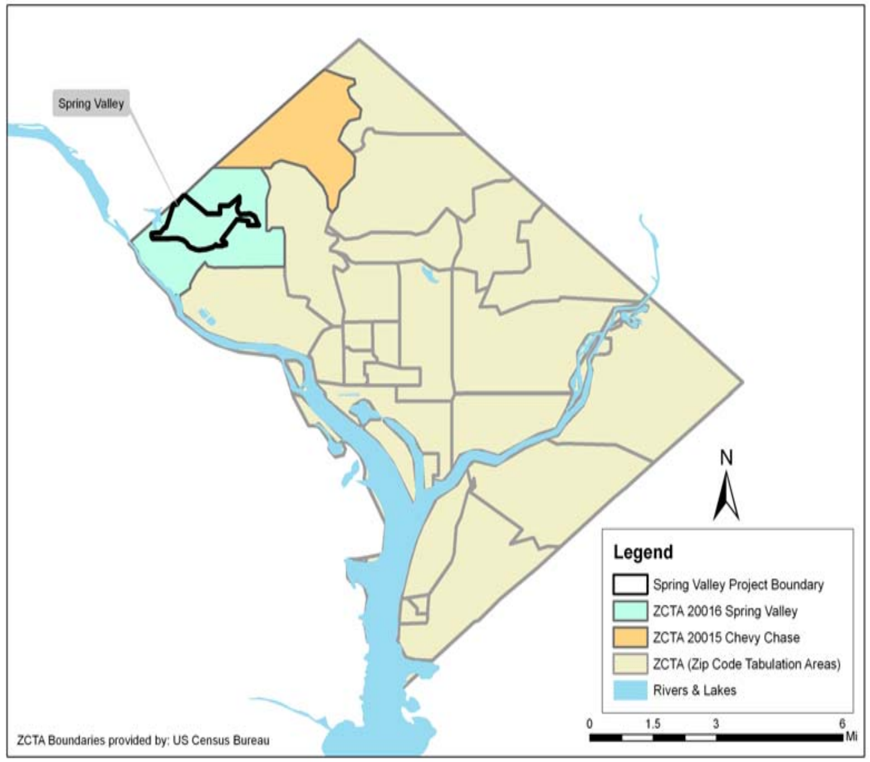
Photo Credit: T. Burke

Johns Hopkins Study Team

Mary Fox
Beth Resnick
Erik Janus
Frank Curriero
Kathryn Kulbicki
Ana Navas-Acien
Ramya Chari
Roni Neff
Keeve Nachman
Joanna Zablotsky
Tom Burke

Spring Valley and Chevy Chase: Census Tracts, ZIP Codes





Timeline (1)

1917-1918 Chemical weapon and counter measures development and testing

1919-1920 Demobilization, transfer to Edgewood, MD

1921 Salvage and restoration of AU grounds

1930s – 80s Residential development

Photo credit: T. Burke

WWI Activities: Examples of chemical weapons made/tested at AUES

- Blister agents
  - Lewisite (As)
  - Sulfur and nitrogen mustard (thiodiglycol)
- Choking agents
  - Phosgene
- Vomiting agents
  - Adamsite (As)
  - Chlorpicrin

WWI Activities: Examples (1)

REP_NO	TITLE	REP_DATE
BM 01-049	PROGRESS REPORT OF MANUFACTURE OF WAR GASES	8/15/1917
BM 01-010	PERMEABILITY TESTS OF FACE PIECES OF US ARMY GAS MASK	8/17/1917
BM 00-007	QUANTITIVE DETERMINATION OF CHLORPICRIN IN AIR	8/18/1917
BM 01-011	PERMEABILITY TESTS OF FACE PIECES OF US ARMY GAS MASK WITH BENZYL BROMIDE	8/18/1917
BM 01-004	TESTING EFFICIENCY OF CANISTERS FOR CHLORPICRIN	8/20/1917
BM 01-002	TESTING EFFICIENCY OF CANISTERS FOR CHLORINE	8/21/1917
BM 01-003	TESTING EFFICIENCY OF CANISTERS FOR HYDROCYANIC ACID	8/21/1917
BM 01-007	TESTING EFFICIENCY OF CANISTERS FOR PHOSGENE	8/21/1917
BM 01-013	PERMEABILITY OF RUBBER FABRIC TO XYLYL BROMIDE	8/23/1917
BM 01-005	GAS CHAMBER AND PERMEABILITY TEST AGAINST XYLYL AND BENZYL BROMIDES	8/25/1917
BM 01-012	GAS CHAMBER TESTS ON MAN WEARING BRITIXH BOX RESPIRATOR MASK IN XYLYL BROMIDE, 30ppm	8/25/1917
BM 01-014	PERMEABILITY OF NEW DOUBLE COATED RUBBERIZED FABRIC TO XYLYL BROMIDE	8/25/1917
BM 01-019	REPORT OF CANISTER TESTS AGAINST STANNIC CHLORIDE	8/25/1917
BM 01-028	TOXICITY EXPERIMENTS ON MICE	9/1/1917
BM 01-029	TOXICITY OF PERCHLORMETHYLCHLORFORMATE, PHOSGENE, CHLORPICRIN, AND ETHYL CHLORFOR	9/1/1917
BM 01-030	TOXICITY EXPERIMENTS ON DOGS, CATS AND RABBITS	9/1/1917
BM 01-031	PHYSIOLOGICAL ACTION OF HYDROCYANIC ACID	9/1/1917
BM 01-032	THE PATHOLOGICAL STUDY OF GASSED ANIMALS	9/5/1917
BM 01-069	DEMONSTRATION OF INCENDIARY BOMBS, SMOKE CLOUDS AND SMOKE BOMBS	9/5/1917
BM 02-017	EXPERIMENTAL WORK ON GAS SHELLS	10/1/1917

WWI Activities: Examples (2) studies

REP_NO	*AGENT*	*TEST_LOCA1*	*OPEN_AIR*	*BOMB_PIT*	*LAB*	*HUMAN_EXP*
BM 10-056	MULTIPLE AGENTS	AU	FALSE	TRUE	FALSE	TRUE
BM 10-057	DIPHENYLCHLOROARSINE	AU	FALSE	FALSE	TRUE	FALSE
BM 10-058	ACROLEIN	AU	FALSE	FALSE	TRUE	FALSE
BM 10-059	MULTIPLE AGENTS	AU	FALSE	FALSE	TRUE	TRUE
BM 10-060	ARSENIC TRICHLORIDE	AU	FALSE	TRUE	FALSE	FALSE
BM 10-060	SODIUM CYANIDE	AU	FALSE	TRUE	FALSE	FALSE
BM 10-061	MULTIPLE AGENTS	AU	FALSE	FALSE	TRUE	FALSE
BM 10-061	MUSTARD	AU	FALSE	FALSE	TRUE	FALSE
BM 10-062	CHLORPICRIN	AU	FALSE	FALSE	TRUE	TRUE
BM 10-062	PHOSGENE	AU	FALSE	FALSE	TRUE	TRUE
BM 10-063	CHLORPICRIN	AU	FALSE	FALSE	TRUE	TRUE

Timeline (2) 1993 - 1995

1/93: Bomb found by contractor digging utility trench

2/93: Army Corps remedial investigation begins

- Review of historical documents, maps to identify Points of Interest
- Geophysical surveys
- Excavations/removals
- Soil sampling – chemicals not at levels of public health concern

6/95 "No further action" – Record of Decision

Photo credit: US ACE

Timeline (3) 1996-Present

DC Department of Health review finds error in location of POI 24

2 large burial pits discovered

Mustard agent found in 14 excavated items

Elevated levels of arsenic in soil at pits and other areas including AU daycare center

Comprehensive arsenic sampling and remediation

Other pits and disposal areas found (e.g., Lot 18)

Photo credit: US ACE

Project Origins

Background:

Multiple health studies

- DC Department of Health
- Agency for Toxic Substances and Disease Registry
- Informal/Anecdotal community surveys

Lack of trust

Wealthy, politically active community

Community concerns:

What to make of all the health data?

Is an epidemiological study needed?

Johns Hopkins Project Objectives

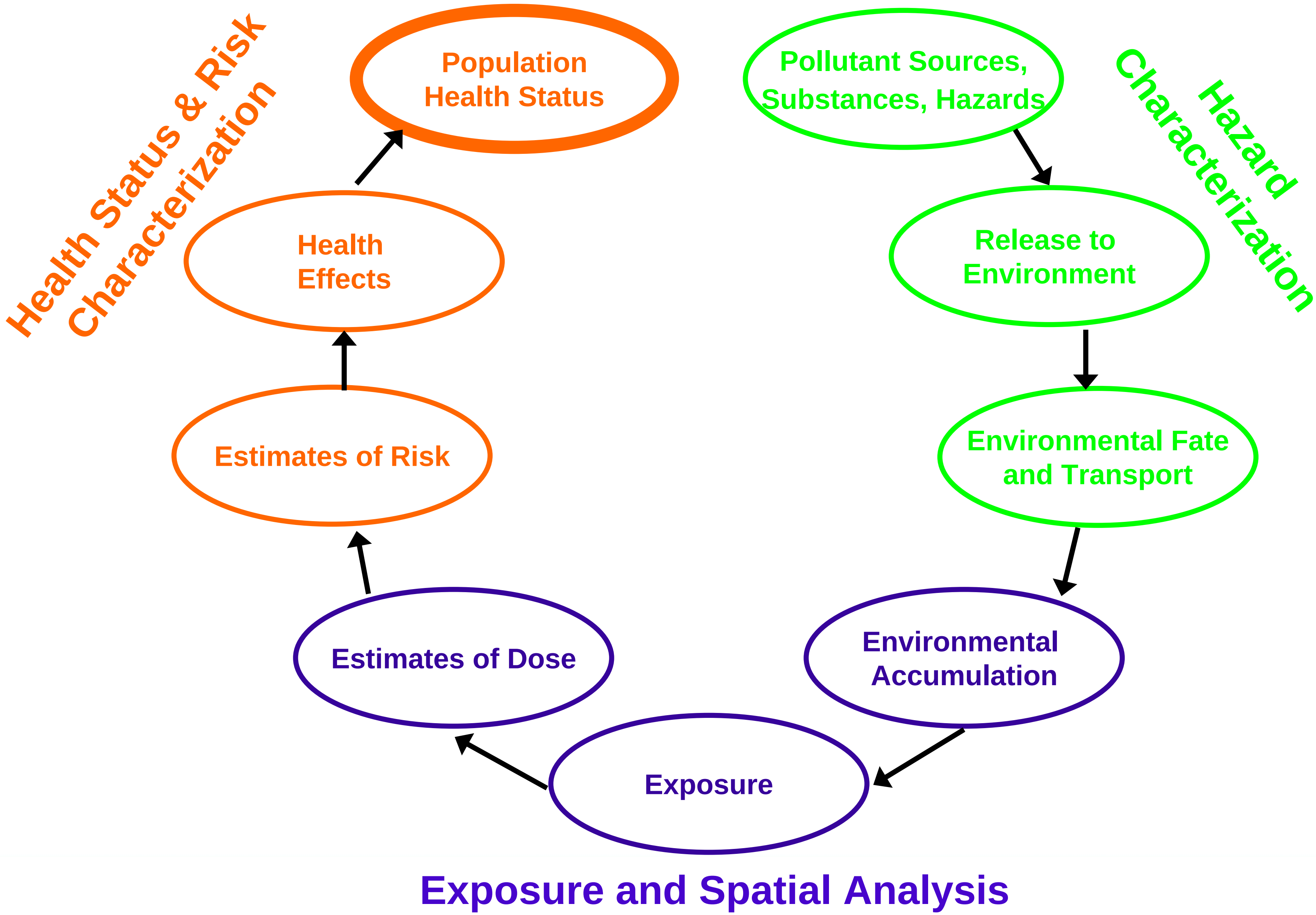
Conduct a Public Health Scoping Study

1. **Review Existing Environmental, Exposure, and Health Data**
2. **Characterize Health and Environmental Risks**
3. **Identify Key Information Gaps**
4. **Provide Recommendations for Further Study**
    - **Hazard, Exposure or Outcome Tracking**

Community Participation Approach

- Outreach to Stakeholders
- Exposure and Health Analysis
  – Community Health Status
  – Epidemiological and Toxicological Literature Review
  – Spatial Analysis of Exposure and Health
  – Assess Health Risks
- Report and Recommendations

Scoping Study Framework



Data and Resources

- ATSDR Public Health Consultation
- American University Studies
- Army Corps Sampling Data, Documents
- District Health Department's Data, Reports, Cancer Study
- EPA Air Monitoring System
- EPA Sampling and Risk Assessments
- Mayor's Spring Valley Scientific Advisory Board Reports
- RAB and Community Members
- Selected Research Literature

Outreach Efforts

Site visits, phone calls and meetings with over 40 individuals representing the following:

- Agency for Toxic Substances and Disease Registry
- American University
- Army Corps of Engineers
- Community Members
- District Health Department
- Elected Officials
- Environmental Protection Agency
- Landscapers
- Mayor's Scientific Advisory Panel
- Northwest Current
- Restoration Advisory Board
- Sibley Hospital
- Technical Experts
- U.S. Army
- Washington Aqueduct

Site Visits and Field Work

- 3 Site Visits
- American University Archives
- Palisades Library Repository
- The U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM)

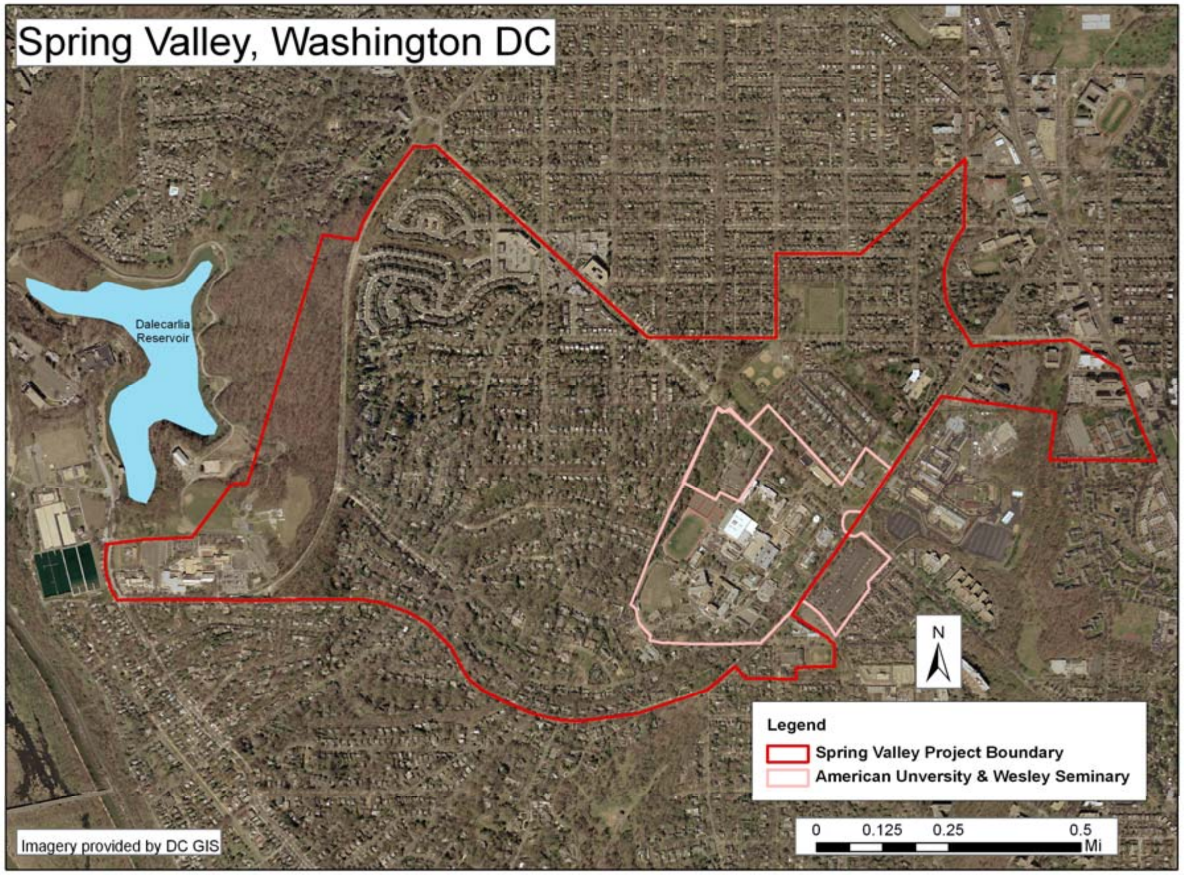
Outreach Findings

- •Understand the Complexity of the Site (90-year Time Lag, Landscape Changes, Poor Historical Documentation)
- •Questions/Uncertainties Concerning Exposures and Long Term Public Health Implications
- •Recognize Dual Nature of Contamination
  - – High Level Disposal Areas
  - – Dispersed Low-Level Contamination
- •Support an Independent Third Party Review

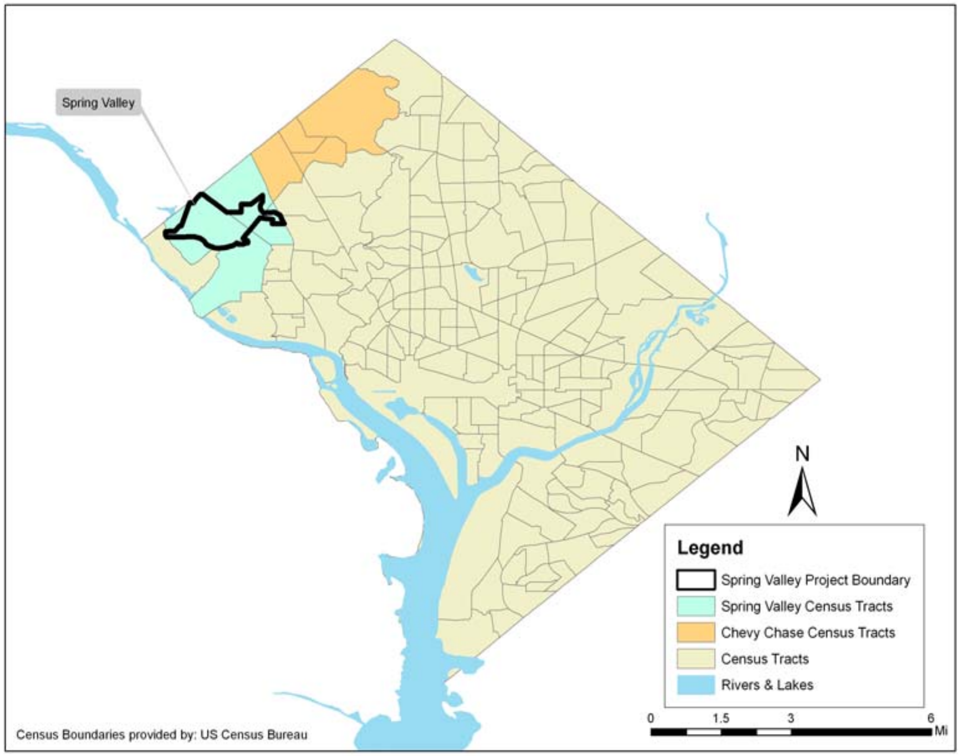
Health Analysis Components

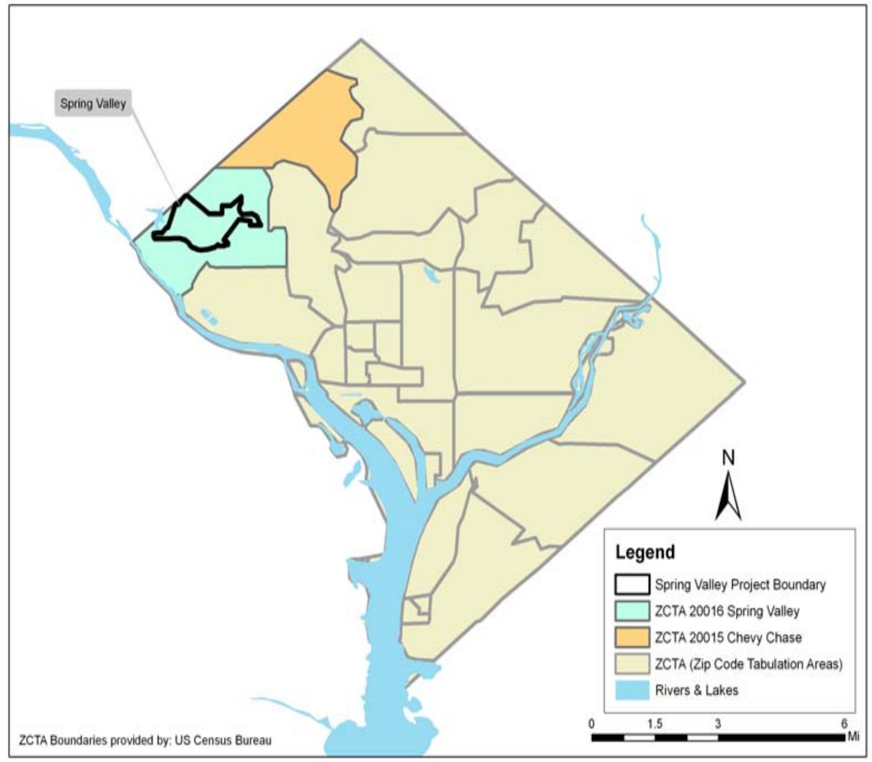
- Community Health Status
- Hazard Characterization
- Exposure Assessment
- Biomonitoring Studies
- Risk Characterization

Community Health Status



Spring Valley and Chevy Chase: Census Tracts, ZIP Codes





Census Tracts:
Cancer Registry

Zip Codes:
Top 15 Causes of Mortality

Demographic Comparisons

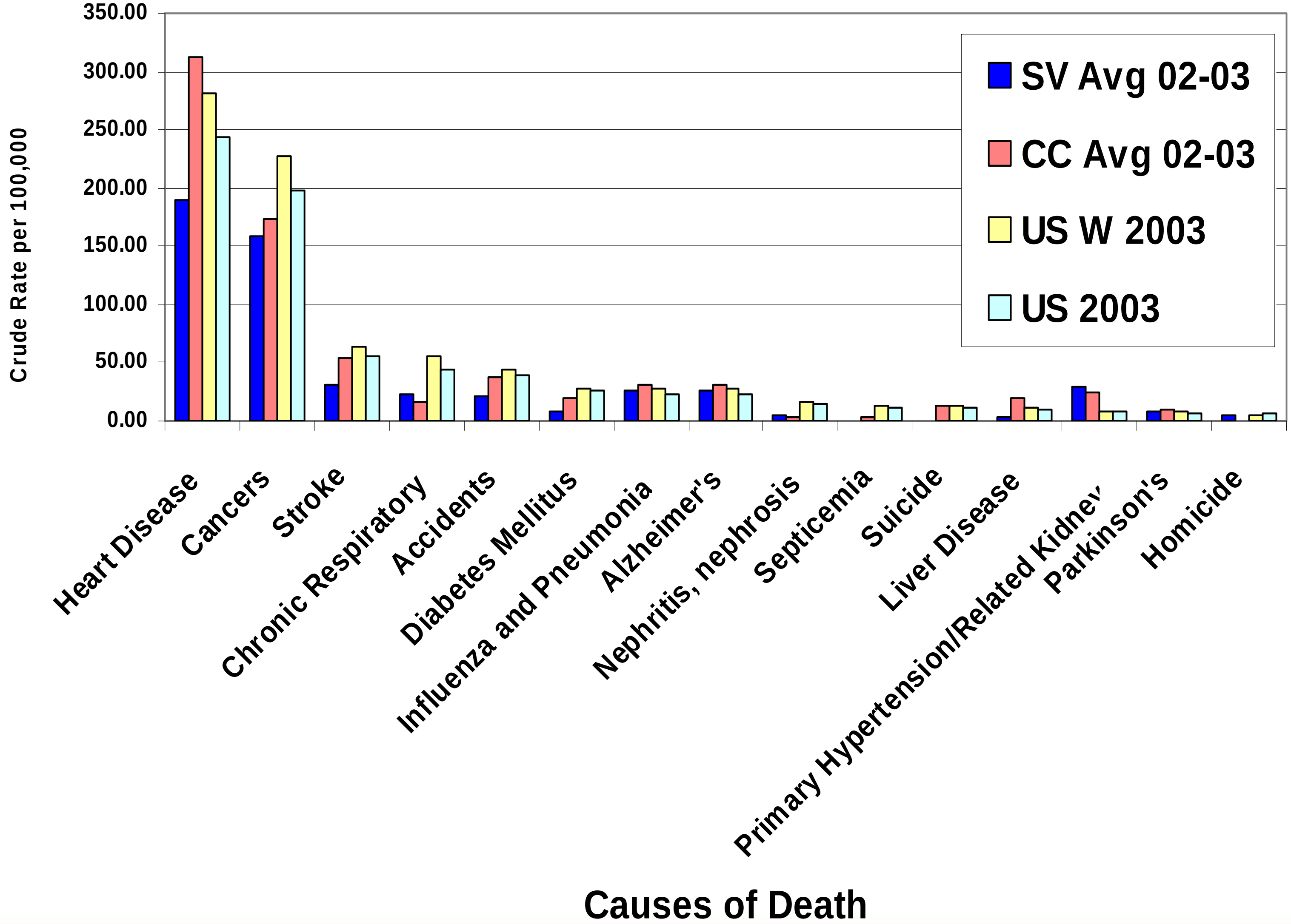
Area Characteristics	Spring Valley[a]	Chevy Chase[b]	D.C.	U.S.
Total Population	23,462	17,152	572,059	281,421,906
% White	79.42%	78.24%	27.73%	69.12%
% Black	4.97%	9.21%	59.45%	11.98%
% Hispanic	6.60%	4.50%	7.87%	12.52%
% Other	9.01%	8.06%	4.50%	6.38%
% College Education	82.70%	69.45%	39.07%	24.40%
Median Income	$100,128.00	$95,757.25	$41,625.15	$41,194.00

[a] Spring Valley is defined by census tracts 001001, 000901, 001002, and 000801
[b] Chevy Chase is defined by census tracts 001500, 001401, 001100, and 001402

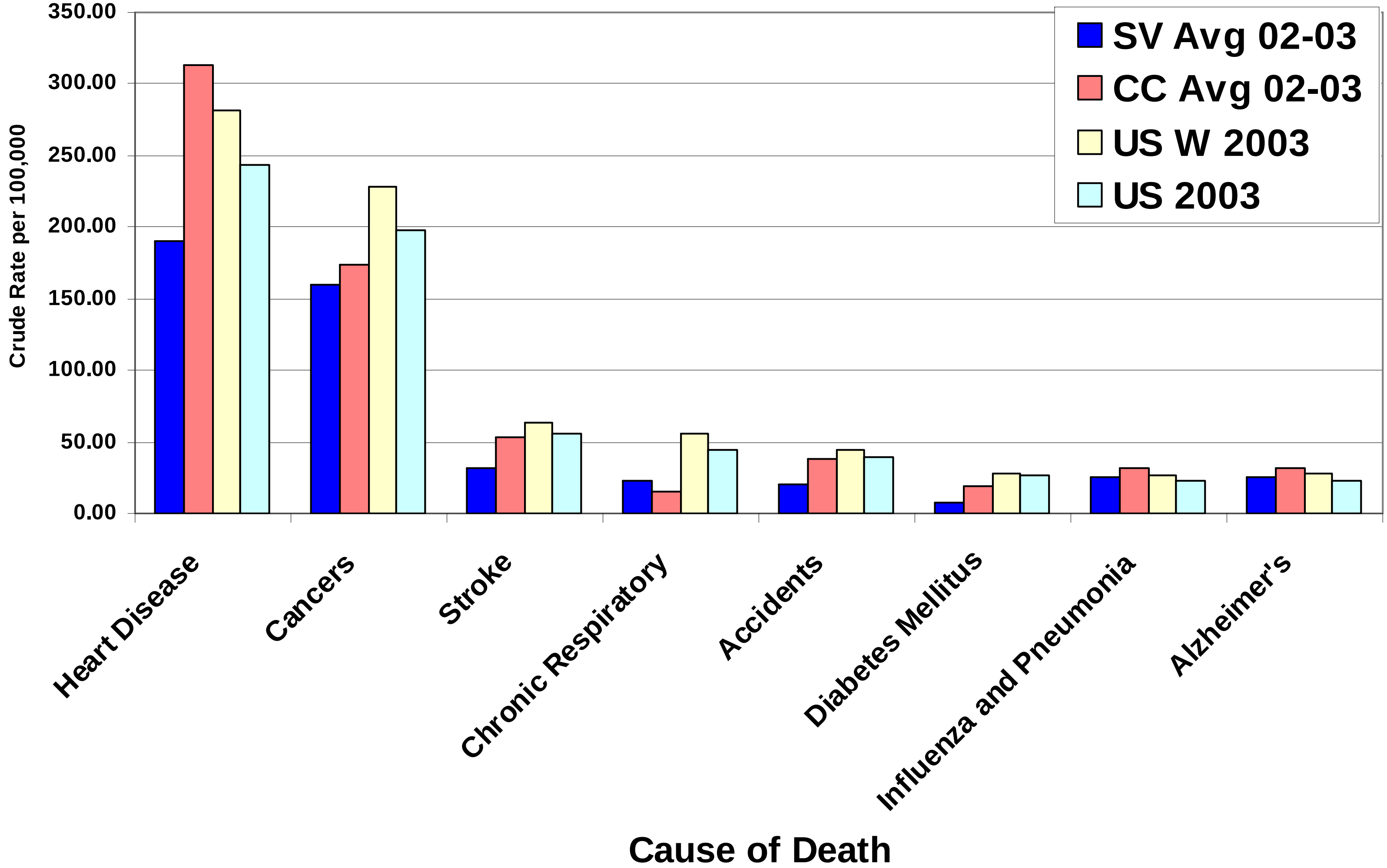
Community Age Distributions

Age Category	Spring Valley Zip Code 20016	Chevy Chase Zip Code 20015	U.S. Whites	U.S. All Races
Less than 20 years	19.4 %	20.1 %	26.1 %	28.60 %
20 to 39 years	33.1 %	21.5 %	27.6 %	28.98 %
40 to 59 years	27.5 %	31.5 %	27.6 %	26.15 %
60 to 79	14.4 %	17.9 %	14.7 %	13.0 %
80 and up	5.7 %	9.2 %	3.9 %	3.3 %

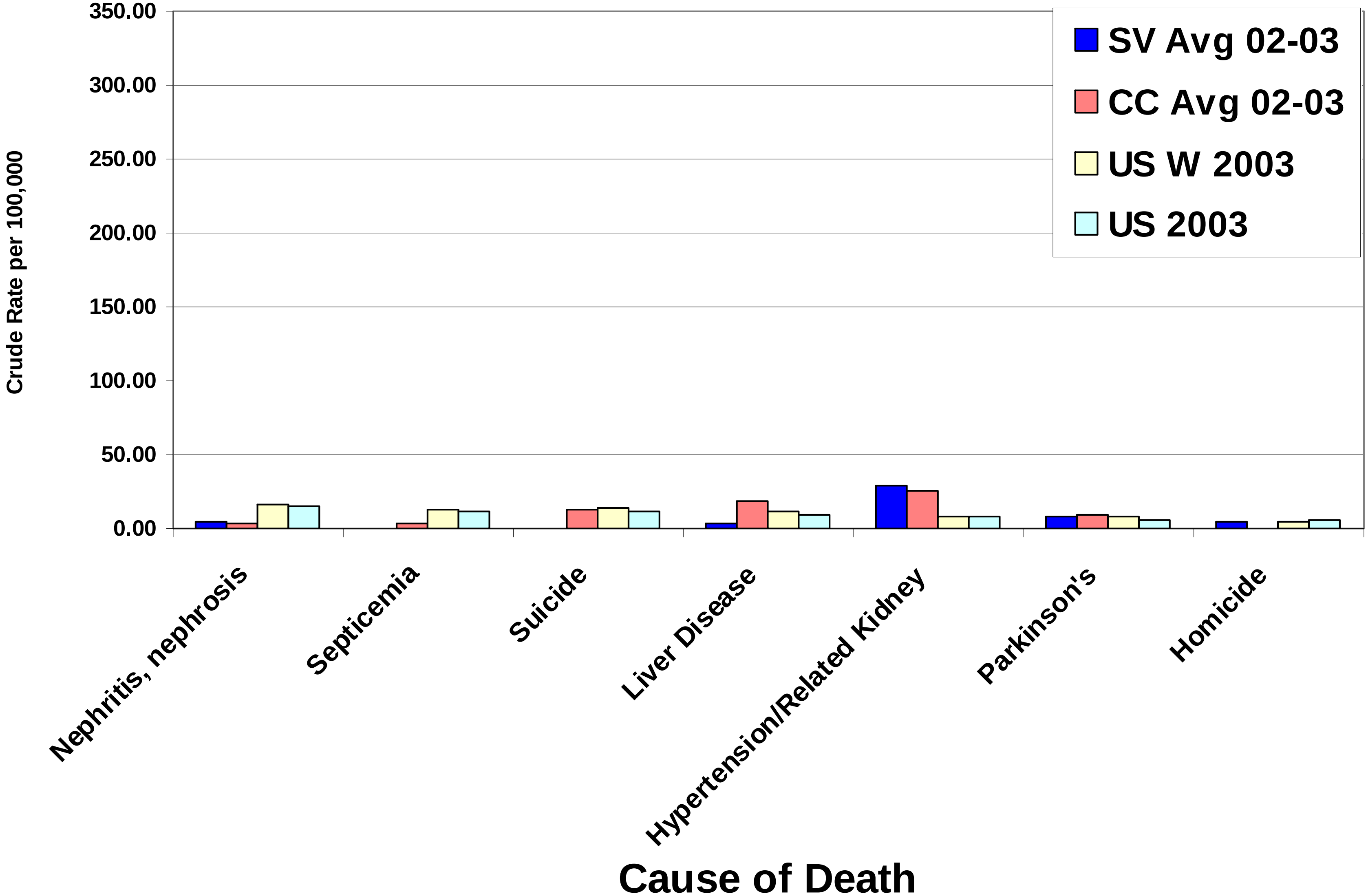
Top 15 Causes of Death in the US



Top 8 Causes of Death in US



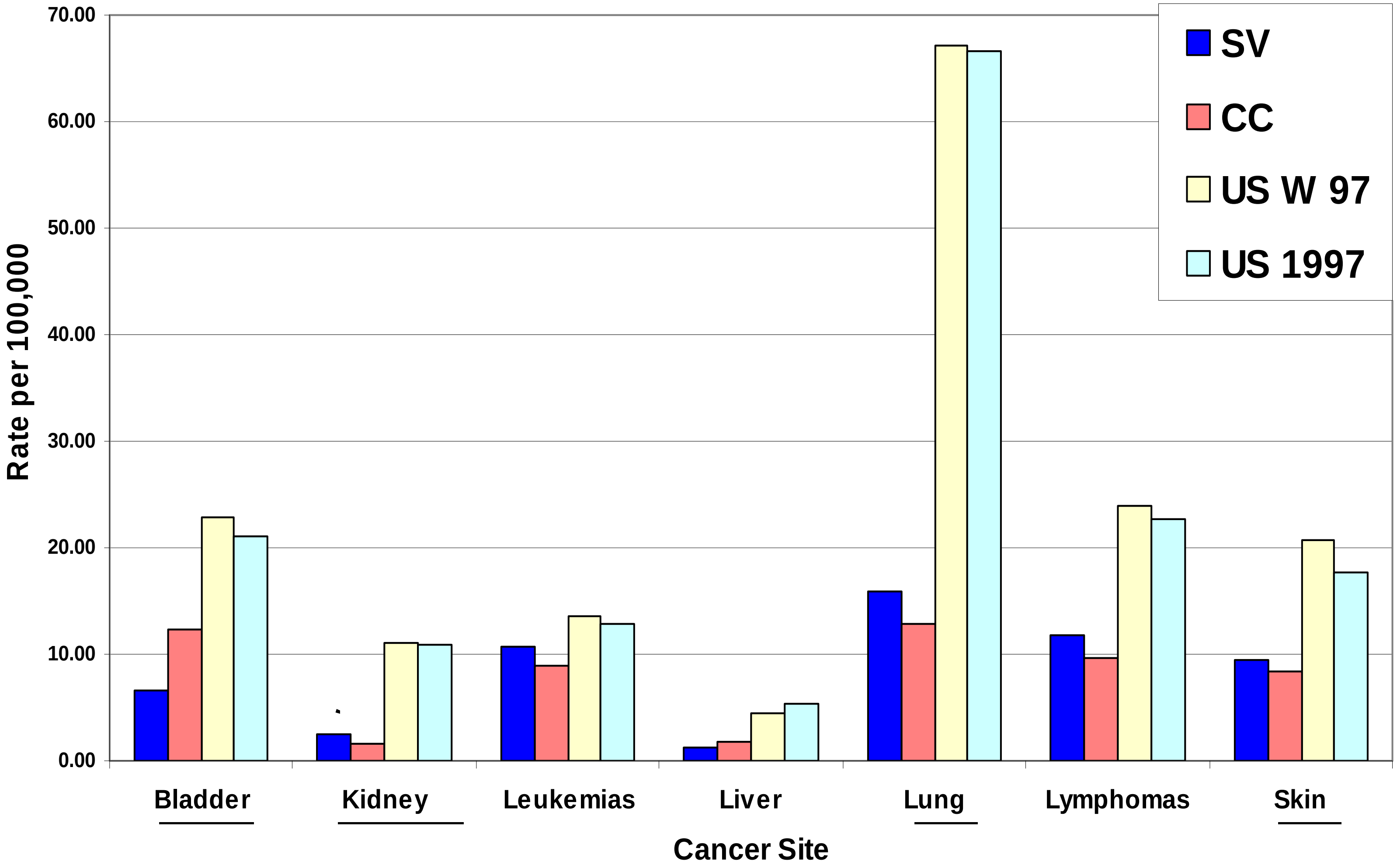
Top Causes of Death in US (#9 - 15)



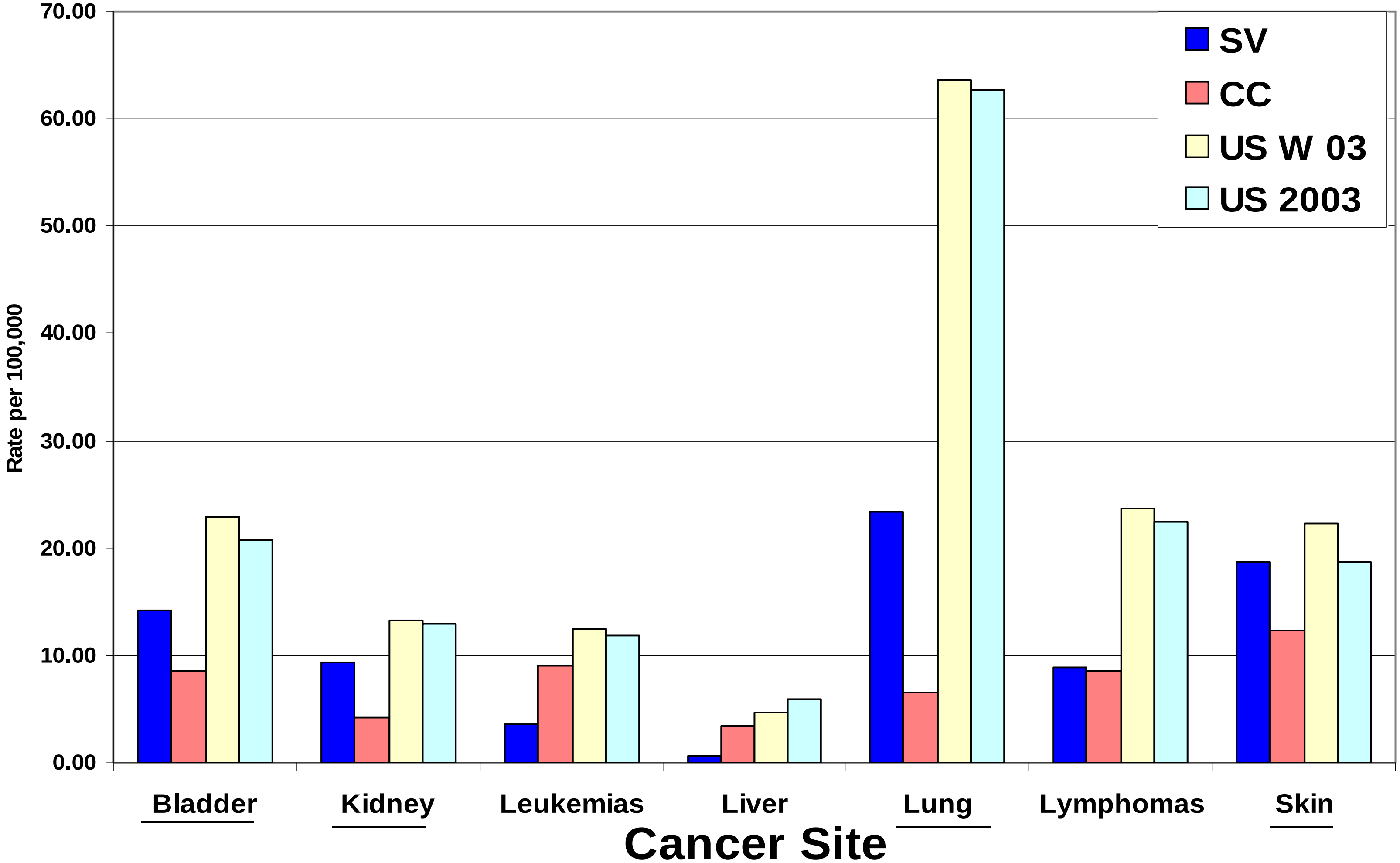
Community Health Status Findings

- Overall Community Health Status of Spring Valley is Very Good
  - For 11 of Top 15 Causes of Death Mortality Rates in Spring Valley are 20 – 70 % lower than US Rates
- Hypertension and Related Kidney Disease is the Only Spring Valley Mortality Rate that Exceeded Rates in Chevy Chase and the US
  - Chevy Chase Rates Also Higher than US Rates

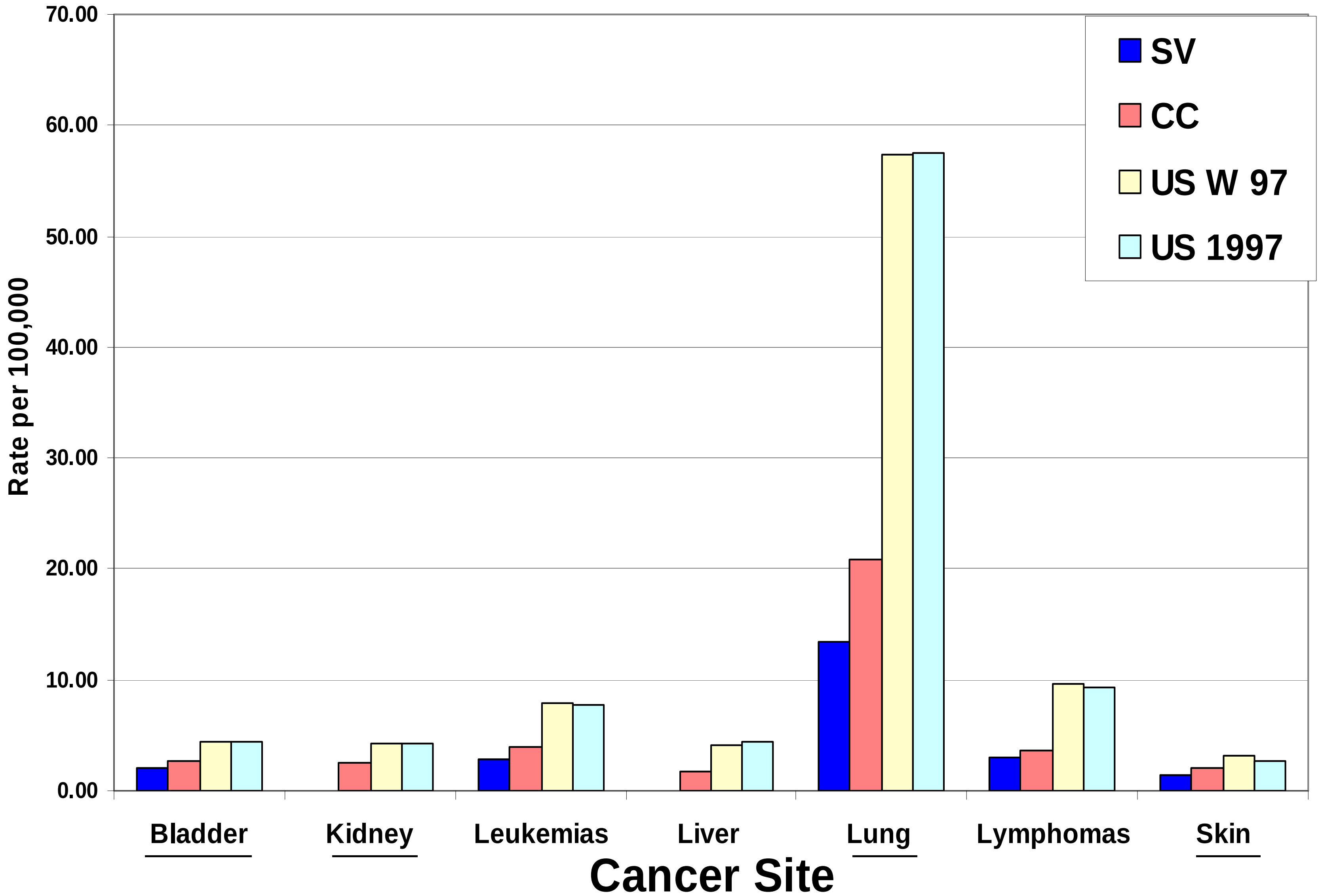
Age-Adjusted Cancer Incidence Rates 1994-1999



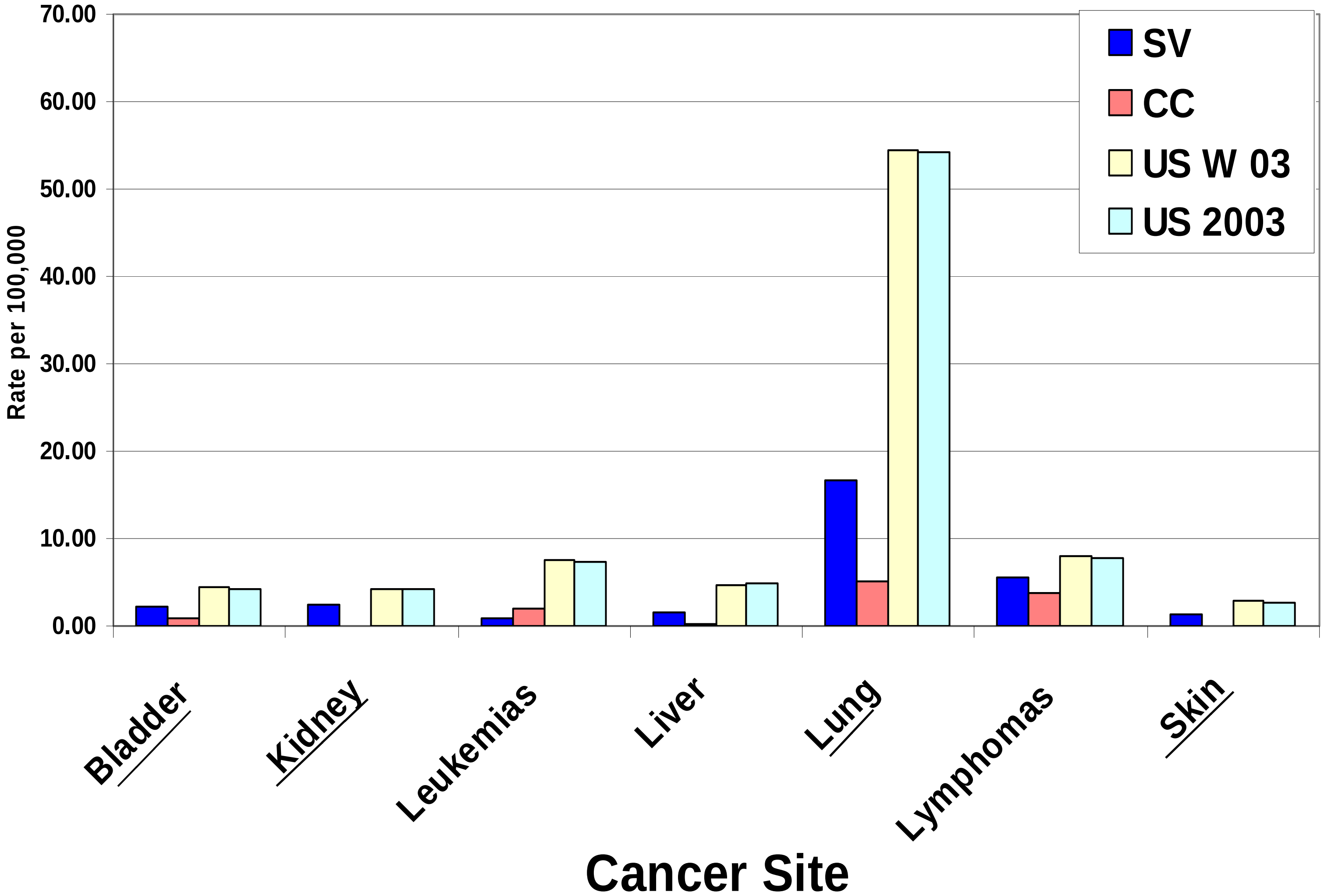
Age Adjusted Cancer Incidence Rates 2000-2004



Age Adjusted Cancer Mortality Rates 1994-1999



Age Adjusted Cancer Mortality Rates 2000-2004



Community Health Status Findings: Cancer (1 of 2)

Rates for Seven Arsenic-Related Cancer Were Reviewed for 1994-1999 and 2000-2004

Mortality

- **In Both Time Periods, Spring Valley Rates Were 30 – 70% Lower than US Rates**

Incidence

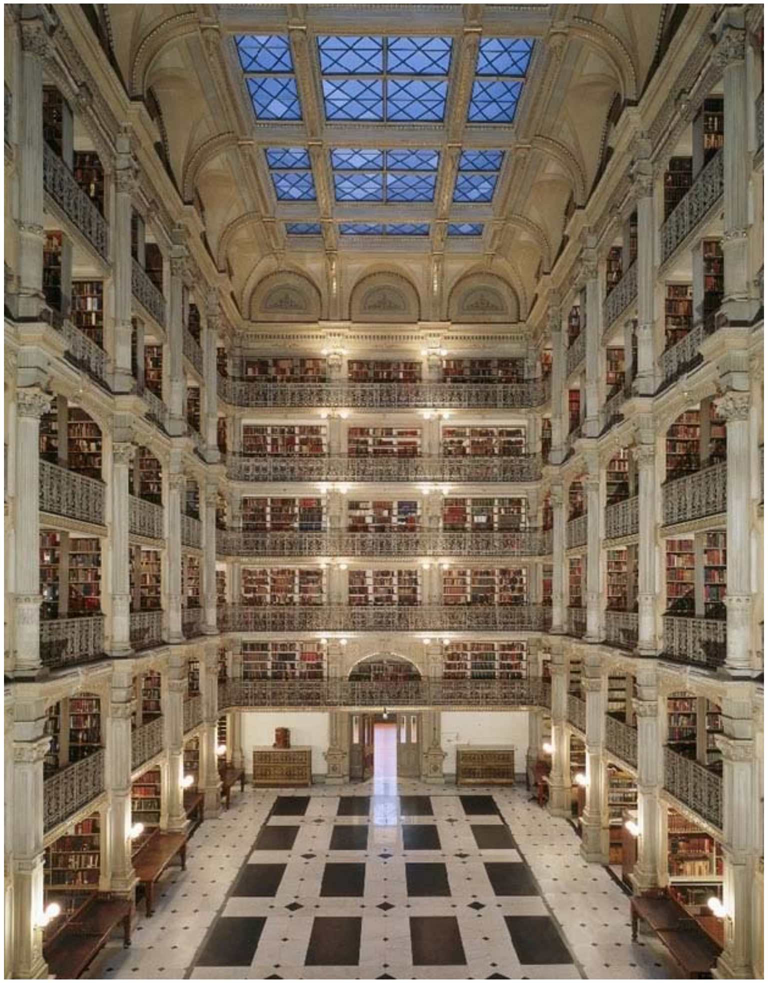
- **In Both Time Periods, Spring Valley Rates for 6 of the 7 Cancers Were 20 – 70% Lower Than US Rates**
  - **Skin Cancer Rate for Spring Valley was the Same as the US in 2000-2004**

Community Health Status Findings: Cancer (2 of 2)

- **Although Lower than National Rates, Analysis Suggests that Kidney, Bladder, Lung, and Skin Cancer Incidence Rates in Spring Valley are Slightly Higher than Chevy Chase Rates**
- **This Pattern Was Also Found with Cancer Mortality Rates in Spring Valley and Chevy Chase**
- **Literature Provides Epidemiological Evidence that These Cancers (Kidney, Bladder, Lung & Skin) Are Associated with Arsenic Exposure**

Literature Review

And Anecdotal Reports



Peabody Library, JHU

Health Conditions: Anecdotal Community Reports

1. Cancer or tumor
2. Central Nervous System/Brain or Mood Disorder
3. Blood Disorder
4. Cardio- or Cerebro-vascular
5. Skin Condition or Rash
6. Peripheral Neuropathy
7. Gastro-intestinal
8. Respiratory
9. Substance Abuse
10. Hypothyroidism
11. Carbon Monoxide Poisoning
12. Weight loss, Failure to gain weight
13. Immune or Auto-immune
14. Juvenile Arthritis
15. Chronic Infections
16. Miscarriage
17. Hydrocephalus

Note: these conditions are in approximate rank order

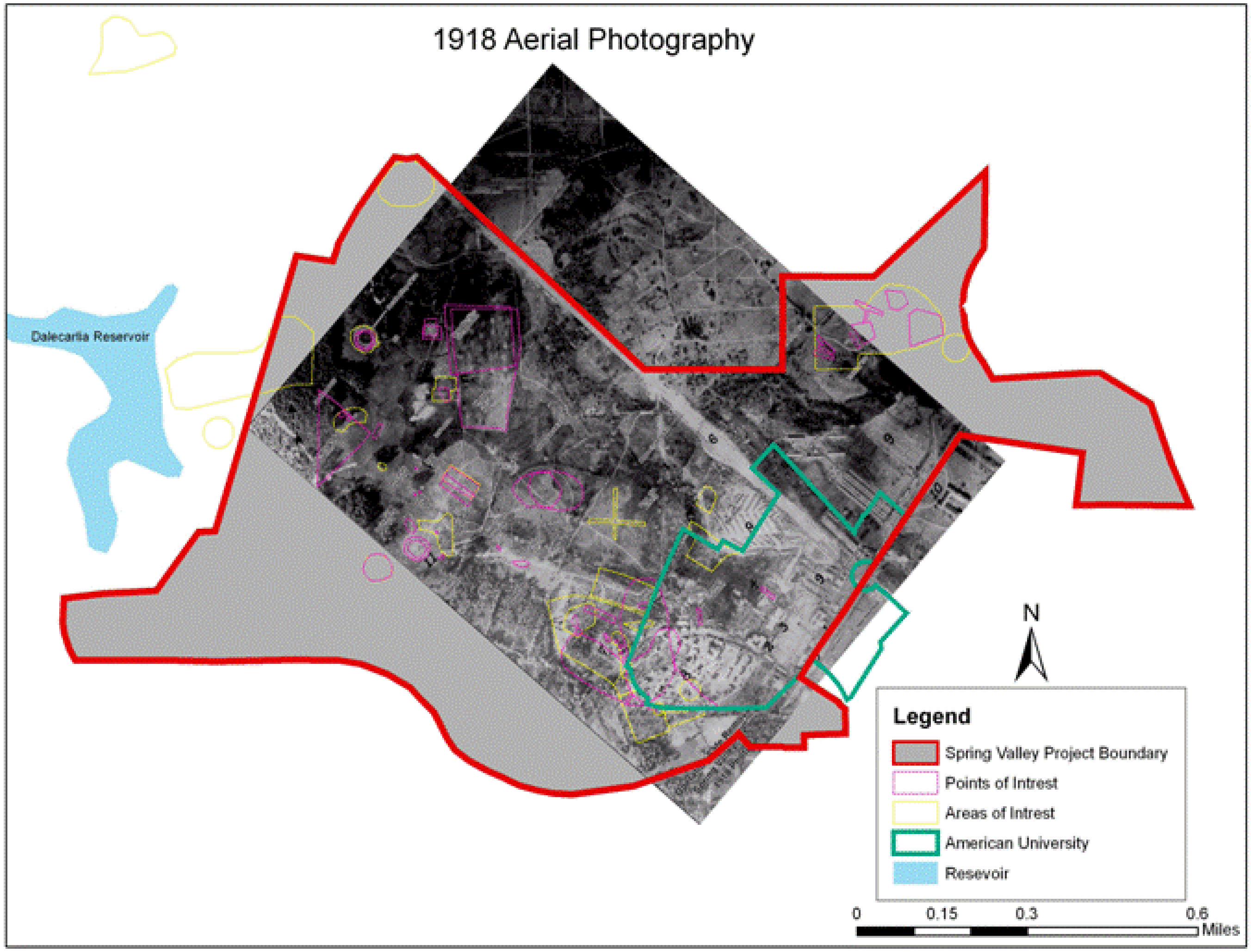
Potential Health Effects of Weapons-Related Chemicals

- Carcinogens
- Blood Effects
- Neurological Effects
- Liver Effects
- Kidney Effects
- Skin Effects
- Changes in body or organ weight
- Gastrointestinal Effects
- Bone/Skeletal Effects

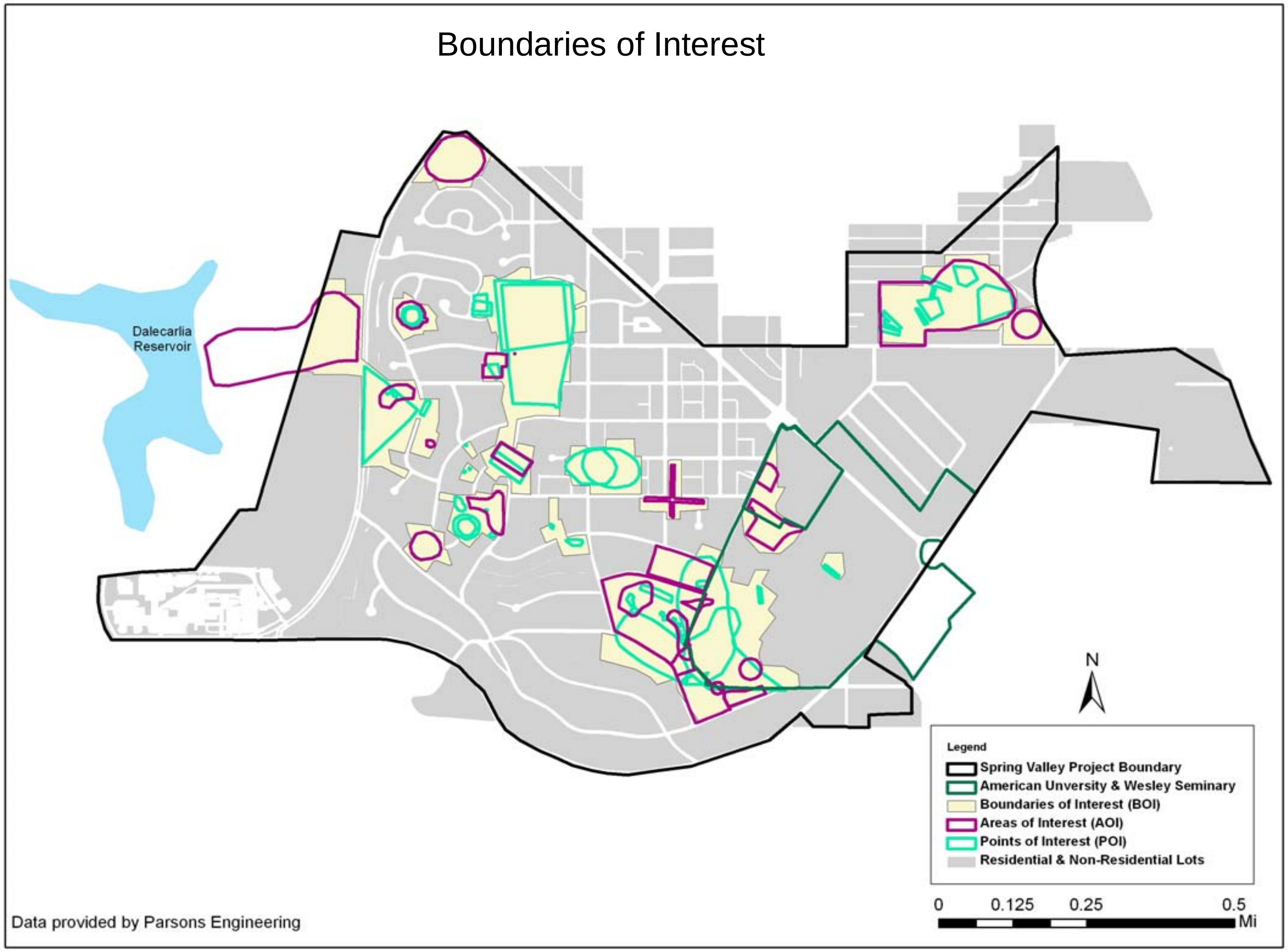
Literature Review Findings

- Limited Information on Long-Term Effects of Most of the AUES-Related Chemical Weapons
- Some Health Effects of Weapons-Related Chemicals are Consistent with Anecdotally Reported Health Problems in Spring Valley (Cancers, Blood Disorders, Kidney Disease, and Neurological Conditions)

Spatial Analysis



Areas, Points & Boundaries of Interest



Summary of Soil Arsenic Data

Data subset	Sample size	Average	Upper CL for Average	Maximum
Child Dev. Ctr.	165	44.92	55.32	498
Lot 18	93	19.53	29.44	329
BOI	7122	10.84	11.48	1040
Background	1,257 (all US)	4	7 (75 %ile)	18

Spatial Analysis Questions

- **Are Arsenic Levels Higher Within the Boundaries of Interest?**

- **Are Anecdotal Reports of Cancer More Likely to Be Within in the Boundaries of Interest Areas?**

- **Are Confirmed DC Cancer Registry Incidence Cases More Likely to Be Within the Boundaries of Interest Areas?**

Pre-Remediation Arsenic Soil Levels at POIs, AOIs & BOIs

Area	Location	# of Samples	Median	Mean	P-value
Points of Interest	Within	5810	4.60	11.13	< 0.01
	Outside	12,134	4.11	9.16	
Areas of Interest	Within	3729	4.80	12.04	< 0.01
	Outside	14,215	4.20	9.21	
Boundaries of Interest	Within	7121	4.55	10.84	< 0.01
	Outside	10,823	4.10	9.12	

- **Arsenic Levels are Higher Within than Outside Boundaries of Interest**

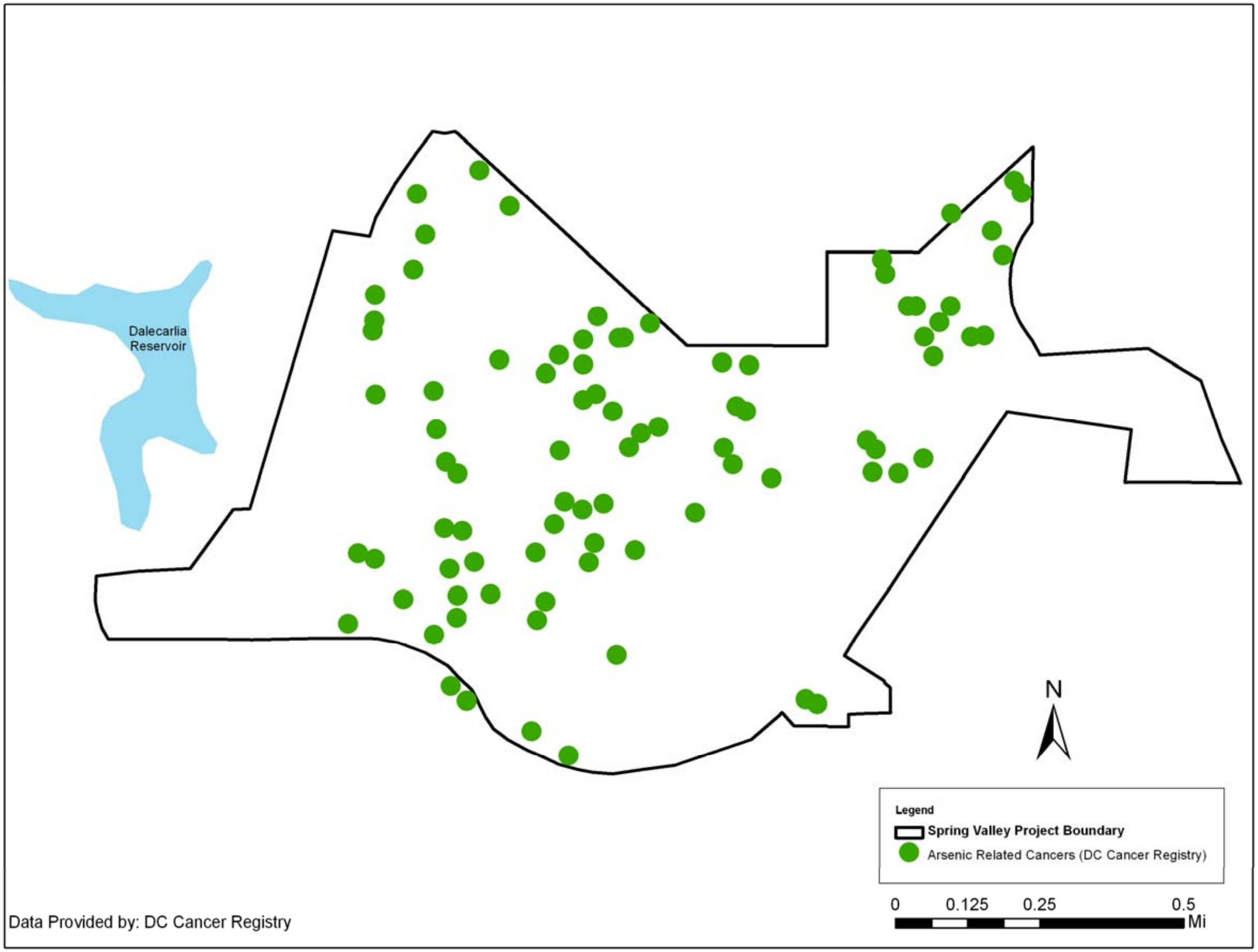
Statistical Spatial Analysis of Cancer

Arsenic–Related Cancers	Within a Boundary of Interest OR (CI)
Anecdotal N= 25	2.09 (0.81, 5.1)
DC Cancer Registry N=90	0.60 (0.30, 1.11)

- **Anecdotal Health Reports are More Likely to be Within Boundaries of Interest (May Be Due to Targeted Sampling & Reporting)**

- **Arsenic Related Cancer Cases from the DC Cancer Registry Are Not More Likely to be Within the Boundaries of Interest**

Cancer Cases From DC Cancer Registry 1994-2004



Statistical and Spatial Analysis Findings

- **Arsenic Levels are Higher Within Than Outside Boundaries of Interest**
- **Anecdotal Health Reports are More Likely to be Within Boundaries of Interest (May Be Due to Targeted Sampling & Reporting)**
- **Arsenic Related Cancer Cases from the DC Cancer Registry Are Not More Likely to be in the Boundaries of Interest**

Biomonitoring Studies

Biomonitoring Studies

Study	Sponsor	Results
Hair N = 32	ATSDR 2001	28 children, 4 adults; 8 with detectable levels (.10 to .14 ppm); ***all below ATSDR 1.0 ppm level of concern***
Hair and Urine N = 66	American University 2001	27 children, 39 adults; 3 had detectable As in hair between .09 and .12 ppm, all below level of concern; 4 adults provided urine samples, ***all had total Arsenic within normal reporting range***
Hair and Urine N = 32	ATSDR 2002	9 children, 23 adults; 4 had detectable inorganic As in urine (10 to 15 ppb); ***all below 20 ppb level of concern*** Note: Individual with highest level had highest house dust Arsenic level. All hair levels between non-detect and .73 ppm, below level of concern
Urine N = 40	ATSDR 2002	6 children, 34 adults; ***all had total urine Arsenic between non-detect and 76 ppb***; 3 had "mild elevations" in inorganic arsenic Note: The household with the highest total Arsenic urine sample had the highest soil level.

Exposure Study Review Findings

- **Overall Findings Indicate Exposures Are Below Level of Concern**
- **The Four Biomonitoring Studies are Difficult to Compare:**
  - **Different Methods**
  - **Different Detection Levels**
  - **Different Environmental Sampling**
  - **Reflect Different Time Periods of Exposures**
- **Possible Relationship Between Arsenic in Soil and Dust and Arsenic Levels in Hair and Urine**

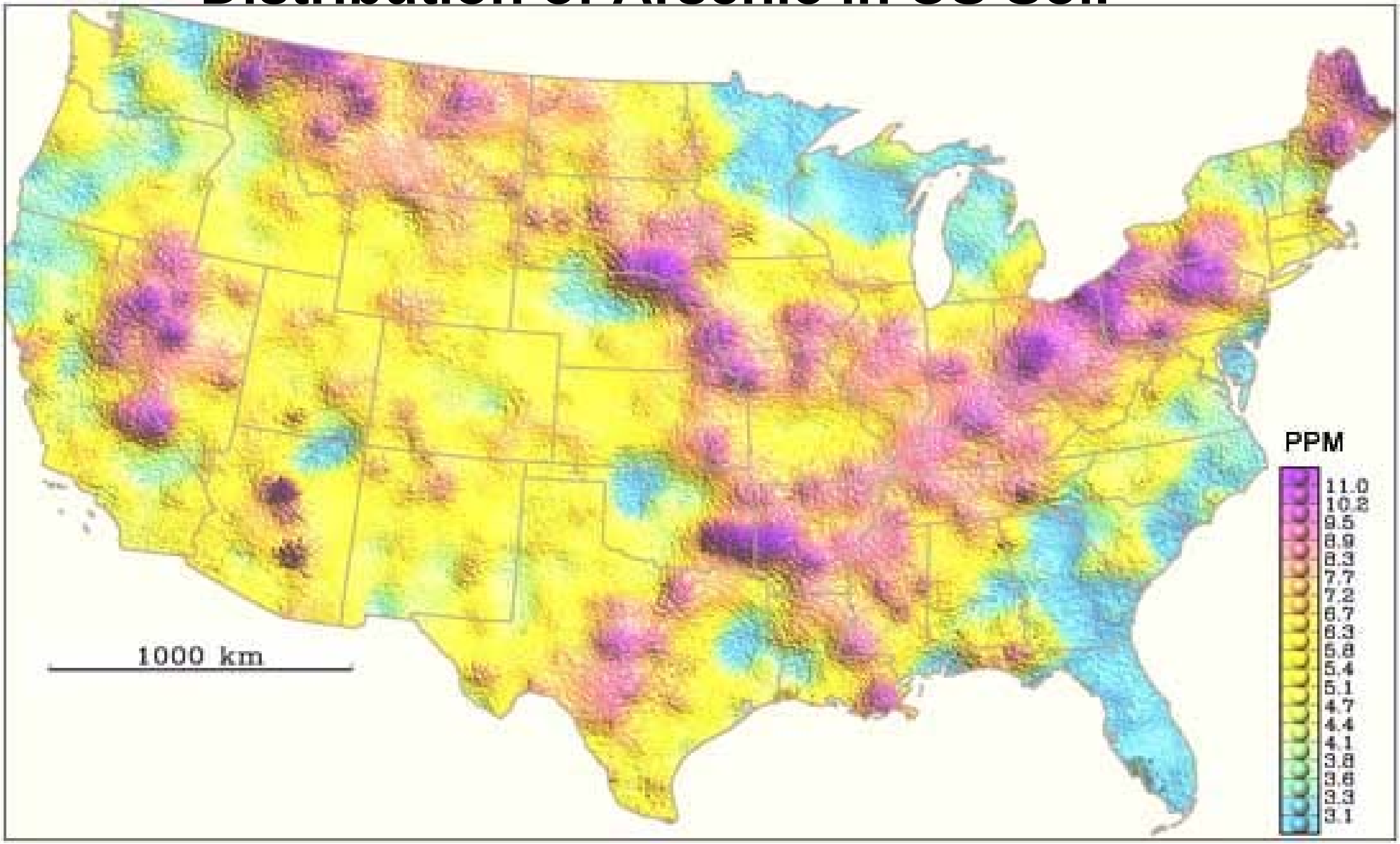
Risk Assessment

Part 1 - Arsenic Exposure Profile

Part 2 – Characterize pre-remediation soil and related exposures

Arsenic Exposure Profiles

Distribution of Arsenic in US Soil

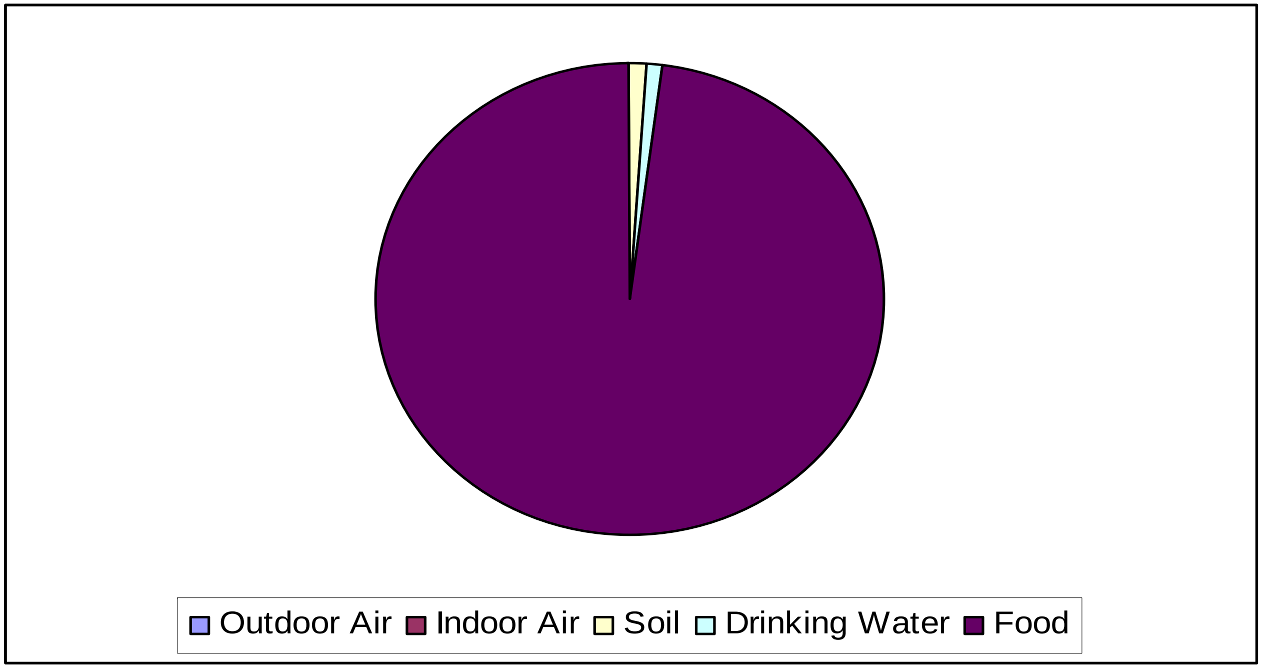


Map of arsenic distribution based on data from Shacklette HT and Boerngen J. (1984)

Source Contributions to Arsenic Exposure

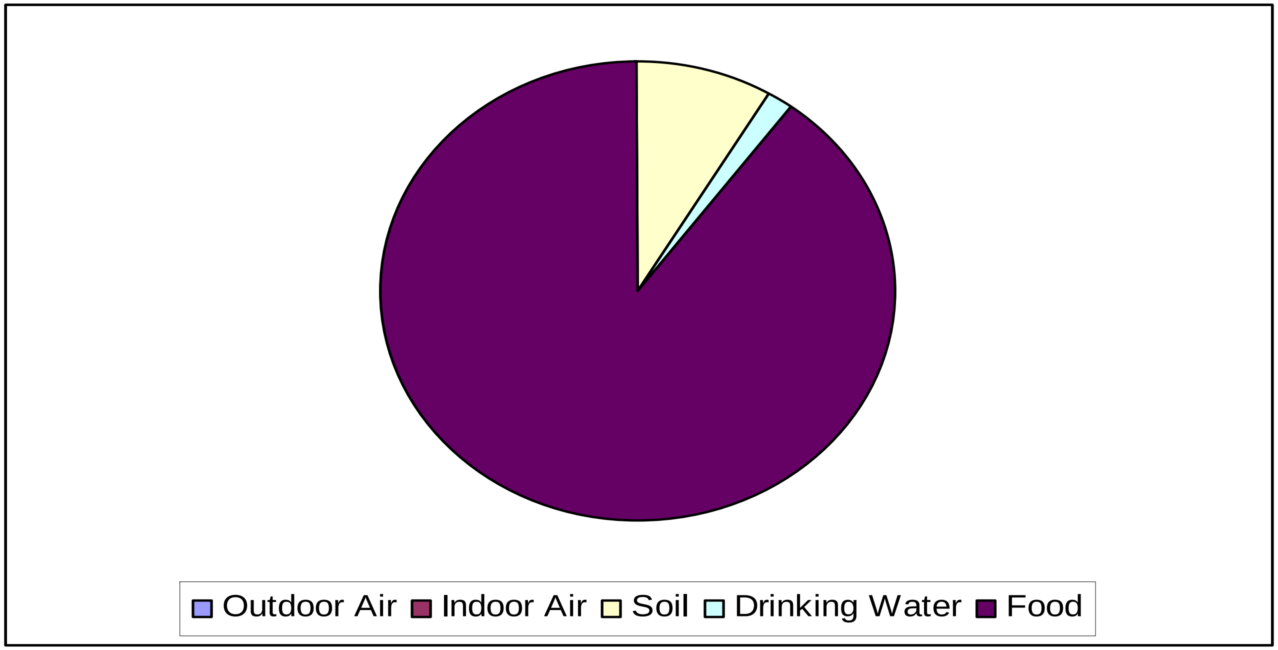
At Arsenic Soil Levels of 20 Parts Per Million and Lower Food is the Primary Source of Inorganic Arsenic Exposure for Adults and Children

Source Contributions to Arsenic Exposure (Adult High-end, Soil 20 ppm)



Food	**97.73522%**
Soil	**1.19405%**
Drinking Water	**1.06308%**
Indoor Air	**0.00754%**
Outdoor Air	**0.00011%**

Source Contributions to Arsenic Exposure (Child High-end, Soil 20 ppm)



Food	**89.85443%**
Soil	**8.68159%**
Drinking Water	**1.45265%**
Indoor Air	**0.01093%**
Outdoor Air	**0.00040%**

Risk Assessment

Features:

Exposure to Dose modeling

- **Soil ingestion**
- **Dermal uptake**
- **Inhalation – ambient and indoor air**

Risk Characterization

- **Cancer - estimate lifetime excess risk**
- **Other – increased lifetime risk Y/N**

Risk Assessment Data Sources

Army Corps soil sampling

Washington Aqueduct drinking water data

EPA NATA 1999 data for D.C.

EPA Exposure Factor Handbook 1997

EPA RAGS Parts A and E 1989, 2004

Dermal absorption (As): Wester et al. (1993)

Oral bioavailability (As): Freeman et al. 1995, Roberts et al. 2007

EPA Soil Screening Guidance 1996

Risk Metrics – Cancer and Noncancer

Cancer risk =

(Lifetime Dose) x (Cancer Risk Factor)

Cumulative/Total cancer risk = $\sum_{i} \text{Cancer risk } i$

Where:
i represents each carcinogen

Hazard Quotient (HQ) = $\dfrac{\text{Exposure Dose}}{\text{RfD}}$

Cumulative/Total Hazard Index (CHI) =

$$\text{CHI} = \sum_{i} HQi$$

Where:
i represents each non-cancer pollutant

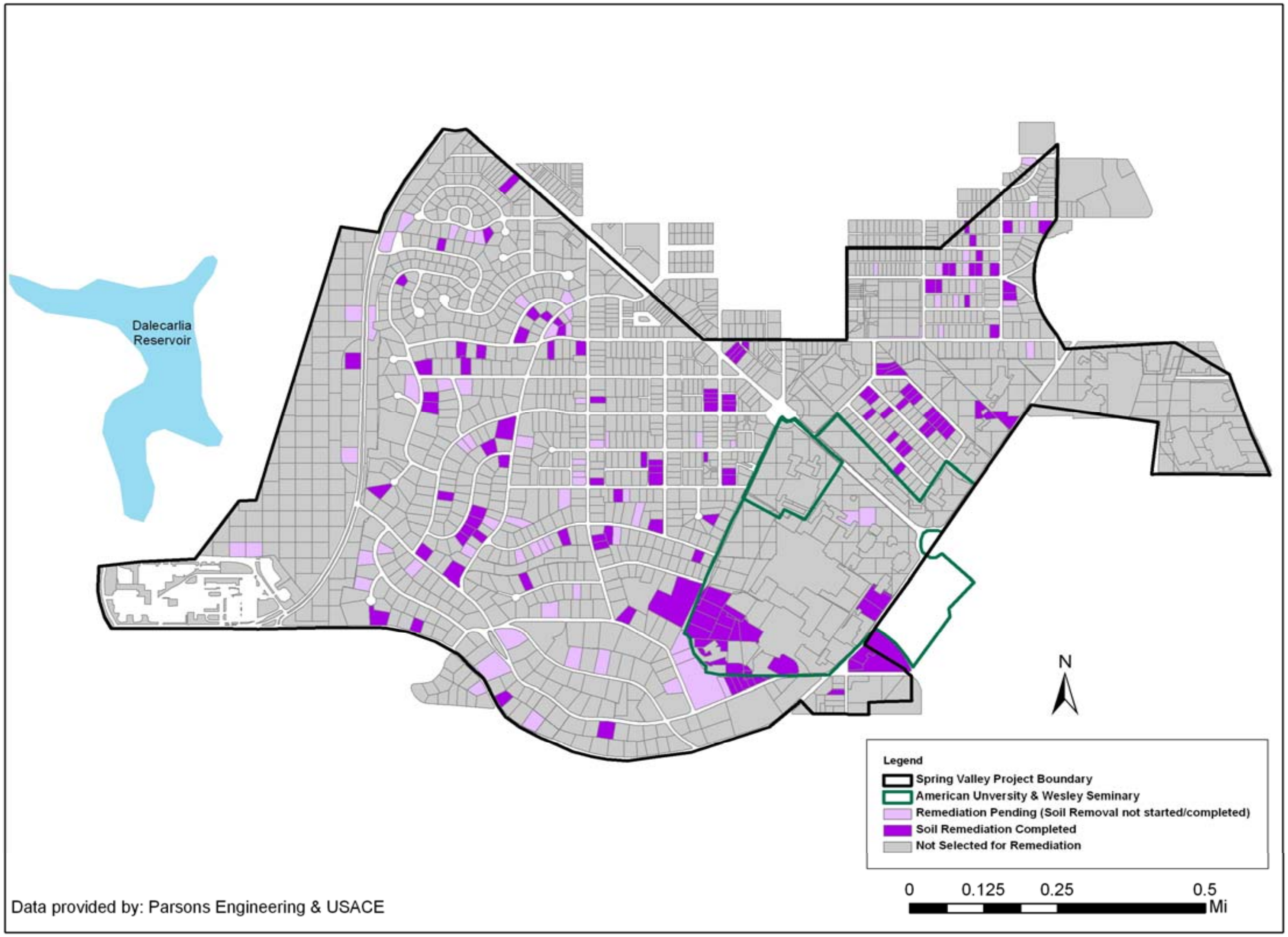
Risk Assessment Inputs: Soil Examples

- Assumptions For Average Child:
  - 200 mg soil a day
  - 350 days per year for 9 years
- Assumptions For High-end Child:
  - 400 mg soil a day
  - 350 days per year for 9 years
- Assumptions For Adult:
  - 100 mg soil a day
  - 350 days per year for 9 years (Average) or 30 years (High)
- Used Soil Sampling Data from Boundaries of Interest, Lot 18 and Child Development Center

Other soil sampling

Chemical	Sample size	Average	Upper CL for Average	Maximum
Lot 18 Metals (except for arsenic)				
Aluminum	82	24,773	27,638	55,100
Antimony	21	9.74	16.89	56.40
Barium	74	143	211	2,240
Beryllium	68	1.05	1.17	2.60
Cadmium	50	2.31	4.92	67
Chromium	74	146	169	524
Cobalt	74	28.50	33.86	135
Copper	77	177	253	2,380
Lead	76	215	365	4,300
Manganese	74	742	978	7,270
Mercury	74	7.96	15.49	241
Nickel	74	69.44	81.46	275
Selenium	54	0.94	1.12	3.00
Silver	74	2.50	4.80	20.9
Strontium	33	12.29	16.75	145
Thallium	71	1.59	1.90	3.60
Tin	71	25.91	44.69	426
Titanium	74	410	477	1,770
Vanadium	78	107	128	473
Zinc	74	263	442	5,690
Specialty Sampling				
Thiodiglycol	546	595	602	2,100
CVAA_CVAO	271	0.03782	0.04252	0.2
Cyanide	266	0.20	0.20	0.32

Soil Remediation
March 2007



Background Cancer Risks from Arsenic (per 100,000)

	Adult Average	Adult High-end	Child Average	Child High-end
Background Arsenic Soil Levels in the U.S. Average = 4 ppm, High-end = 7 ppm	1.5	3.1	4.2	17

As a Point of Reference, the U.S. EPA National Drinking Water Standard for Arsenic Corresponds to Risks Ranging from 57 to 98 for Child Exposure Scenarios.

Site-Related Increased Cancer Risk Estimates (per 100,000) from Pre-Remediation Arsenic Soil Levels

	Adult Average	Adult High-end	Child Average	Child High-end
Boundaries of Interest	0.5	0.89	3.2	7.7
Lot 18	1.1	3.9	7.4	**39**
Child Dev. Ctr.	3.0	8.3	**19**	**83**

"Acceptable" Range = 0.1 to 10

Occupational Cancer Risk Estimate

- Landscaper Scenario
  - 5 Days of Work Per Week
  - 50 Weeks Per Year
  - 30 Year Career
  - High-End Soil Concentration

- Risk Estimate = 30 Excess Cases per 100,000

“Acceptable” Risk up to 100

Non-Cancer Exposures Evaluated

Pre-Remediation Soil Arsenic Exposure Compared with Non-Cancer Health-Based Guidance Levels

Location/Data subset	Adult Average	Adult High-end	Land-scaper	Child Average	Child High-end
Boundaries of Interest	<1	<1	<1	<1	<1
Lot 18	<1	<1	<1	<1	**>1**
Child Dev. Ctr.	<1	<1	<1	<1	**>1**

<1 is Considered Below Level of Concern

Arsenic Risk Assessment Findings (1)

The Exposure and Risk Estimates Calculated are Likely Overestimates of Actual Risks and Reflect Dual Nature of Contamination

Adult

No Elevated Cancer or Non-Cancer Risks Calculated for Any of the Adult Scenarios

Arsenic Risk Assessment Findings (2)

Child

•No Elevated Non-Cancer Risks for the Average Child Scenario

•Potential Cancer Risks Calculated are Elevated Above the Level of Concern for the Average and High End Child Scenarios at Pre-Remediation Soil Levels

•Potential Non-Cancer Exposures Are Elevated Above the Level of Concern for the High-End Child at Pre-Remediation Soil Levels

Non-Arsenic Compounds – Exploratory Assessment

Cumulative Risk Assessment was Conducted for Non-Arsenic Compounds that Were Detected in Spring Valley

Limitations:

- **Limited Sampling Data**
- **Non-Representative Sample**
  - **Most Samples from Lot 18**

Non-Arsenic Compound Findings

- No Elevated Cancer Risks for Adults or Children
  - All Cancer Risk Estimates Less Than 2 per 100,000
- No Elevated Exposures for the Adult Scenarios for Any of the Non-Cancer Health Effects
- Potential Exposure to the Non-Arsenic Chemicals are Above the Level of Concern for a High-End Child at Pre-Remediation Soil Levels at Lot 18 (HI = 1.06)

Risk Assessment Findings

- Risk Assessment Findings Reflect the Dual Nature of Contamination
- Adult Average and High and Child Average Exposures and Risks are Low
- Children's High-End Exposures and Risks Elevated from Pre-Remediation Soil at Hot Spots

Summary of Health Findings

Health Concerns	Anecdotal Community Reports	Scoping Study Community Health Analysis	Scoping Study Review of Literature	Scoping Study Risk Assessment
Cancers	√	√	√	√
Kidney Diseases	√	√	√	
Blood Disorders	√		√	√
Neurological Conditions	√		√	

Recommendations

Health

- Examine Additional Years of Mortality and Cancer Registry Data
- Further Investigation of Non-Cancer Outcomes of Concern (Blood Disorders, Neurological and Kidney Diseases)
  - Develop Strategy for Case Finding and Verification and, if Warranted, Other Epidemiological Follow-Up
- Obtain/Review Detailed Data From the ATSDR Biomonitoring Studies
  - If Warranted, Consider a Systematic Exposure Study

Recommendations (2)

Environmental Sampling and Potential Exposures

- Continue Tracking Environmental Sampling Data
- Conduct Post-Remediation Sampling to Demonstrate Exposure Reductions
- Ensure Future Sampling Design and Implementation Address Community Health Concerns
- Establish Notification/Communication Protocol Regarding Digging or Potential Soil Disturbance Within the Study Area
- Examine Water Sampling Results to Evaluate Potential for Water-Related Exposure Pathways

Recommendations (3)

Response Capacity and Ongoing Risk Communication

- Continue Public Health Outreach, Response, and Risk Communication
- Reinforce Preventive Community and Household Measures to Reduce Exposure to Soil

Technical commentary

Limitations

- “Small numbers” problem – health outcomes
- Past exposures?
- Groundwater?

Epidemiological issues

- Comparison population?

Technical commentary

Value of multi-disciplinary analysis

Community health status

Spatial analysis – map of cancers distributed across site

Risk assessment to inform public health

- Its not ALL about the “numbers”
- Who is at risk and why

Link to project report

http://www.nab.usace.army.mil/projects/WashingtonDC/springvalley/Other/HopkinsHealthStudy.pdf

Thank You
Questions? Comments?