Environmental Division

virtuAIChE

Welcome

Dan Lambert, VLS Chair

virtual.aiche.org

Environmental Division

Agenda

virtuAIChE

- 9:00 pm VLS Welcome
- 9:05 pm Environmental Div Welcome
- 9:10 pm Chief Information Officer
- 9:15 pm Speaker Introduction
- 9:16 pm Keynote Speaker
- 9:45 pm Questions and Answers
- 9:55 pm Closing Comments

Environmental Division

Questions and Comments

virtuAIChE

- Ask your question or make comment any time
- "Raise your hand" if you want to ask a question
  - We will call your name so you can ask your question
  - We unmute you (people will see you if webcam is on)
  - Please let us know where you are from and work
  - We will answer your question
- Send a chat message to Amanda Robben or Dan Lambert if you have a question
  - We will read the question for you
  - We will answer your question

Environmental Division

Welcome New Attendees

virtuAIChE

- Thank you for joining us
- We are glad you took time to join us
- Consider becoming a member of VLS
  - Cost: Nothing
  - Need to be AIChE member: No
  - How to join: http://virtual.aiche.org/content/join
- Join us on Facebook and LinkedIn

Environmental Division

Welcome
Returning Attendees

virtuAIChE

- Thanks for coming back
- Please let us know what we can do to improve the VLS
- Meeting attendees will receive
  - Copy of presentation with links
  - Link for archived WebEx meeting
  - Link for edited video on AIChE website
  - Will be on VLS communication list for 1 year

Environmental Division

Join the Virtual Local Section

virtuAIChE

- Please join the Virtual Local Section
  - No cost in 2012
  - $10 in 2013
  - http://virtual.aiche.org
  - Click on “Join Virtual Section” in Quick Links
  - You don’t have to be an AIChE member

An Overview of the Environmental Division (ENV)

Christian Lastoskie
2012 Environmental Division Chair

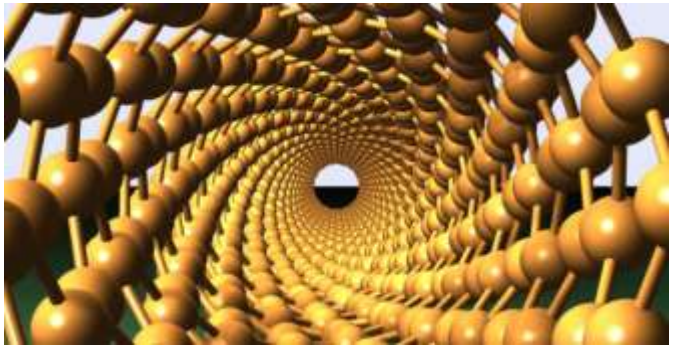
AIChE Virtual Local Section Meeting
July 26, 2012

The Environmental Division's **mission** is to further the application of chemical engineering in the environmental field.

sustainable water use

natural gas extraction

climate change



nanotechnology

biofuels

AIChE

Environmental Division: Functions

- programming on environmental topics of current interest
- coordinate AIChE's activities with other societies active in the environmental field
- an information source for chemical engineers not actively engaged in the environmental field, and a communication medium for those who are
- encourage chemical engineering educators to place suitable emphasis on environmental protection

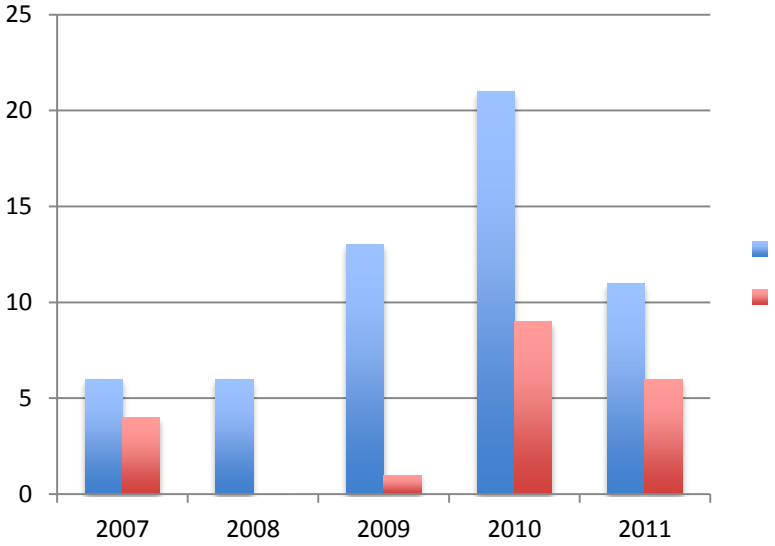
AIChE

ENV Division: Key Programs and Activities

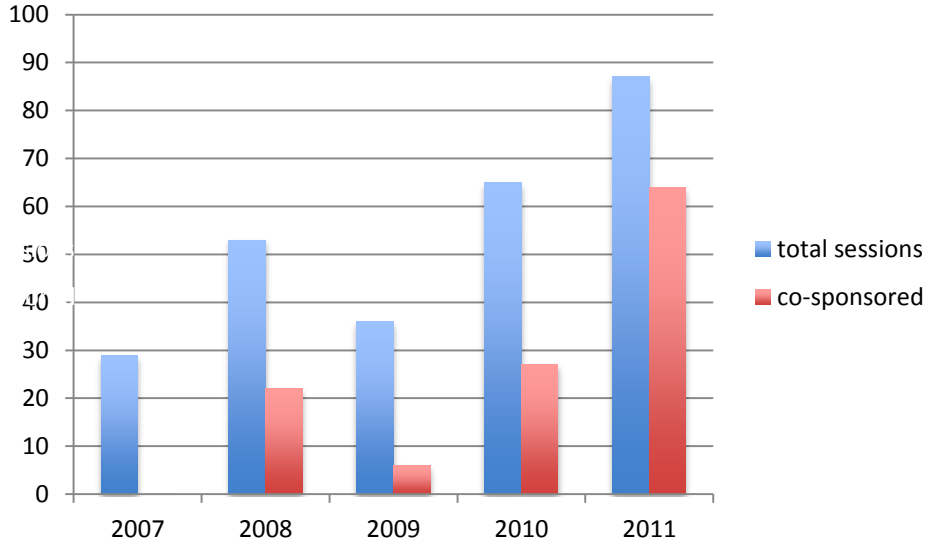
- **Programming** in eight thematic areas: (1) Air, (2) Water; (3) Climate Change; (4) Hazardous Waste; (5) Legal and Regulatory; (6) Fundamentals; (7) Process Development; (8) Sustainability
- 30 primary sessions at 2011 Annual Meeting (74 co-sponsored); 10 sessions at the 2012 Spring Meeting
  - Co-sponsors include SEF, Forest Bioproducts, Separations, Fuels & Petrochemicals, NSEF, ChemE & the Law
  - **Lawrence K. Cecil Award** for environmental chemical engineering
- Student awards and programs
  - Graduate and undergraduate student best paper competitions
  - Undergraduate poster competition reinstated in 2011
  - WISE program scholarship and mentorship
- *Environmental Progress & Sustainable Energy* journal
  - $45 membership fee includes journal subscription

AIChE

Environmental Division Programming



Spring Meeting



Annual Meeting

- steady growth in number of fall session offerings
- increasing co-sponsorship

AIChE

ENV Division Officers

- 2nd Vice Chair → 1st Vice Chair → Chair → Past Chair
  - all one year terms; orderly succession planning
- Programming Chair and Assistant Chairs, with section chairs and vice chairs in each thematic area
- Directors
  - three year terms; key volunteers with a specific focus
- Secretary, Treasurer, Webmaster, Liaisons
- monthly teleconferences
- business meetings at Annual and Spring Conferences

AIChE

Interactions with Other Divisions

- primary coordinator of World Congress on Sustainable Engineering
- dinners at Annual and Spring Meetings with Management Division and ChemE & the Law
- sponsorship of Young Professionals Advisory Board and Committee events
- joint webinar series with AWMA
- Virtual Local Section!

AIChE

Thank you! Please join us.

Christian Lastoskie, 2012 ENV Division Chair
cmlasto@umich.edu

Environmental Division **featured events** at the 2012 Annual Meeting (Pittsburgh) on Tuesday, October 30:

12:30 p.m. Lawrence K. Cecil Lecture
2012 Awardee: Prof. Gregory Carmichael

7:00 p.m. ENV/MGMT/CHE&L dinner @ the Carlton

AIChE

Environmental Division

virtuAIChE

Chief Information Officer Update

Amanda Robben, VLS Chair

Environmental Division

What's New in AIChE

virtuAIChE

- AIChE is ready to release a new website next month
- Donia Elsherbeni, Local Sections Support from AIChE has resigned as her husband accepted a postdoc at Berkeley

Environmental Division

UPCOMING CONFERENCES

virtuAIChE

http://www.aiche.org/Conferences/Calendar/2012.aspx

- **Ensuring the Sustainability of Critical Materials and Alternatives: Addressing the Fundamental Challenges in Separation Science & Engineering**
  - Pennsylvania Convention Center, Philadelphia, PA
  - August 12, 2012
- **2012 Annual Safety in Ammonia Plants&Related Facilities Symposium**
  - Hyatt Regency Chicago, Chicago, IL
  - September 9 - 13, 2012
- **2012 AIChE Regional Process Technology Conference**
  - South Shore Harbour Resort and Conference Center, League City, TX
  - October 4 - 5, 2012
- **2012 Annual Meeting**
  - Pittsburgh Convention Center, Pittsburgh, PA
  - October 28 - November 2, 2012

Environmental Division

Upcoming Webinars

http://apps.aiche.org/chemeondemand/LiveWebinars.aspx

virtuAIChE

On-Site Biological Graywater Treatment

- **Presented by Bobbie Swinson**
- **Wednesday, August 1, 2012**

Biofuels: Metrics and Challenges

- **Presented by John Carberry**
- **Wednesday, August 22, 2012**

AIChE Webinar: Failure Mechanisms in Lithium Ion Batteries: Opportunities for Materials Development

- **Presented by Dee Strand**
- **Wednesday, September 19, 2012**

AIChE Webinar: Working Across Cultures, the Challenges of Global Teams

- **Presented by Henry T. Kohlbrand**
- **October 17, 2012**

Environmental Division

New in VLS

4th Thursday 9:00 pm EDT

virtuAIChE

- **Uncovering Energy Savings in Process Plants**
  - Todd Willman, founder and director of EPCON
  - Thursday, August 23, 2012

- **Troubleshooting Distillation Columns**
  - Henry Kister, Fluor, Director of Fractionation Technology
  - Thursday, September 27, 2012

- **Process Engineering Problem Solving**
  - Joe Bonem, author, consultant, Exxon retiree
  - Thursday, October 25, 2012

Environmental Division

Questions, Comments and Answers

virtuAIChE

- "Raise Your Hand"
  - We'll unmute you so you can ask question
- Send a WebEx chat message to Amanda Robben or Dan Lambert if you have a question
  - We will read the question for you
- Laura will answer your question

Speaker Introduction

Dan Lambert, VLS Chair

Environmental Division

Tonight's Thanks

virtuAIChE

- Thanks to the Environmental Division for cosponsoring this Meeting

Disclaimer

- ***Neither the American Institute of Chemical Engineers (AIChE), the presenters and author(s) of this work, their employer, nor their employers' officers and directors, warrant or represent, expressly or by implication, the correctness or accuracy of the content of the information presented. As between (1) the AIChE, the presenter and author(s) of this work, their employers, and their employers' officers and directors, and (2) the user/viewer of this work, the user/viewer accepts any legal liability or responsibility whatsoever for the consequence of its use or misuse.***

Environmental Division

VLS Keynote Speaker
Laura Gimpelson

virtuAIChE

- **President, LG Environmental Engineering**
  - **Registered Professional Engineer in multiple states**
  - **More than 30 years of experience in the use of green remediation technologies**
  - **Former RCRA enforcement officer with the US EPA**
  - **Fellow of the American Institute of Chemical Engineers**
  - **Fellow of the Society of Women Engineers**

Sustainable Remediation:
More than Greenhouse Gases

Laura J. Gimpelson, P.E.
LG Environmental Engineering
Orlando, Florida

lg_environmental@bellsouth.net

Sustainability

Reduce Greenhouse Gases

Carbon Dioxide Emissions

Greenhouse Gases

CO_2

CH_4 N_2O

PFC HFC

SF_6

Source: UNFCCC/EPA

BASIS OF APPROACH

- Dictionary: The act of maintaining or supporting an object, action or person.
- Ecologist: Meeting human needs in a socially just manner without depriving ecosystems of their health.
- EPA: Meeting our needs while preserving the ability of future generations to meet their needs without creating new problems.
- ASTM: The maintenance of the ecosystem components and functions for future generations.

ELEMENTS OF SUSTAINABLE REMEDIAL ACTION PLAN

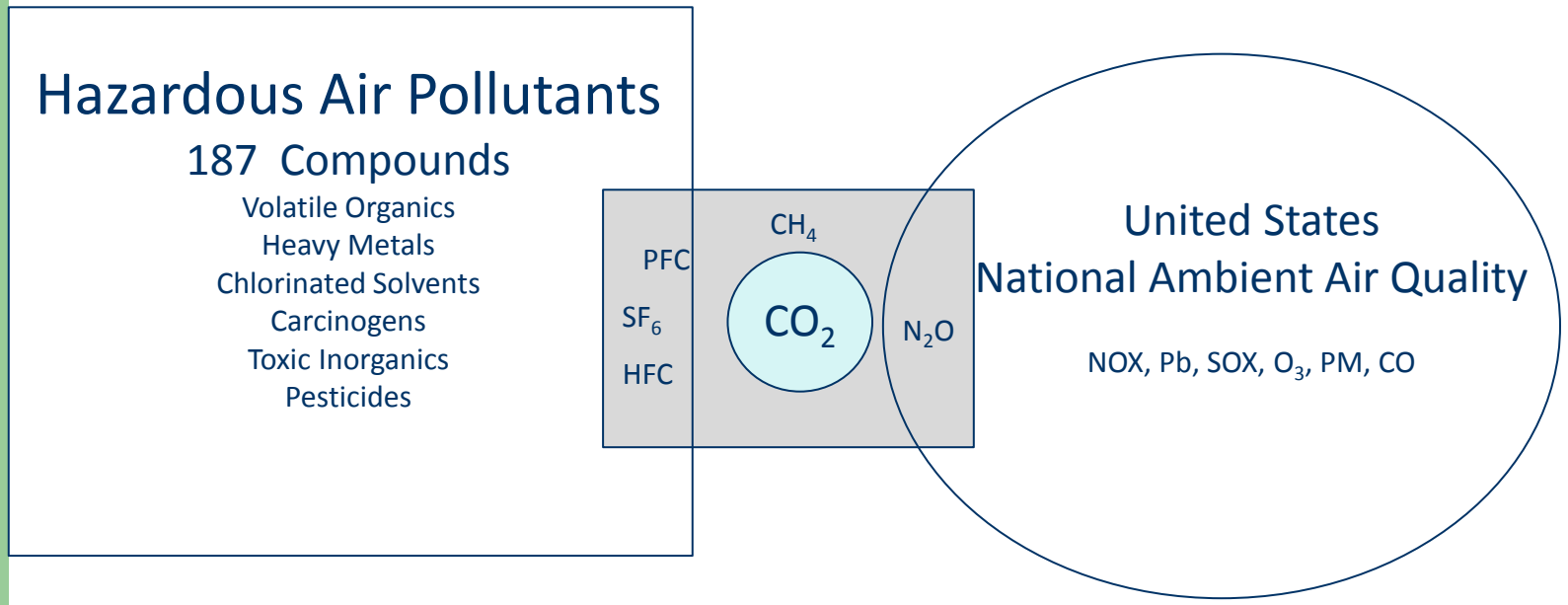
- Air Emissions
- Energy Requirements
- Water Resources
- Materials and Waste Management
- Land Use and Ecosystem Impacts

Air Emissions

Point Sources

Non-Point Sources

Air Emissions



Energy Impacts

- Operating Demand
- Source of Power
- Use of renewables
- Include installation and commuting

Water Resource Use and Impacts

- Consumption – Continuous and Intermittent
- Discharge location – Sewer, Groundwater, Pond
- Source – Potable, Reclaim, Rainwater, Groundwater
- Reuse/Recycle Options – Replace Potable
- Use of water efficient vegetation
- Erosion and sediment control

Materials and Waste Management

- Minimizing use of virgin materials
- Reuse/Recycle equipment and materials
- Reuse of waste streams
- Use of rapidly renewable or certified materials
- Includes paper

Land Use and Ecosystem Impacts

- Small Physical Presence on-site
- Minimize Noise and Light Pollution
- Limit on-site modifications
- No or limited impact to undeveloped areas
- Stormwater Runoff Management
- Destruction or Transfer

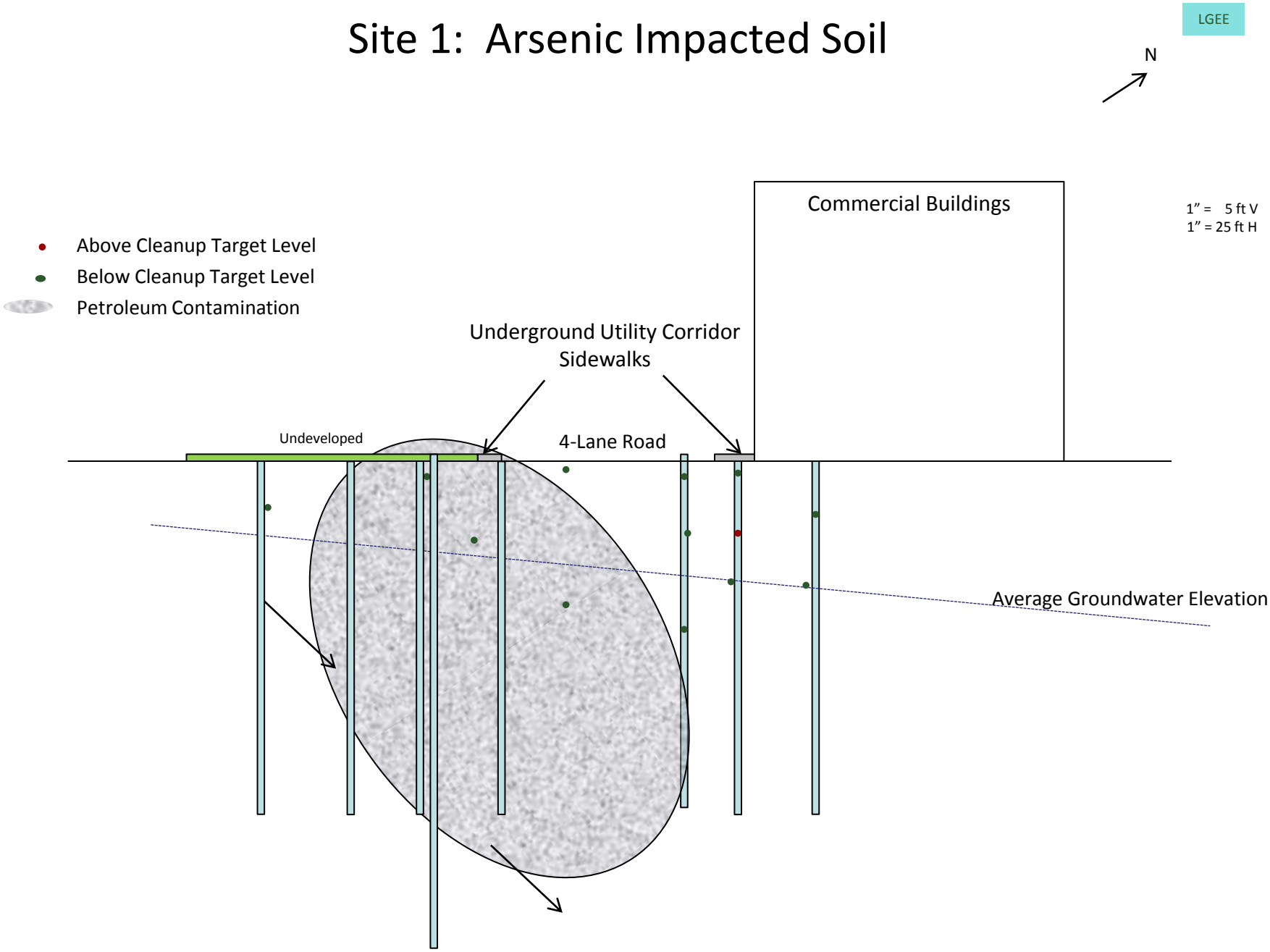
Secondary Impacts

Examples

- No Action Option
  - Risk Based Closure
- In-situ Options
  - Mass Transfer vs. Reactions
- Offsite Options
  - Alternatives to Landfills

Site 1: Arsenic Impacted Soil

LGEE



LGEE

LGEE

Site 1 Notes

- Arsenic background levels are higher than soil cleanup target levels.
- Detected concentrations are below area background levels.
- Arsenic has not be detected in adjacent groundwater monitoring wells.
- The “hot spot” is located within 2 feet of building footers.
- Underground utility lines are located next to the “hot spot”.
- Property owner is willing to modify deed to note “hot spot”.
- Adjacent building can not be closed down during the day.

LGEE

Excavation vs. RBCA

Element	Excavation	Deed Restrictions
Air Emissions	525 pounds CO_2 (2 cars, 2 trucks + 1 excavator)	22 pounds of CO_2 (1 car)
Water Emissions		
Land Use		
Materials		
Energy Consumption		

LGEE

Excavation vs. RBCA

Element	Excavation	Deed Restrictions
Air Emissions	525 pounds CO_2 (2 cars, 2 trucks + 1 excavator)	22 pounds of CO_2 (1 car)
Water Emissions	Dust Suppression - 2,000 gals	None
Land Use		
Materials		
Energy Consumption		

LGEE

Excavation vs. RBCA

Element	Excavation	Deed Restrictions
Air Emissions	525 pounds CO_2 (2 cars, 2 trucks + 1 excavator)	22 pounds of CO_2 (1 car)
Water Emissions	Dust Suppression - 2,000 gals Rainwater if it rains	None
Land Use	Close sidewalk for 72 hours Support building during excavation Noise and dust from excavation	No impact as sidewalk Future residential use restricted.
Materials		
Energy Consumption		

LGEE

Excavation vs. RBCA

Element	Excavation	Deed Restrictions
Air Emissions	525 pounds CO_2 (2 cars, 2 trucks + 1 excavator)	22 pounds of CO_2 (1 car)
Water Emissions	Dust Suppression - 2,000 gals Rainwater if it rains	None
Land Use	Close sidewalk for 72 hours Support building during excavation Noise and dust from excavation	No impact as sidewalk Future residential use restricted.
Materials	25 cubic yards of clean fill 2 cubic yards of concrete Landfill 22 cubic yards of soil and 2 cubic yards of concrete Sheet piling to protect bldg	50 sheets of paper and 5 CDs
Energy Consumption		

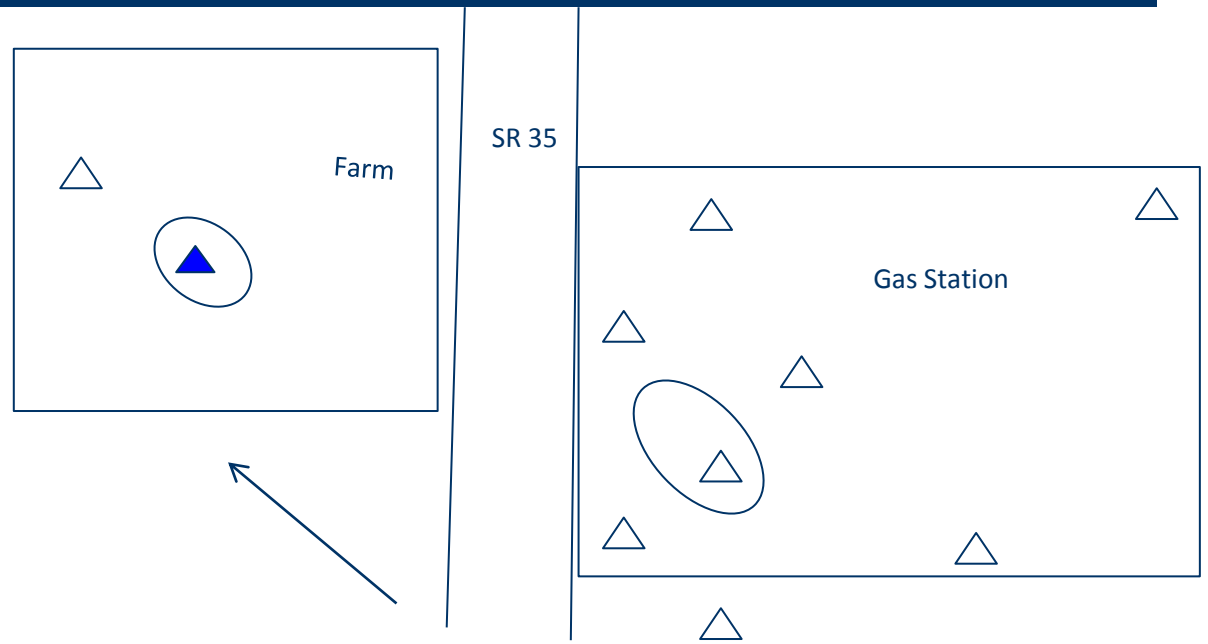
LGEE

Excavation vs. RBCA

Element	Excavation	Deed Restrictions
Air Emissions	525 pounds CO_2 (2 cars, 2 trucks + 1 excavator)	22 pounds of CO_2 (1 car)
Water Emissions	Dust Suppression - 2,000 gals Rainwater if it rains	None
Land Use	Close sidewalk for 72 hours Support building during excavation Noise and dust from excavation	No impact as sidewalk Future residential use restricted.
Materials	Landfill 22 cubic yards of soil and 2 cubic yards of concrete 25 cubic yards of clean fill 2 cubic yards of concrete Sheet piling to protect bldg	50 sheets of paper and 5 CDs
Energy Consumption	300 gallons of diesel 8 gallons of gasoline	4 gallons of gasoline for surveyor to document location

LGEE

Site 2:
Petroleum Impacted Groundwater



Extent of Plume

Monitoring Well

Drinking Water Well

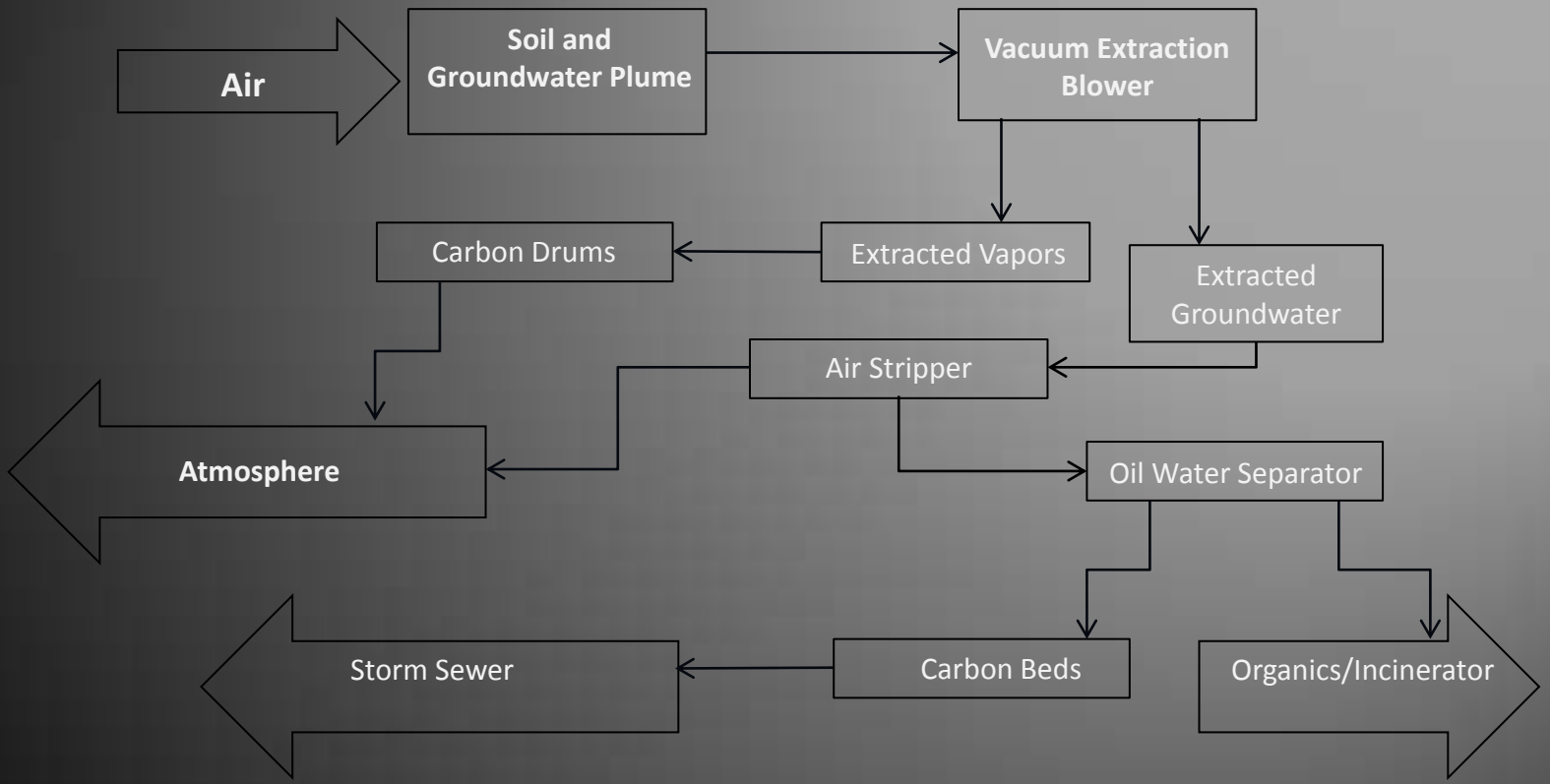
1” = 10 ft

Site 2: Notes

- Chemical of concern is MTBE.
- Off-site plume has impacted drinking water supply.
- Air sparge/soil vapor extraction is standard treatment technology.
- Size of plumes mandates use of portable AS/SVE treatment train.
- Portable AS/SVE requires local building permits for installation.
- New electrical meter installation requires licensed electrician.
- Street can not be closed down during the day.
- Installation of header system will shut down store for 6 weeks.
- 6 month backlog in obtaining portable AS/SVE system due to operating issues.

LGEE

Air Sparge/Soil Vapor System



Chemical Injection Requirements

- 8 injection points using Badger System
  - 2 wells to be treated
  - 4 points per well located 90^0 apart and 15 feet from impacted monitoring wells
  - Expected depth = 34 feet (sandy soil)
- Badger System uses a 2-kW household generator for injection system control
- Standard push rig to install temporary injection points
- 700 gallons of oxidant into each injection point
- 100 gallons of catalyst into each injection point
- Pulse reagents into injection point at multiple depths and ports
- Overpressure aquifer to force reagents into vadose zone

Badger Injection System

Air Sparge and Soil Vapor Extraction Systems

www.**mleequipment.com**/.../**air**-**sparge**...extraction-**systems**

RESOURCE COMPARISON

	AS/SVE	Chemical Injection
Operational Time		
Power Consumption		
Greenhouse Gases		
Other Air Emissions		
Groundwater Discharges		
Impact on Site and Neighbors		
Secondary Contamination		

RESOURCE COMPARISON

	AS/SVE	Chemical Injection
Operational Time	3 years (1.5 years in operations)	0.75 years
Power Consumption		
Greenhouse Gases		
Other Air Emissions		
Groundwater Discharges		
Impact on Site and Neighbors		
Secondary Contamination		

RESOURCE COMPARISON

	AS/SVE	Chemical Injection
Operational Time	3 years (1.5 years in operations)	0.75 years
Power Consumption	102,000 kw/yr (24 hr /337 days/yr)	480 kw/year (4 hr/3 days/2 events)
Greenhouse Gases		
Other Air Emissions		
Groundwater Discharges		
Impact on Site and Neighbors		
Secondary Contamination		

RESOURCE COMPARISON

	AS/SVE	Chemical Injection
Operational Time	3 years (1.5 years in operations)	0.75 years
Power Consumption	102,000 kw/yr (24 hr /337 days/yr)	480 kw/year (4 hr/3 days/2 events)
Greenhouse Gases (CO_2)	~500,000 lbs./yr	~1,200 lbs./year
Other Air Emissions		
Groundwater Discharges		
Impact on Site and Neighbors		
Secondary Contamination		

RESOURCE COMPARISON

	AS/SVE	Chemical Injection
Operational Time	3 years (1.5 years in operations)	0.75 years
Power Consumption	102,000 kw/yr (24 hr /337 days/yr)	480 kw/year (4 hr/3 days/2 events)
Greenhouse Gases (CO_2)	~500,000 lbs./yr	~1,000 lbs./year
Other Air Emissions	VOCs: ~ 600 lbs./yr Dust: 350 lbs	VOCs: 4 lbs/event Dust: 1 lb /event
Groundwater Discharges		
Impact on Site and Neighbors		
Waste Streams		

RESOURCE COMPARISON

	AS/SVE	Chemical Injection
Operational Time	3 years (1.5 years in operations)	0.75 years
Power Consumption	102,000 kw/yr (24 hr/337 days/yr)	480 kw/year (4 hr/3 days/2 events)
Greenhouse Gases	~500,000 lbs./yr	~1,200 lbs./year
Other Air Emissions	VOCs: ~ 600 lbs./yr Dust: 350 lbs	VOCs: 4 lbs/event Dust: 1 lb/ event
Groundwater Discharges	~500,000 gal/yr to sewer system	1,000 gal/event
Impact on Site/Neighbors	Motor Noise (24 hr /337 days/yr) Attracts rodents and homeless	Lost of 7 parking spaces for 6 days
Waste Streams		

RESOURCE COMPARISON

	AS/SVE	Chemical Injection
Operational Time	3 years (1.5 years in operations)	0.75 years
Power Consumption	102,000 kw/yr (24 hr/337 days/yr)	480 kw/year (4 hr/3 days/2 events)
Greenhouse Gases	~500,000 lbs./yr	~1,200 lbs./year
Other Air Emissions	VOCs: ~ 600 lbs./yr Dust: 350 lbs	VOCs: 4 lbs/event Dust: 1 lb/ event
Groundwater Discharges	~500,000 gal/yr to sewer system	1,000 gal/event
Impact on Site/Neighbors	Motor Noise (24 hr /337 days/yr) Attracts rodents and homeless	Lost of 7 parking spaces for 6 days
Waste Streams		

RESOURCE COMPARISON

	AS/SVE	Chemical Injection
Operational Time	3 years (1.5 years in operations)	0.75 years
Power Consumption	102,000 kw/yr (24 hr/337 days/yr)	480 kw/year (4 hr/3 days/2 events)
Greenhouse Gases	~500,000 lbs./yr	~1,200 lbs./year
Other Air Emissions	VOCs: ~ 600 lbs./yr Dust: 350 lbs	VOCs: 4 lbs/event Dust: 1 lb/ event
Groundwater Discharges	~500,000 gal/yr to sewer system	1,000 gal/event
Impact on Site/Neighbors	Motor Noise (24 hr /337 days/yr) Attracts rodents and homeless	Lost of 7 parking spaces for 6 days
Waste Streams	Excess soil and pavement, Carbon Beds, Used Oil, PPE, Treatment Compound	Pavement Cores, PPE

Deciding Factors

Chemical Injection – Converts MTBE to water and CO_2

AS/SVE – Transfer MTBE from subsurface to environment

Install new drinking water supply well to reduce size of AS/SVE leaving off-site MTBE plume intact.

Site 3: Spill Response

- 10,000 cubic yards/14,000 tons
- Petroleum contaminated soils - mixed sand, silts and crushed limestone
- Average Concentration - 5,000 mg/kg TRPH
- 36% moisture content (just enough to for a water layer at the landfill)
- Nearest landfill – 500 miles with limited delivery hours
- Mobile Thermal Treatment – 50 miles roundtrip
- Daylight hours only due to artificial light restrictions
- Load 3 trucks per hour for 9 hour per day
- Daily Removal – 540 cubic yards/756 tons

www.**clark-environmental.com**

LGEE

RESOURCE COMPARISON

	Landfill	Thermal Treatment
Operational Time	3 weeks	3 weeks
Energy Consumption		
Greenhouse Gases		
Backfill		
Absorbent		
Transport Issues		
Lab Tests		
Future Liability		

RESOURCE COMPARISON

	Landfill	Thermal Treatment
Operational Time	3 weeks	3 weeks
Energy Consumption	300,000 btu/ton	830,000 btu/ton
Greenhouse Gases		
Backfill		
Absorbent		
Transport Issues		
Lab Tests		
Future Liability		

RESOURCE COMPARISON

	Landfill	Thermal Treatment
Operational Time	3 weeks	3 weeks
Energy Consumption	300,000 btu/ton	830,000 btu/ton
Greenhouse Gases	450 lb/ton	~800 lb/ton
Backfill		
Absorbent		
Transport Issues		
Lab Tests		
Future Liability		

RESOURCE COMPARISON

	Landfill	Thermal Treatment
Operational Time	3 weeks	3 weeks
Energy Consumption	300,000 btu/ton	830,000 btu/ton
Greenhouse Gases	450 lb/ton	~800 lb/ton
Backfill	12,000 cu yd of virgin soil	None – reuse treated soil
Absorbent		
Transport Issues		
Lab Tests		
Future Liability		

RESOURCE COMPARISON

	Landfill	Thermal Treatment
Operational Time	3 weeks	3 weeks
Energy Consumption	300,000 btu/ton	830,000 btu/ton
Greenhouse Gases	450 lb/ton	~800 lb/ton
Backfill	12,000 cu yd of virgin soil	None – reuse treated soil
Absorbent	800 lb(2 drums)/truck	None
Transport Issues		
Lab Tests		
Future Liability		

RESOURCE COMPARISON

	Landfill	Thermal Treatment
Operational Time	3 weeks	3 weeks
Energy Consumption	300,000 btu/ton	830,000 btu/ton
Greenhouse Gases	450 lb/ton	~800 lb/ton
Backfill	12,000 cu yd of virgin soil	None – reuse treated soil
Absorbent	800 lb(2 drums)/truck	None
Transport Issues	60 trucks/event One round trip every 2 days	8 trucks/event One round trip every 2.5 hrs
Lab Tests		
Future Liability		

RESOURCE COMPARISON

	Landfill	Thermal Treatment
Operational Time	3 weeks	3 weeks
Energy Consumption	300,000 btu/ton	830,000 btu/ton
Greenhouse Gases	450 lb/ton	~800 lb/ton
Backfill	12,000 cu yd of virgin soil	None – reuse treated soil
Absorbent	800 lb(2 drums)/truck	None
Transport Issues	60 trucks/event One round trip every 2 days	8 trucks/event One round trip every 2.5 hrs
Lab tests	1 sample/250 cu yd	One per event
Future Liability		

RESOURCE COMPARISON

	Landfill	Thermal Treatment
Operational Time	3 weeks	3 weeks
Energy Consumption	300,000 btu/ton	830,000 btu/ton
Greenhouse Gases	450 lb/ton	~800 lb/ton
Backfill	12,000 cu yd of virgin soil	None – reuse treated soil
Absorbent	800 lb(2 drums)/truck	None
Transport Issues	60 trucks/event One round trip every 2 days	8 trucks/event One round trip every 2.5 hrs
Lab Tests	1 sample/250 cu yd	One per event
Future Liability	If landfill leaks Accident on Road	No – Organics destroyed

Tabulation of Evaluation

	Landfill	Thermal Treatment
Operational Time	1	1
Energy Consumption	3	5
Greenhouse Gases	3	5
Backfill	4	1
Absorbent	3	1
Transport Issues	5	3
Lab Tests	3	1
Future Liability	3	1
Total	25	18

1 = Best , 3= Average, 5 = Worst

CONCLUSION

- Carbon footprint is only first step.
- Calculate other air emissions.
- Include water, materials and other resources
- Look at physical footprint
- Reduce waste generation
- Identify potential secondary impacts
- Compare results of option

REFERENCES

- http://www.astm.org
  - *General Principles of Sustainability Relative to Buildings*
  - *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites*
  - *Standard Guide for Risk-Based Corrective Action*
  - *Standard Guide for Remedy Selection Integrating Risk-Based Corrective Action and Non-Risk Considerations*
- *http://www.clu-in.org/greenremediation/*
- *http://www.epa.gov/oswer/greenercleanups/index.html*
- *http://www.epa.gov/swerust1/pubs/tums.htm*
- *http://www.iso.org*
  - *14000 Family of Standards*
  - *14040, 14044, 14051, 14047/9*
- *ww.epa.gov/superfund/greenremediation*
- *www.knovel.com*
- *http://www.youtube.com/watch?v=zQ3hHTvjgtc (University of California at Berkley)*

CONTINUING EDUCATION CREDIT

1. Send e-mail to lg_environmental@bellsouth.net by August 30, 2012.
2. Include name as printed on license, number and state of registration.
3. Credit for Florida PE continuing education hour will be posted on-line by September 30, 2012. No certificate will be issued.
4. Certificate will be issued for other states by September 30, 2012.

Contact Information

Laura J. Gimpelson, P.E.
LG Environmental Engineering
407-829-0293
lg_environmental@bellsouth.net

Providers of Sustainable Technology and Training

www.badgerlive.com

www.clarkenvironmental.com

www.cl-solutions.com

www.geocleanse.com

www.suncam.com

www.knovel.com

Closing Comments

Dan Lambert, VLS Chair

Thank you Laura

- Thank you for speaking tonight
- As our way of saying thanks, we have shipped you a coffee cup

Environmental Division

Thank everyone for attending

virtuAIChE

- Thank you!!
- VLS meeting next month
  - Uncovering Energy Savings in Process Plants
    - Todd Willman, founder and director of EPCON
    - Thursday, August 23, 2012