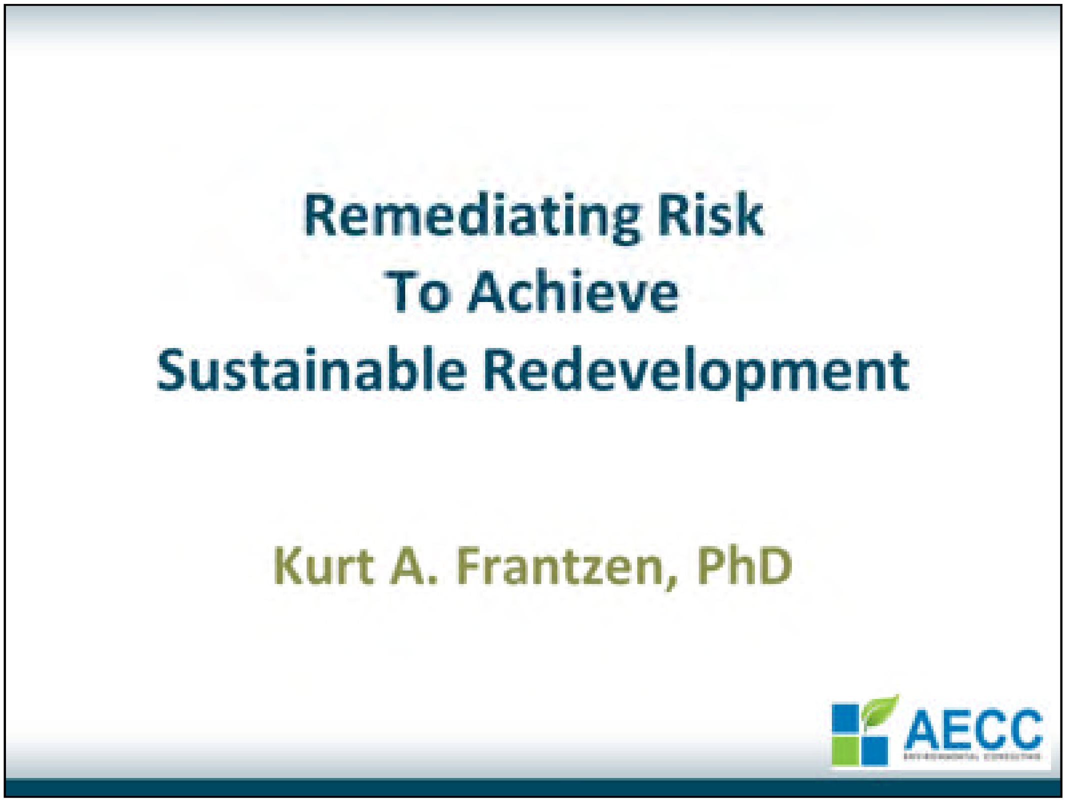
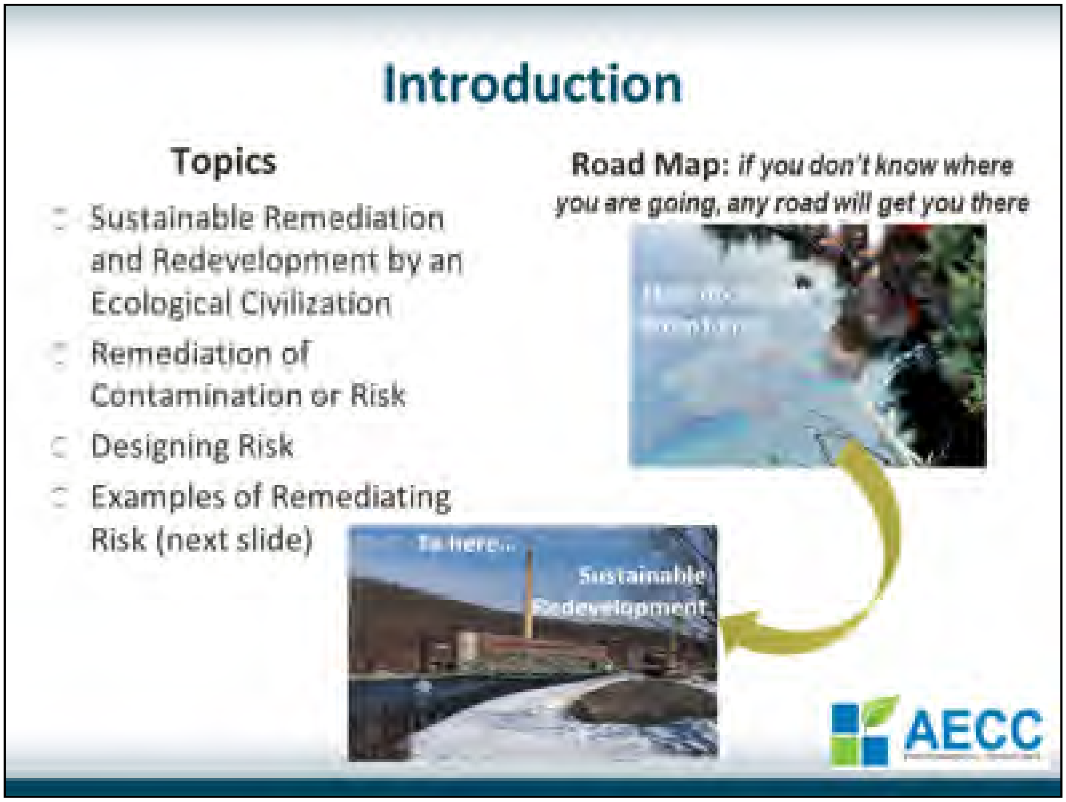


Kurt Frantzen is an environmental science professional with three-three years of experience. His work focuses on environmental risk analysis, and impaired property (Brownfield) investigation and remediation. He has advised developers and commercial; clients concerning a variety of environmental management and compliance issues (due to legacy and current operations), as well as assisting in environmental litigation (serving as science adviser and expert testimony regarding cost recovery, cost allocation, and environmental insurance). His work has involved: subsurface and groundwater impacts from coal tar and petroleum hydrocarbons, building surfaces contaminated with chemicals such as PCBs and heavy metals, surface water and sediment contamination, chlorinated and other pesticide residues in former agricultural soils, and oil spills within ports. He also provides environmental liability advice to developer, legal, and insurance broker clients. He edited and co-author of Risk Based Analysis for Environmental Managers (Lewis Publishers, 2001) and is a regular lecturer in the Brownfield Practicum course in the Graduate School of Design at Harvard University.

Education: BS-Biology, MS-Plant Pathology, PhD-Biochemistry

Experience: 33 years



Abstract

Remediation is not merely cleaning-up chemicals. Rather, we remediate the risk posed by those chemicals to the environment and people living or working in the redevelopment to follow. I will speak about <u>Remediating Risk through Redevelopment</u> in three ways:

> Ecological Civilization requires an environmentally friendly consciousness that improves ecological health, enhances economic development, and builds social harmony. This demands <u>Cross-Disciplinary Thinking</u> in our work of sustainable remediation and redevelopment.

> There are many remediation techniques, but integrating them to control or mitigate risk requires <u>Risk-Based Analysis</u> measure success, inform land-planning design, guide economic development models and plans, and communicate to people about risk and redevelopment and to encourage social harmony.

> By focusing on risk, instead of chemicals, we imagine new ideas of how to apply the science and engineering of remediation. It forces us to properly define "*how clean is clean enough*." One way to do this is to think of <u>Redevelopment as Remediation</u>. Designing Risk integrates land planning (landscape architecture) for sustainable development that is healthy for humans and the environment over time (*amortizing risk*).

I will demonstrate these concepts using examples from the United States of remediating risk in the built environment and agricultural areas.

Introduction *continued*

Examples of Remediating Risk

- ALCO Nott Street Site, Schenectady, NY
- 150 year old manufacturing site, **redevelopment as remediation**

- Bandelier NP, Los Alamos, NM
- DDT, **defining risk & the risk of remedy to cultural fabric**

- PG&E Site, Hinkley, CA
- Large hexavalent chromium plume, **waste as a resource**

- Former Apple Orchards, Marlborough, MA
- Pesticide contamination, **redesigning the risk**

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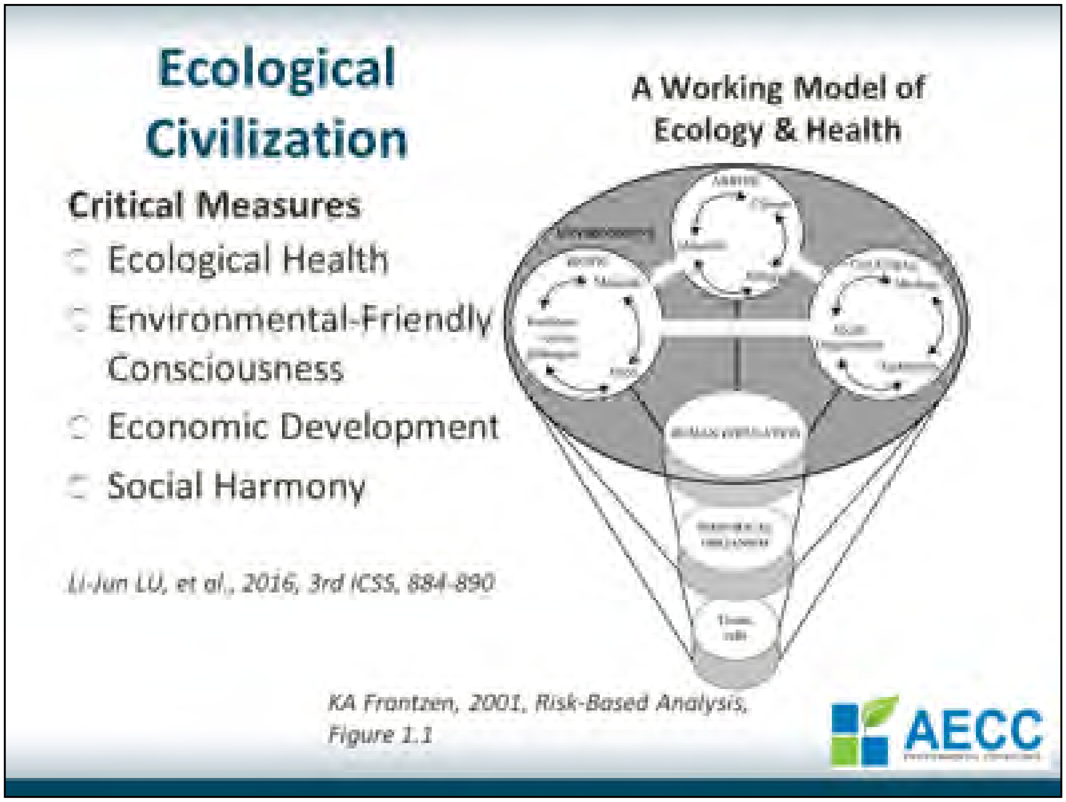

One possible definition (adapted from Roy Morrison, 1995) of *Ecological Civilization*: Diverse lifeways with sustainable linkages between natural and social ecologies, operating within a framework of "*Constructive Postmodernism*," where continual change and transformation are fundamental.

The figure in the slide is derived from Figure 1.1 IN Risk-Based Analysis for Environmental Managers (KA Frantzen, editor, CRC Press/Boca Raton, FL, 250pp), and which was derived from the working model of ecology & health developed by A McElroy and PK Townsend in their book *Medical Anthropology in Ecological Perspective*, Third Edition, Westview Press, Boulder, CO, 434p, 1996.

The McElroy—Townsend model reminds us that the parts of a system depend on other parts and are in continual interaction. The spheres or units function as an ecosystem with relationships among organisms (including people) and their environments. Interdependency is important because we often manage things and solve urban problems based on immediate interpretations of cause-and-effect. Adverse health and ecological impacts never have single causes. Resolving environmental impairment issues involves more than just removing "toxic molecules." Instead, it involves individuals, populations, and diverse "systems"—biotic, abiotic, and cultural. This complexity requires that environmental risk management address a great breadth of issues to get things done.

Adapted from Chapter 1 Introduction by K Frantzen and J Ackerman IN *Risk-Based Analysis for Environmental Managers* (KA Frantzen, editor, CRC Press/Boca Raton, FL, 250pp)

This is a different way of thinking…it involves an Ecological Synthesis associated with each of the disciplines necessary to achieve any kind of remediation as well as redevelopment that effectively interfaces urban and rural areas, residential, commercial, industrial, agriculture, and country-side.

Integrated, cross-disciplinary thinking is critical when managing environmental risk systems. Today, I am providing a tool to empower you to better influence the multi-component and multi-party decision-making processes and negotiations involved with (environmental) risk management. We believe that this tool is a practical approach that can improve the interface between you and others involved in performing the analysis of environmental risk systems in concert with various technical fields within and beyond your organization. The tool will help you develop knowledge and understanding to guide internal decision-making, as well as contribute to external decision-making processes. Why is this important? The management of environmentally impaired property involves grappling with many different concerns.

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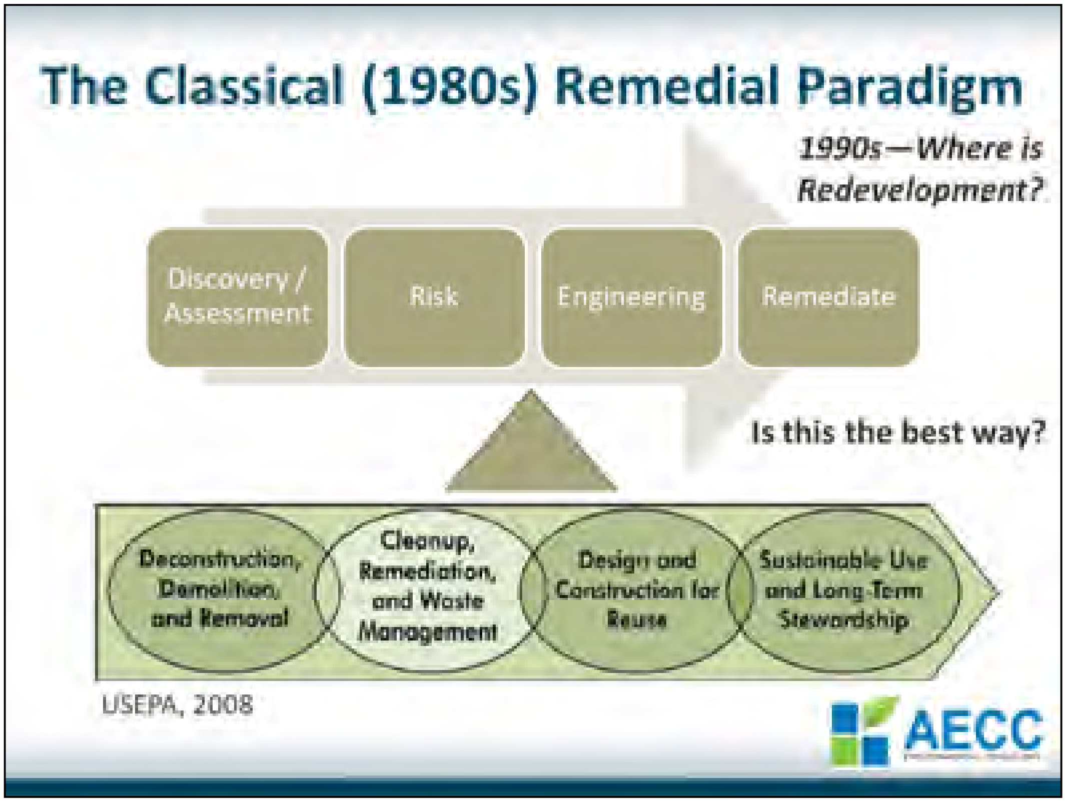
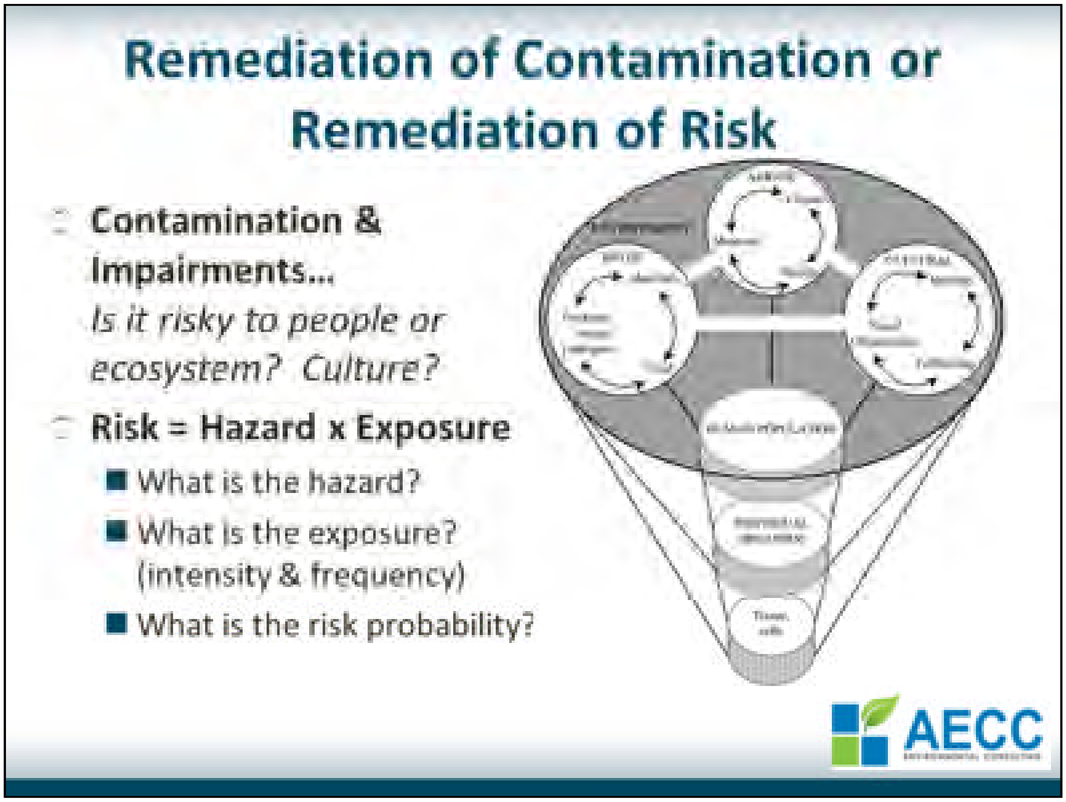


Here is the classical way the United States approached remediation…we completely ignored redevelopment. Then we began to re-think our approach beginning in 1994. But notice that 14 years, in 2008, even the Green Remediation approach of the USEPA always thought about reuse after remediation.



Before we continue, let’s stop and think about whether we are remediating contamination or environmental impairments or risk…risks to people (whether it is cancer or non-cancer health risks) or to the environment (organisms, assemblages, communities, or whole ecosystems).

Earlier in this talk, I mentioned critical measures of the Ecological Civilization; these measures can use or be based upon measurement of risk to human health and the environment and how much we have reduced that risk and thus improved the ecological civilization.

Definitions

Hazard: The likelihood that a substance will cause an injury or adverse effect under specified conditions.

Exposure: Co-occurrence of or contact between a stressor and a receptor with some frequency and intensity.

Risk: The probability of that a substance (chemical, physical, or biological) will produce harm under specified conditions.

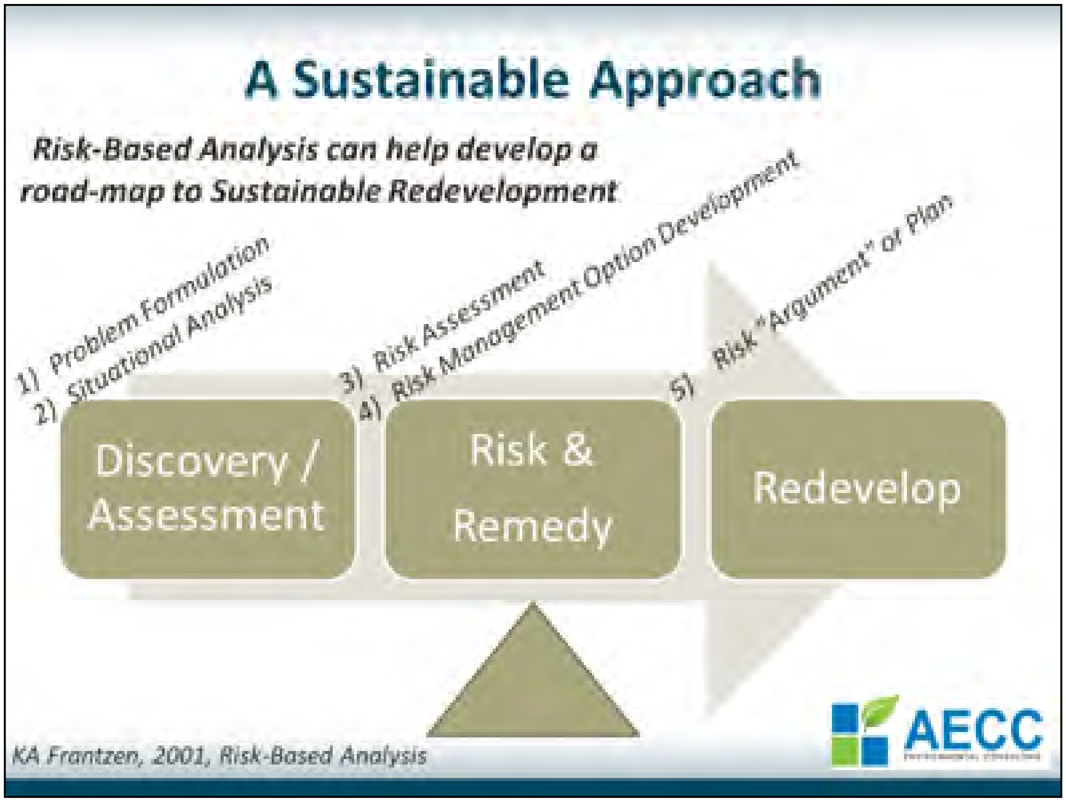
Risk Analysis: A two-step process of evaluating (quantifying) risk(s) and making (policy or reuse) decisions based on the evaluation together with other input.

Risk Assessment: The process of estimating the likelihood that a given effect will result from a specific, presence, action, or activity. Where likelihood is a probability and interpreted as the portion or fraction of time a consequence might be observed. Concerning toxic substances, risk assessment involves determining the likelihood of release (exposure) and the resulting consequence (hazard).

Sustainable development accentuates the concept of redevelopment as remediation. Such development can be defined as a coordinated action among business, government, communities, and individuals that leads to meeting present needs without compromising the ability of those in the future to meet their own needs (Robinson, 2000). As an integrating function, sustainable development is not and can never be the province of one individual or entity.

The approach taken to defining what is clean must be risk-based, but also must address long-term liability, regulatory interests, and other stakeholder concerns. This is where the concept of redevelopment as remediation can be crucial, using development concepts to spur the innovation of cost-effective source removal, techniques to cut-off exposure routes, and land uses that eliminate exposure/risk while simultaneously building value into the real estate asset, improving the community, and augmenting sustainability of the surrounding ecosystem in which the site is located.

The pictures are of the former ALCO railroad engine manufacturing facility in Schenectady, New York originally built around 1859. I became the environmental manager of the facility in 2001 and kept the 50+ acre site from becoming a Superfund Site. We successfully got the facility into the New York State Brownfields program in 2011 at the same time that the facility was sold to developers. Using Risk-Based Analysis, we contributed to positioning this significant Brownfield site to subsequently be remediated (capping, among other actions) and redeveloped as a hotel / casino / commercial / industrial / marina facility.



When we combine the concept of Remediation of Risk with the action of Redevelopment of Remediation we get a sustainable approach.

Environmental risk management requires consideration of not just hard, objective, scientific fact but thoughtful consideration of their subjective nature amid various personal and cultural perspectives. As described below, Risk-Based Analysis is an integrative technique with five progressive, knowledge-building value points to guide the management, collection, and analysis of risk information. The procedure provides a system to help you minimize cost and potential liability by articulating cleanup within the context of a property's socioeconomic value, planned redevelopment approach, and intended reuse(s). It provides the knowledge foundation critical to making strategic plans for managing a site and its impairment.

It is not a model for a regulatory approach. Rather, it is a five-step tool to help inform your management process throughout its operation for a particular impairment or property. In so doing, Risk-Based Analysis provides: Insight, Aid, Support, Information, and Guidance.

Sustainable Remediation Using Risk-Based Analysis (RBA)

1) Problem Formulation—*define the problem* (begin with the end in mind)

2) Situational Analysis—*understand the ecosystem, built-environment, regulatory, political, & socioeconomic circumstances*

3) Risk Assessment—*qualify & quantify nature, frequency, and intensity of risk within redevelopment/reuse contexts*

4) Risk Management Option Development—*permanently reconstruct risks to remove or reduce them; where necessary amortize risk reduction over a time horizon*

5) Risk "Argument"—*communications approach to achieve optimal "mutual gain" solutions*

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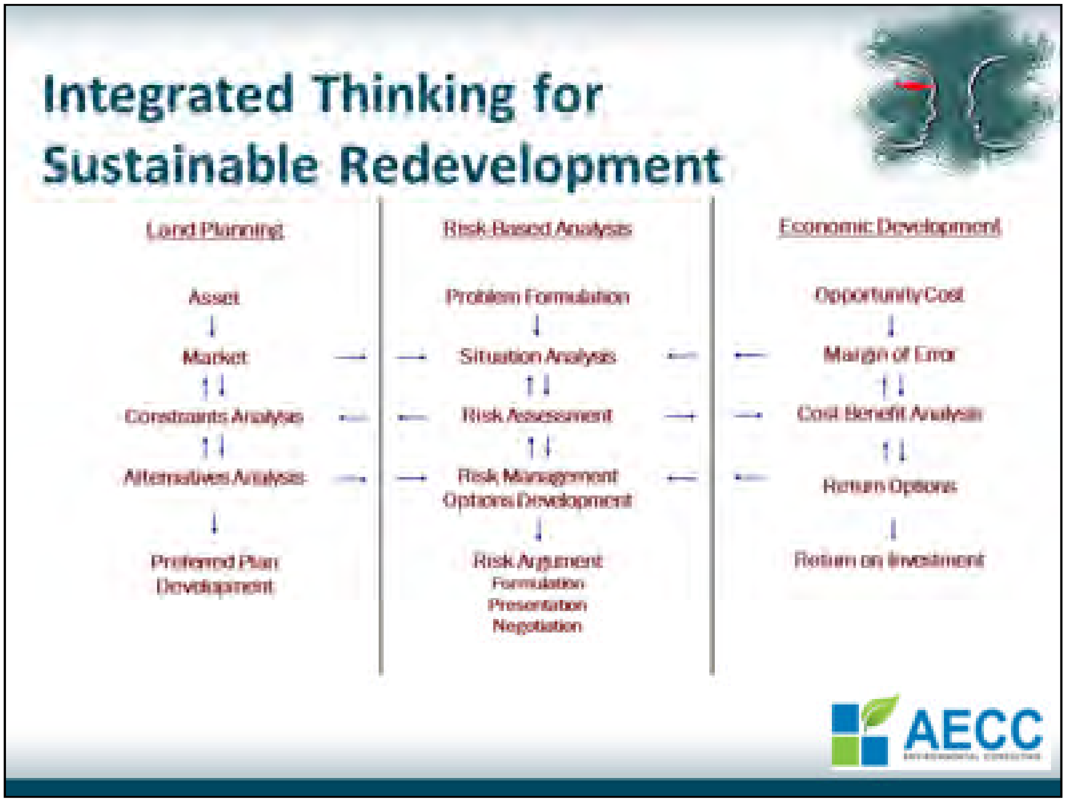
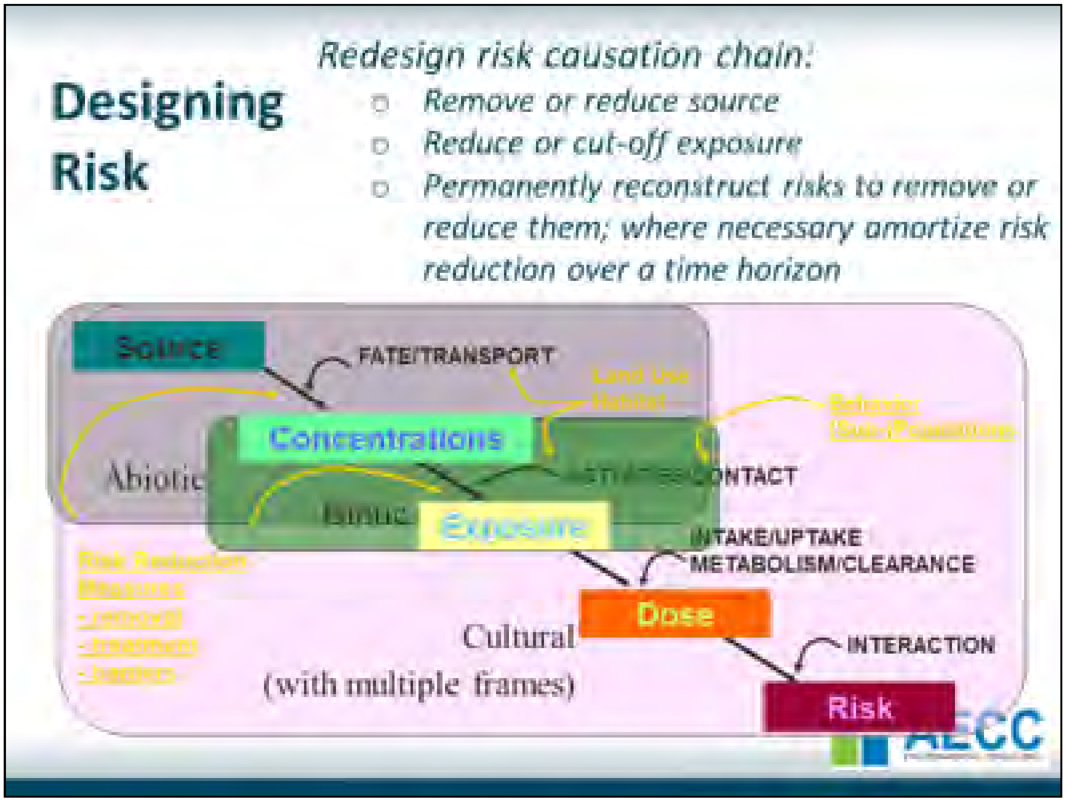


"*By day, we work with statistics; in the evening, we consult astrologers and frighten ourselves with thrillers about vampires. The abyss between the rational and the spiritual, the external and the internal, the objective and the subjective, the technical and the moral, the universal and the unique, …grow deeper.*" (Havel, 1996)

The quote above comes from an article based on a speech given by Vaclav Havel titled, "*The Need for Transcendence in the Postmodern World*." In the past decade at least, realization has grown for the need to transcend boundaries in order to end the insularity of our thinking and ourselves. Society in general seems in search of a strategy to integrate knowledge. New cooperative and cross-disciplinary approaches are emerging in many areas. Likewise, integrative approaches are essential in environmental problem solving.

Environmental risk management involves the definition of potential loss in terms of hazard, harm, risk, and cost. It is a multi-dimensional effort using input from many sources (within and without the corporation), disciplines, and perspectives. Thus, its real problems are trans-boundary, requiring a holistic approach to yield solutions that integrate corporate needs with those of society.

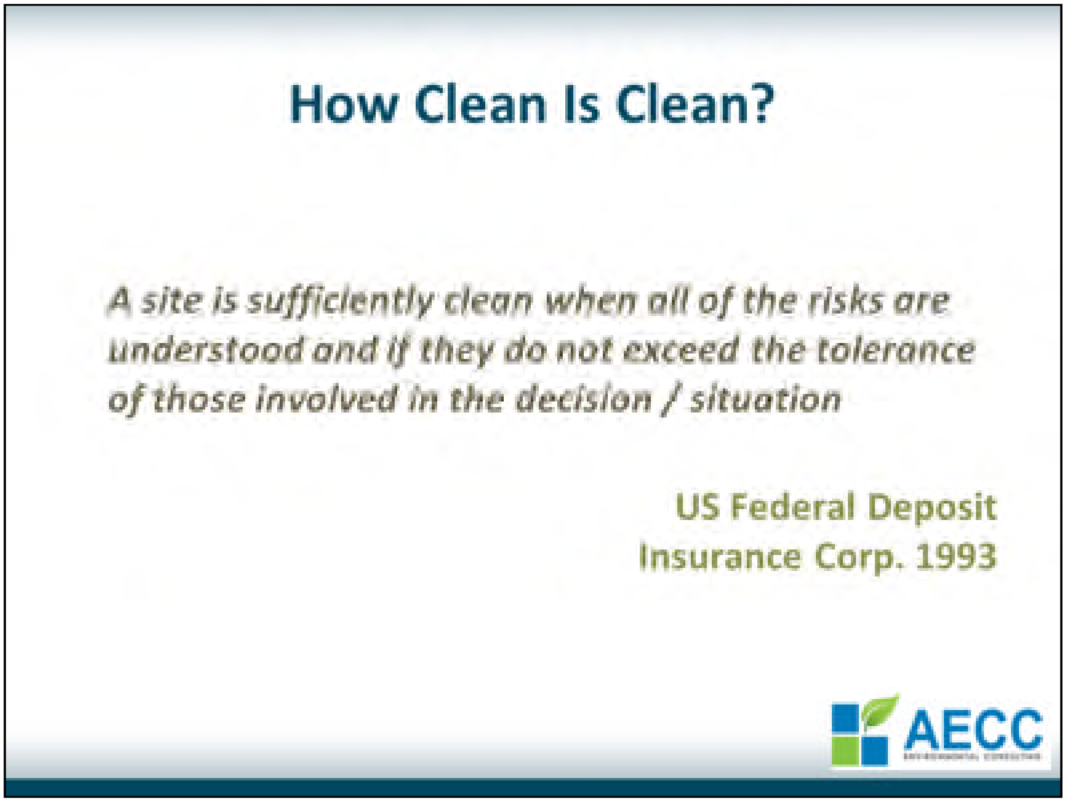
Adapted from Chapter 2 Environmental Risk Management by K Frantzen IN *Risk-Based Analysis for Environmental Managers* (KA Frantzen, editor, CRC Press/Boca Raton, FL, 250pp)



Most of us who get into the environmental business are originally fascinated by the science and engineering. Our interest in this work and the fundamental problem to be solved is summarized by the Conceptual Risk System Model.

It is this problem, as presented by this model, that requires effective formulation, definition, agreement upon, measurement of, and ultimately management.

Sooner or later, those who get in this business find that in order to solve problems in the applied realm it is especially necessary to understand the context of the Risk System: abiotic, biotic, and cultural. Not only is it necessary to understand the system within this context, one must be prepared to deal with this context in a management sense.



Managing How Risk Is Defined

How much soil do we clean-up? How many kilometers of stream? How many hectares? When do we stop? What can we afford? How do we integrate science, cultural and personal values, health, cost, ecosystem needs to make these decisions?

The complexity of environmental risk management and the difficulties of setting standards and answering the question “how clean is clean,” appear to hinge on a single management problem composed of three questions:

- ❑ How to define the peril (that is, the human and ecological risk)?
- ❑ Who defines the peril?
- ❑ When is the definition of peril made?

It is axiomatic that risks to human health and the environment—the peril—cannot be absolutely quantified. Any risk measurement is relative to the person making it and subject to observational constraints. It is impossible to prove that anything is entirely harmless, let alone an environmental impairment due to “chemical contamination”. The matter has political dimensions. Thus, risk measurements in this context depend upon socially set rules and values (conventions) pertaining to the issue at hand; even so, it must be appreciative of sciences’ value and limits.

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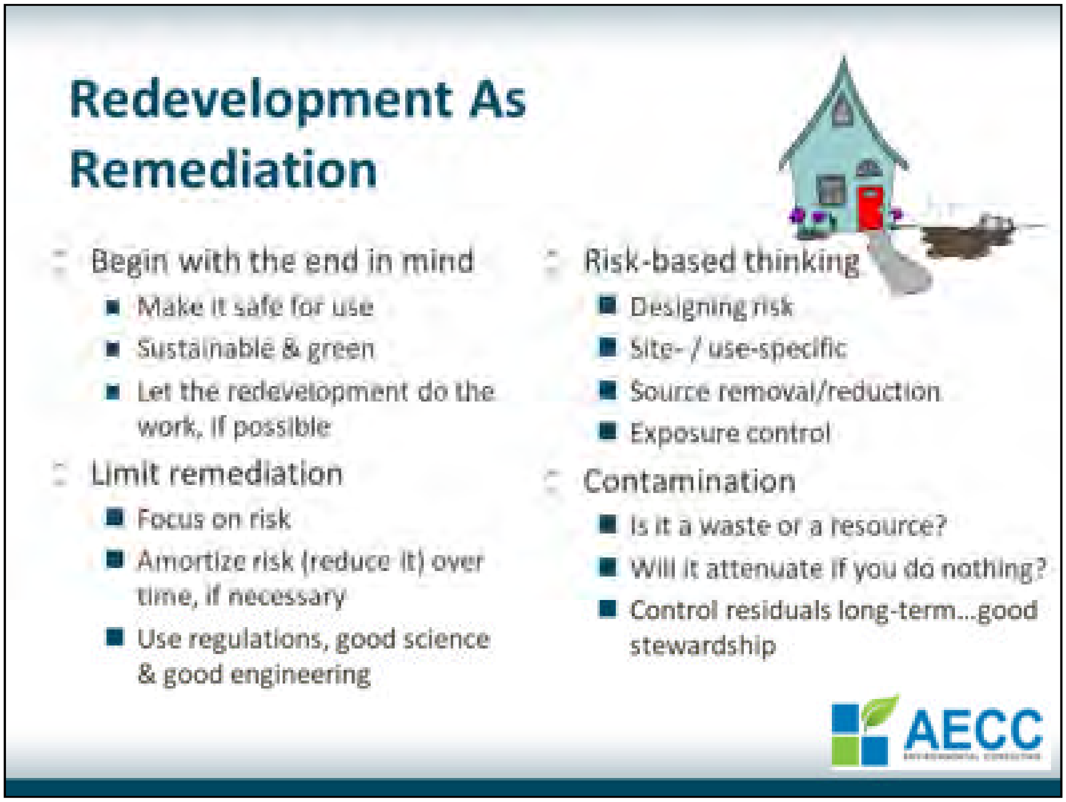


Many remedial options are available for implementation at a particular site, ranging from "no action" to wholesale removal, and there are many factors—*e.g.*, performance, cost, community acceptability—underlying the decision to select a particular remedial strategy from possible options such as: No Action, Repair, Operations and Maintenance Program, Isolation / Institutional Controls, Encapsulation, Enclosure, Removal and Disposal, Removal and Treatment, Treatment In-Place, and Natural Attenuation.

Remedial Technology Evaluation Criteria

- Remedial objectives & goals
  - ❑ Protect health & environment
  - ❑ Compliance
- Effectiveness
  - ❑ Short- & long-term
  - ❑ Permanence
- Reduction
  - ❑ Toxicity / Mobility
  - ❑ Volume / Area
- Implementability
- Cost
- Acceptance
  - ☐ National level
  - ☐ State level
  - ☐ Local level

These criteria establish the basic requirements for selecting a remedial technique, approach, and design. However, more is required.

Examples of Remediating Risk

- ❑ ALCO Nott Street Site, Schenectady, NY—150 year old manufacturing site, redevelopment as remediation
- ❑ Bandelier NP, Los Alamos, NM—DDT, defining risk & the risk of remedy to cultural fabric
- ❑ PG&E Site, Hinkley, CA—Large hexavalent chromium plume, waste as a resource
- ❑ Former Apple Orchards, Marlborough, MA—Pesticide contamination, redesigning the risk

The assessment or characterization of risk as "harm" goes beyond just human health and the environment to include terms of socio-cultural health through various measures, for example:

➢Social/demographic indicators,

➢Historic/archaeological/ religious/cultural resources and landscapes,

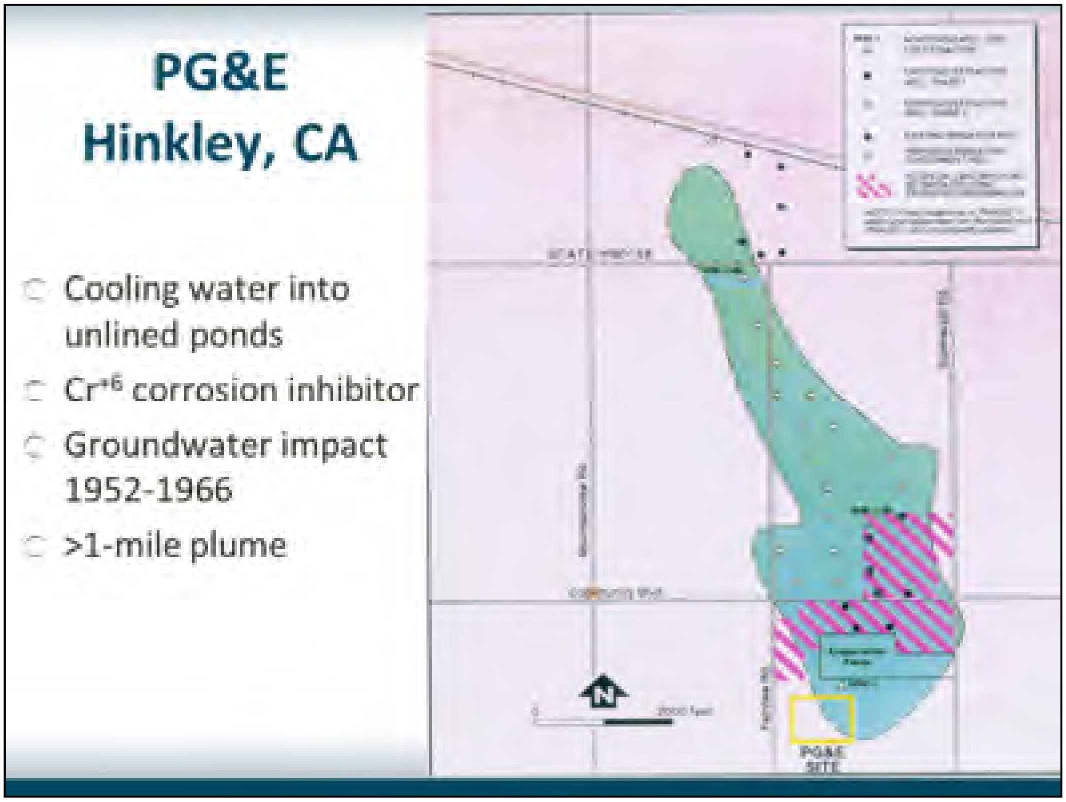
➢Employment and economic growth, and

➢Land use patterns and changes.

For example, I led a team that developed a three-dimensional analysis of a risk system involving the pesticide DDT at the Bandelier National Monument in New Mexico. This long-standing problem involved not only public health and ecological concerns, but implications to important historical and cultural aspects of the monument. This risk assessment considered the classical ecotoxicological and human health effects and evaluated the implications to the cultural/historical landscape, archaeological sites, and native and traditional cultural properties. The analysis aided the United States National Park Service in its discussion with state and federal environmental regulators and natural resource trustees in deciding what to do and how much. The analysis suggested that while the pesticide was present, it posed no current or future risks for humans (park rangers or visitors) or the important ecological resources present. Furthermore, the analysis provided an understanding of risk to the special cultural fabric of the monument, both from the DDT and from remedial measures. This assessment document served as a basis for the regulators, trustees, and the park service to develop an approach to discuss with other interested parties. The result was a successful resolution of the issue with minimal remediation, no harm to the cultural resources, and support of all parties.

From *Risk-Based Analysis for Environmental Managers*, 2001, Frantzen, ed., Lewis Pub., used with permission.

Hinkley, California had its groundwater contaminated with hexavalent chromium starting in 1952, the result from operations of a compressor station for natural gas transmission pipeline owned by PG&E. The hexavalent chromium in groundwater created the world's largest plume of this cancer-causing chemical.



Two-types of Chromium

Trivalent Chromium Cr^{+3}

- Common, stable, insoluble
- Low acute toxicity

Hexavalent Chromium Cr^{+6}

- Less common, reactive, soluble
- Carcinogenic

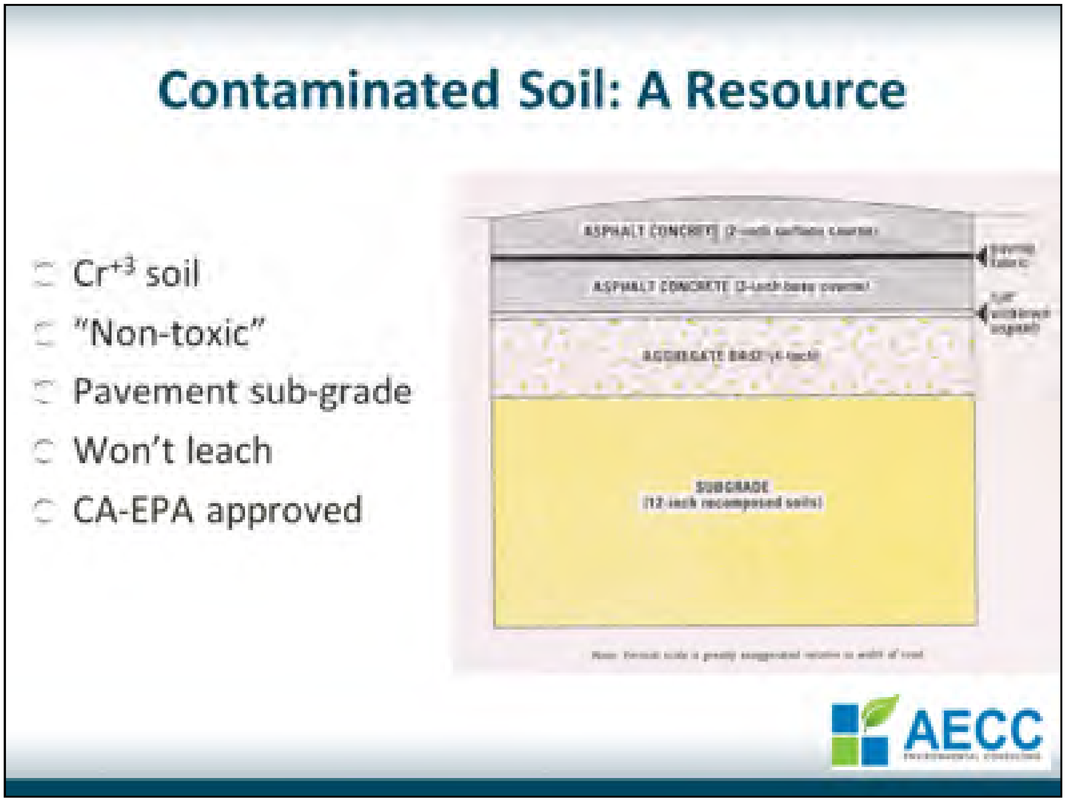
The two types convert via Reduction-Oxidation (Redox) reactions.

$$\text{Oxidant} + e^- \xrightarrow{\text{Reduction}} \text{Product}$$

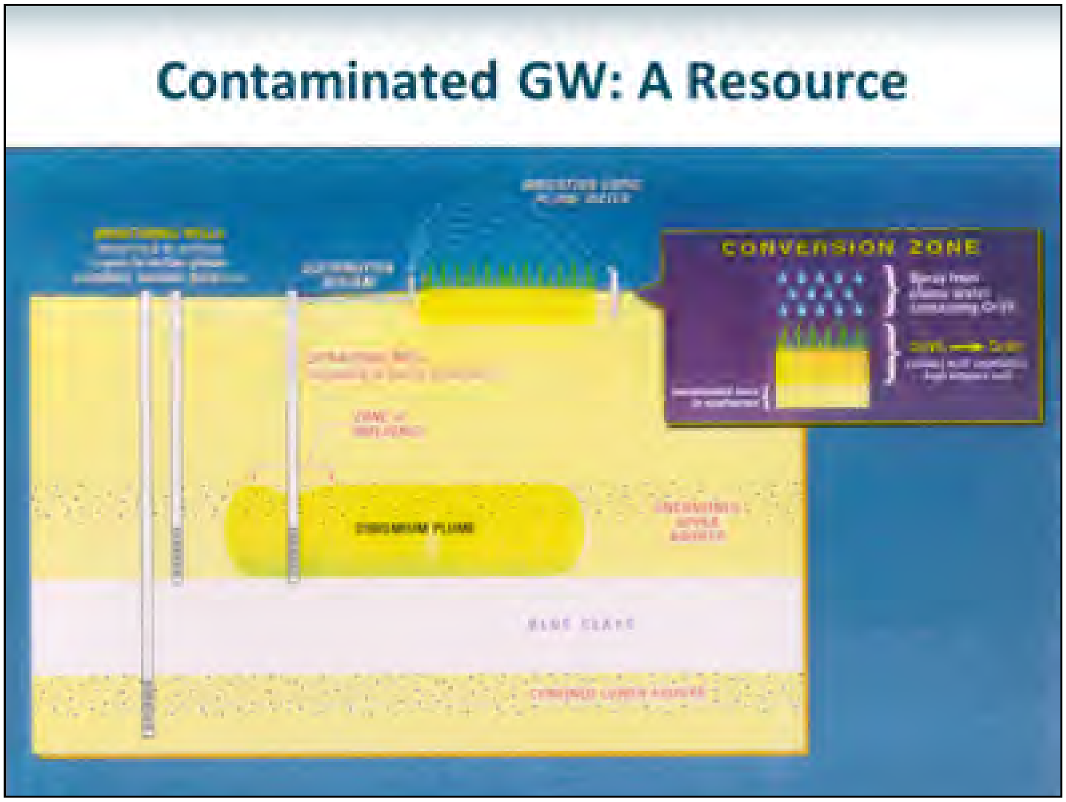
(Electrons **gained**; oxidation number **decreases**)

$$\text{Reductant} \xrightarrow{\text{Oxidation}} \text{Product} + e^-$$

(Electrons **lost**; oxidation number **increases**)



Soils heavily contaminated with Trivalent Chromium were re-used as sub-base underneath pavement for roadways in the immediate area.



Groundwater heavily contaminated with Hexavalent Chromium was extracted from the aquifer (approximately 30 meters below ground surface) and used as a source supply to local farmers to irrigate their alfalfa crops.

Marlborough, MA
Corporate Center Development

> Former orchard to retail, residential & office

> Soil contamination: Pb As DDT Dieldrin

> Exempt from Mass Contingency Plan [MCP], but must meet intent (protection)

> Some public resistance

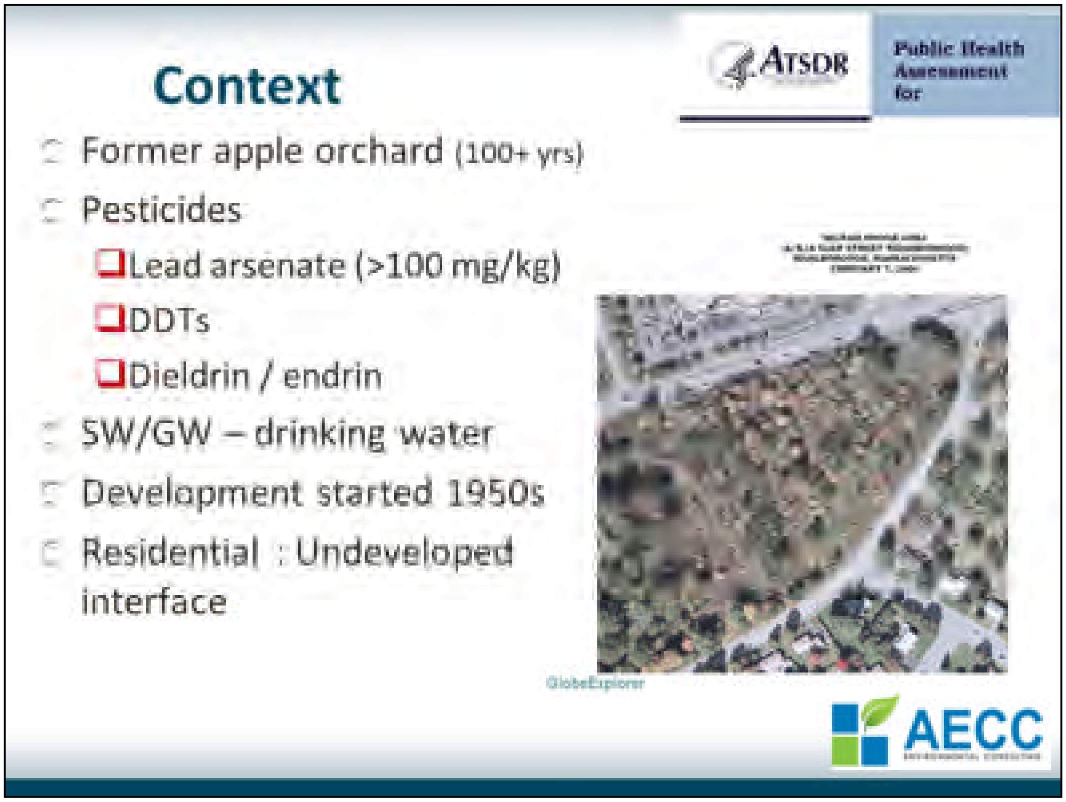
> How does one achieve permitting, overcome fear, be protective, and make money

Aerial view of site: Reservoir, Brook, Soil Storage Area

Note: > development sites: Beacon A, B….Commonwealth, Devonshire….Beacon Large

> activist house

> historical extent of orchards



Regulatory Requirements

Former agricultural property is exempt

Reality: do what you must to move forward

- Commitments & thresholds
- Vertical mixing / commercial land use soil standard
- Anti-degradation compliance
- Avoid appearance of waste
- Monitor to demonstrate compliance
- Pre- and post- assessments
  - Demonstrate change of state
  - Demonstrate end state

Approach

- Environmental Assessment
- Soil Management Plan
- Health & safety advisory
- Communication
- Construction Monitoring
- Post-construction Report

Photo series of remediation, construction, and redevelopment.

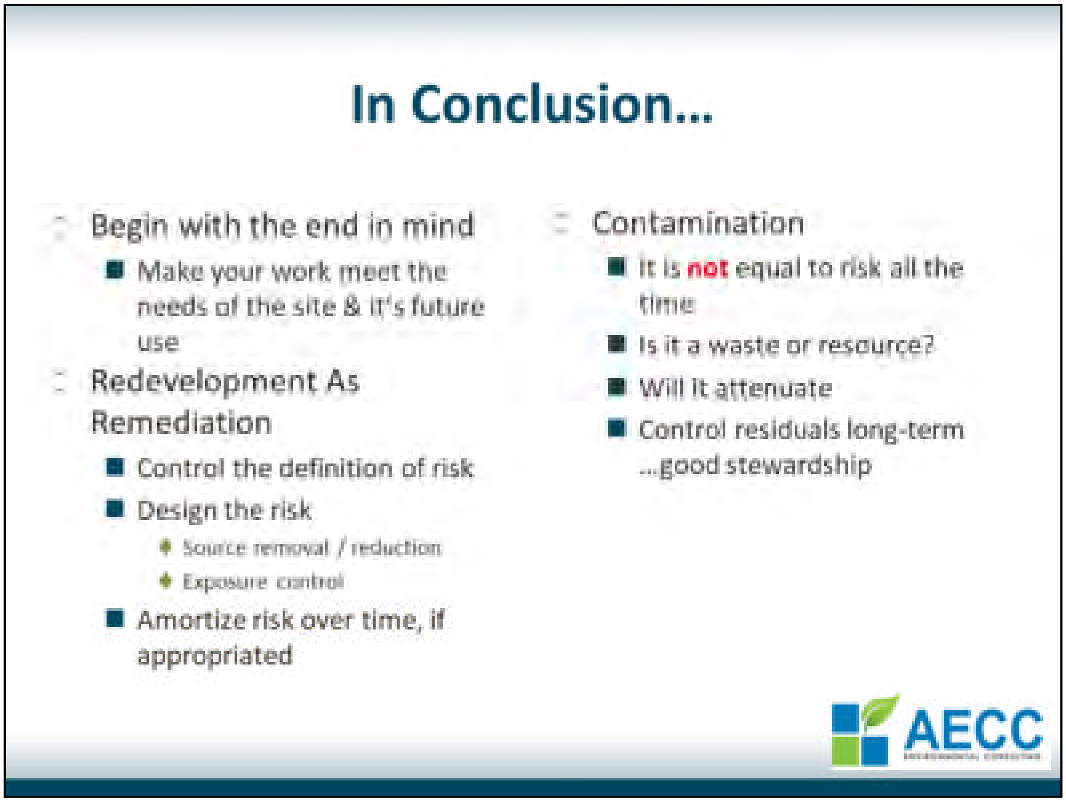
Construction occurred during the rainiest construction season in 10-years.

“Cleanup” achieved

We had on-site dust excursion of lead arsenate, but no off-site excursion, and only de minimis pesticide inhalation exposure.

Neighbors eat, drink, & work here

Before (2005) and after (2009) photos of the apple orchard redevelopment site located in Marlborough, Massachusetts (MA) USA.



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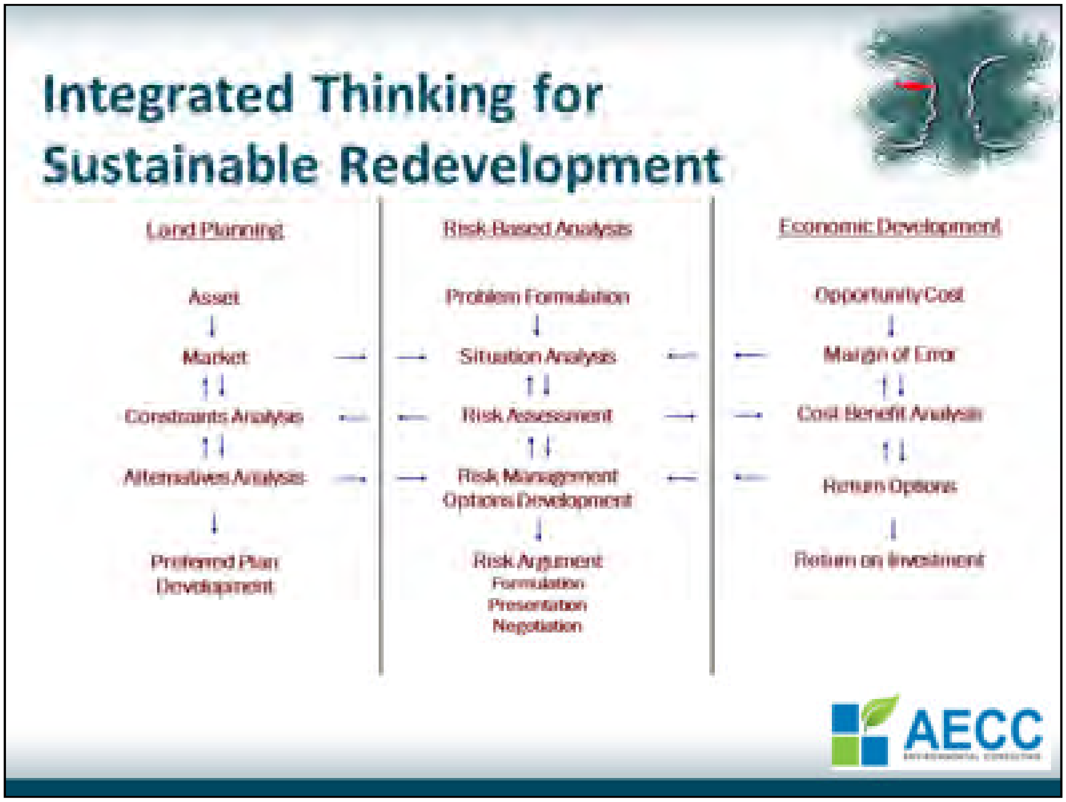

Working toward a sustainable urban-industrial landscape requires creating value beyond the apparent reality. To achieve this goal means addressing very complex issues, requiring sophisticated strategies that combine environmental and economic models to enable successful outcomes. The basis for these models lies in the use analysis for the property (which considers environmental risk as a constraint) and the property's impact on the surrounding vicinity (including the environment, people, and culture). This use analysis is dynamic and must consider stakeholder interests in correlation with reasonable adaptive use options. As a point of reference, turning a former factory site into a park has a total different set of economic and environmental influences if the site is in the middle of a residential neighborhood versus an industrial zone.

The hard work comes when applying Risk-Based Analysis to a project-specific opportunity. With genuine commitment from allied stakeholders, it really is possible to reap the future from the past (i.e., sustainable economic, environmental, and social benefits created from a former industrial property with environmental impairment and stigma). Government, communities, and businesses can realize gains through loss (i.e., repositioning a negative economic component of a property to derive positive value). Using an environmental–economic model, one can ascribe a monetary value for each step of the site cleanup and reuse process, starting with site identification and review. Following an analysis to define and scope (formulate) the problem and create an integrated strategy, one formulates a baseline from which the financial profile and parameters for project success are determined. At each remaining step in the process, value rises above the baseline. The more value created, the more a sustainable urban-industrial landscape vision takes hold.

>>Adapted from Chapter 4 The Practice of Risk-Based Analysis by KA Frantzen, C Williams, J Vangalio, and J Ackerman IN *Risk-Based Analysis for Environmental Managers* (KA Frantzen, editor, CRC Press/Boca Raton, FL, 250pp)