Worker exposure to TCE in drinking water: Proposed follow-up activities at the View-Master Toy Factory in Beaverton, Oregon
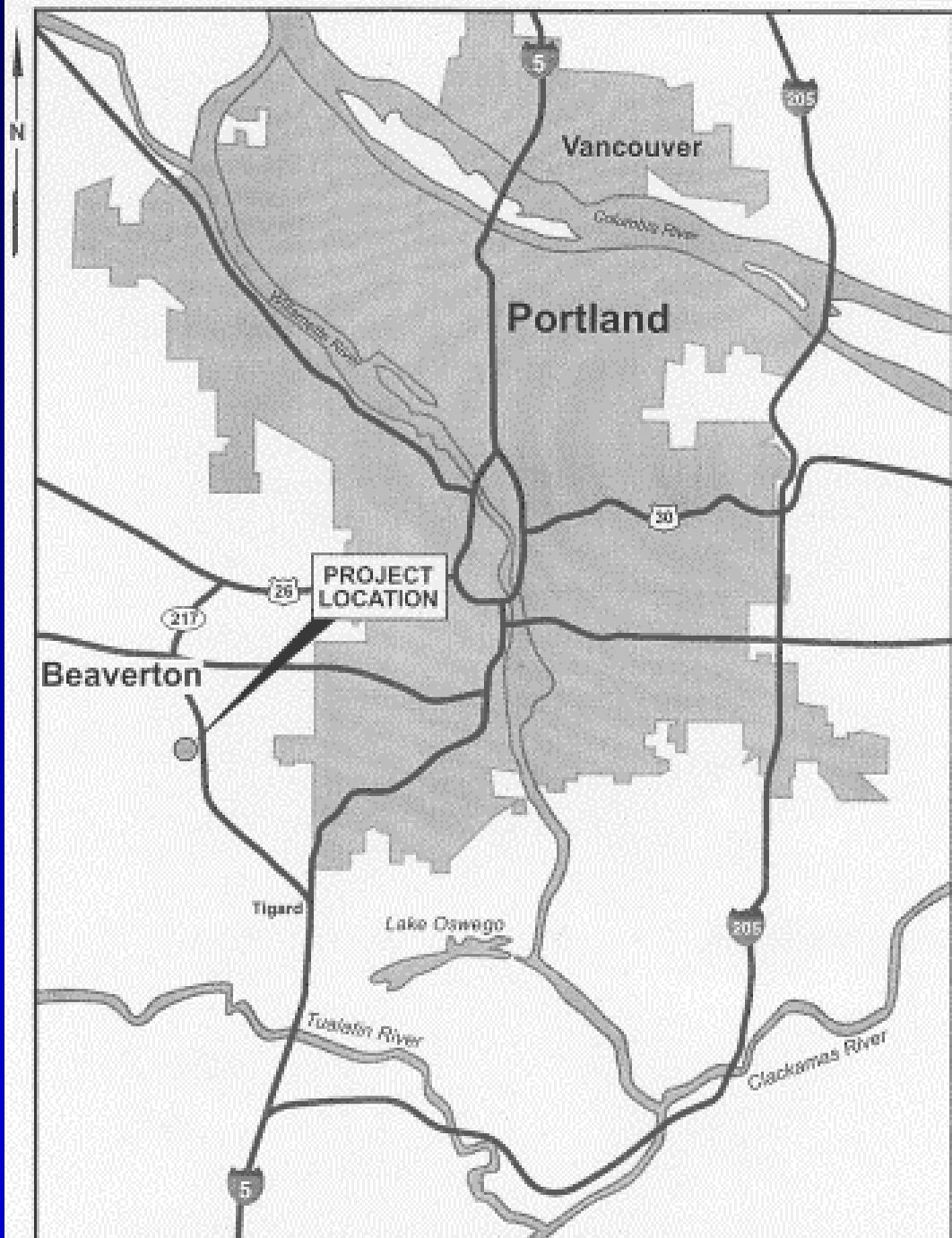
Oregon Department of Human Services (ODHS)

Michael Heumann, MPH, MA

Michele Freeman, MPH

ATSDR

Morris Maslia, PE

Trichloroethylene (TCE)

- **Used as a metal degreaser, 1952-1980**
- **Dumped on-site from 1950s till 1970s**
- **Chemical accidents with TCE**
  - TCE spills allegedly occurred in paint shop
  - Chemical fire of degreaser system in 1969

Outcomes associated with TCE

Cancers

Kidney

Liver

NH Lymphoma

Hodgkin's disease

Multiple myeloma

Cervix uteri

Non-cancer outcomes

Hepatotoxicity

Nephrotoxicity

Neurotoxicity

Reproductive

Immuno/hemato-poietic toxicity

Endocrine

Genotoxic effects

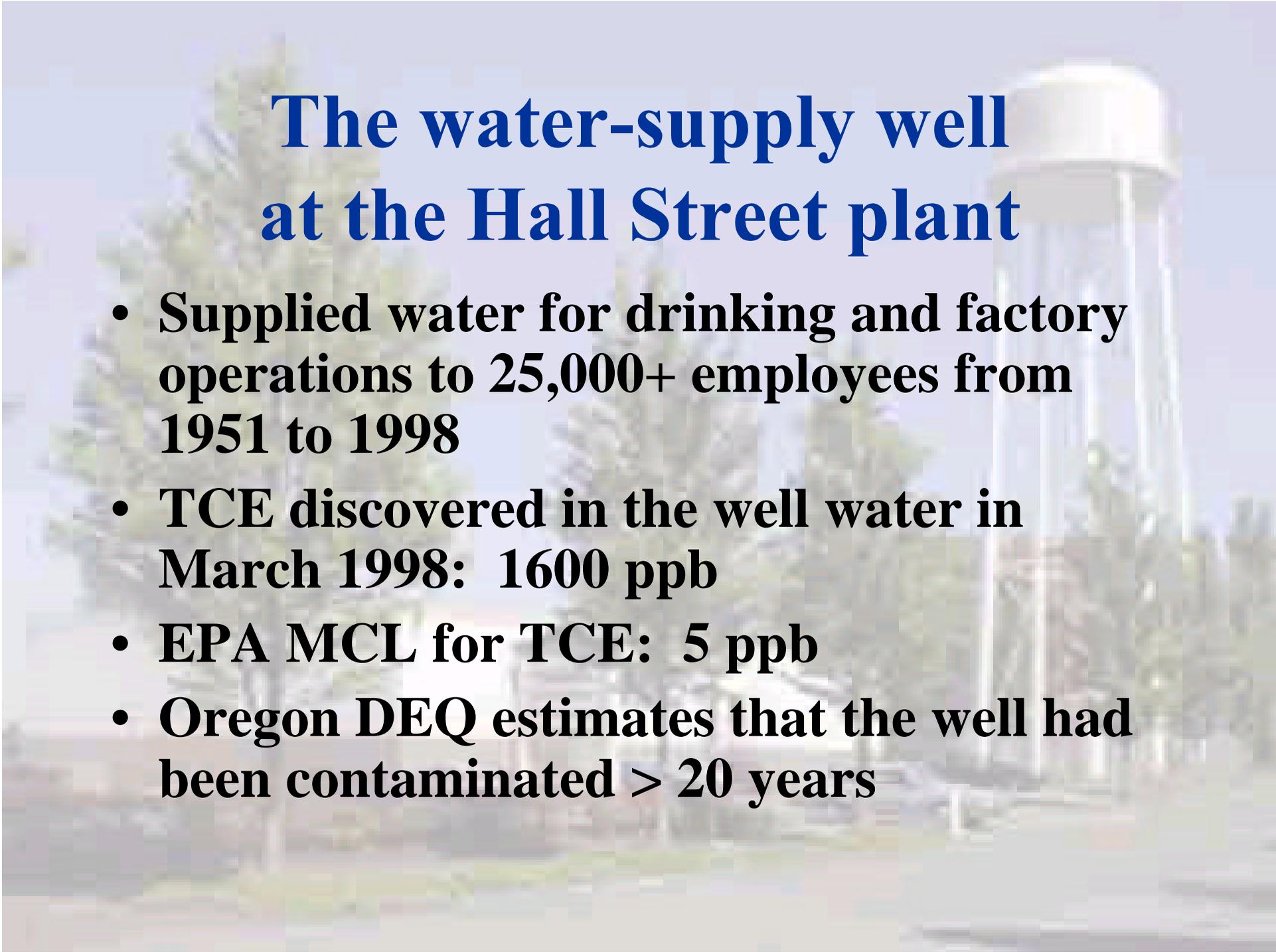**Developmental/ child health effects**

Cardiac anomalies

Cleft palates

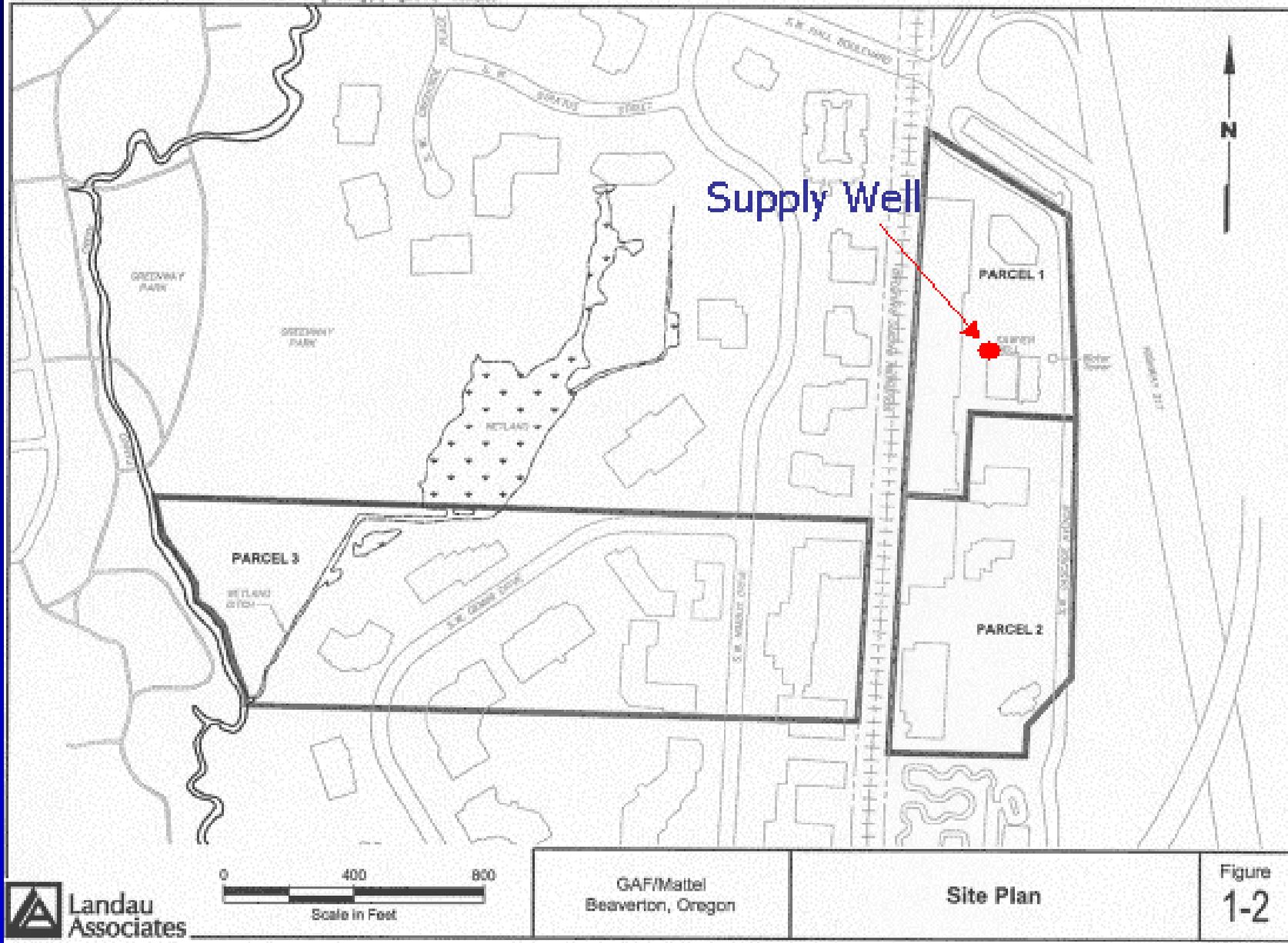Neural tube defects

Eye & ear anomalies

Low birthweight

Developmental disabilities

Childhood leukemia

The water-supply well at the Hall Street plant

- Supplied water for drinking and factory operations to 25,000+ employees from 1951 to 1998
- TCE discovered in the well water in March 1998: 1600 ppb
- EPA MCL for TCE: 5 ppb
- Oregon DEQ estimates that the well had been contaminated > 20 years

GAF/Phase 2 RI Report |T:\5301801640\PHASE II RI\Fig1-2.dwg |A| "Figure 1-2" 11/03/2000

Supply Well

PARCEL 1

GREENWAY PARK

GREENWAY PARK

WETLAND

PARCEL 3

WETLAND DITCH

PARCEL 2

N

0   400   800
Scale in Feet

Landau Associates

GAF/Mattel
Beaverton, Oregon

Site Plan

Figure
1-2

ATSDR

DHS

Volatile organic compounds in the View-Master well (ppb)

Sample date	TCE	cis-1,2-DCE	PCE
03/16/1998	1220	15.2	34.5
03/24/1998	1520	20.5	56.0
03/24/1998	1390	33.0	42.3
03/26/1998	1460	14.1	38.2
03/26/1998	1670	14.7	42.4
MCL*	5	70	5

*U.S. Environmental Protection Agency Drinking Water Standards

ATSDR

DHS

The Health Evaluation

- **Oregon DHS (ODHS) received a cooperative agreement from ATSDR, Sept 2001**
- **Primary Objectives**
  - Develop methods to assess exposure and health outcomes
  - Reconstruct historical cohort

ATSDR

DHS

Importance of the study

- **Respond to community concerns**
- **Unique opportunity for public health response**
  - Confined nature of the exposure
  - "Clean" exposure (single compound)
  - High levels of TCE
  - Large number of people exposed
  - Specific exposure route: direct ingestion
  - Lengthy exposure and follow-up time

ATSDR

DHS

Proposed Public Health Response Plan

Objective: determine standardized incidence and mortality ratios for selected health outcomes

Reference group: general Oregon population

Components:

Mortality Study

Interview Study

Cancer Study

Estimation of Human Exposure

- **Fate and transport analyses**
  - Determine start of aquifer contamination
  - Determine temporal and spatial distribution of TCE
- **Frequency and duration of human contact**
  - Date of hire, years of employment
  - Drinking water consumption
  - Direct dermal contact with the degreasing solvent

ATSDR

DHS

Timeline of factory operation, TCE release, & groundwater contamination

1950	1960	1970	1980	1990	2000

Sawyer's, Inc. | **GAF** | **View-Master** | **Tyco Toys** | **Mattel**

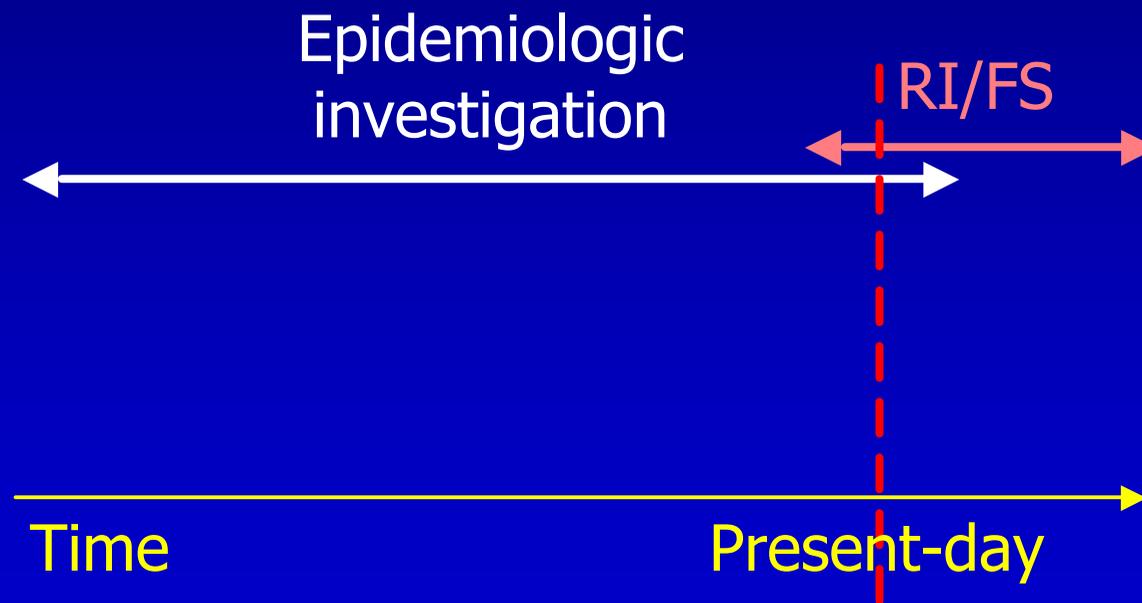**TCE discharged on factory grounds** | **TCE recycled** | **TCE use discontinued**

TCE reaches well (ODEQ)   TCE discovered

ATSDR

DHS

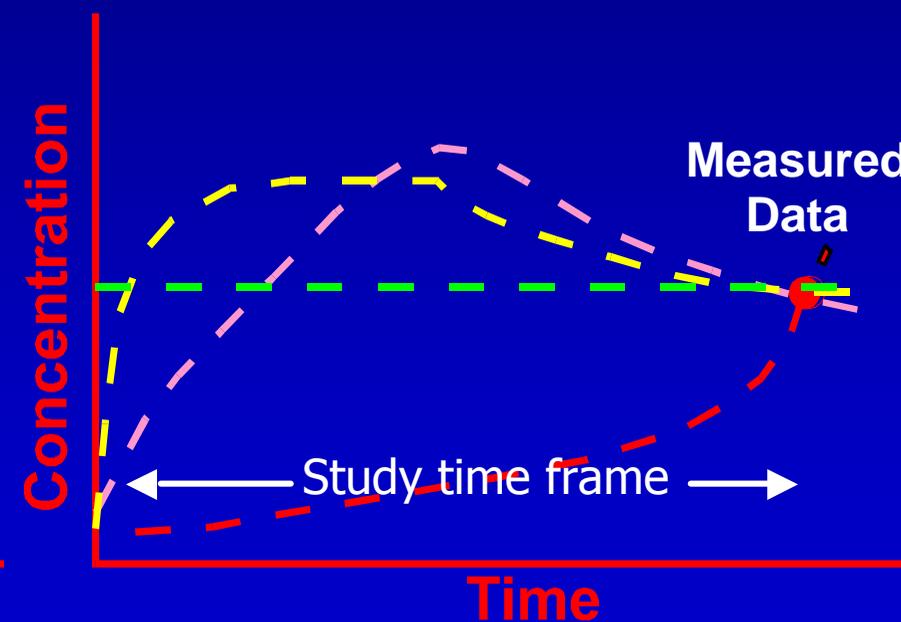# Relationship of epidemiologic investigations to remediation activities

Epidemiologic investigation

RI/FS

Time

Present-day

ATSDR
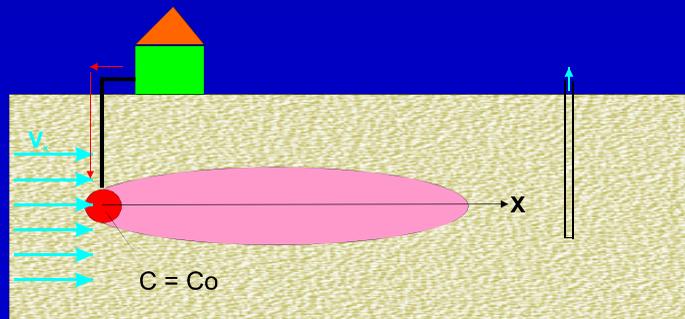
DHS
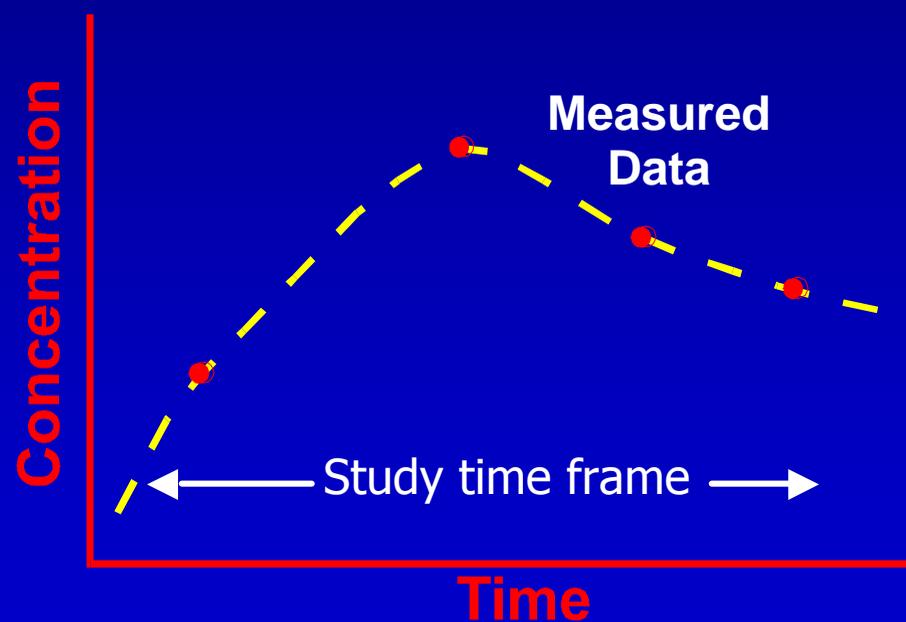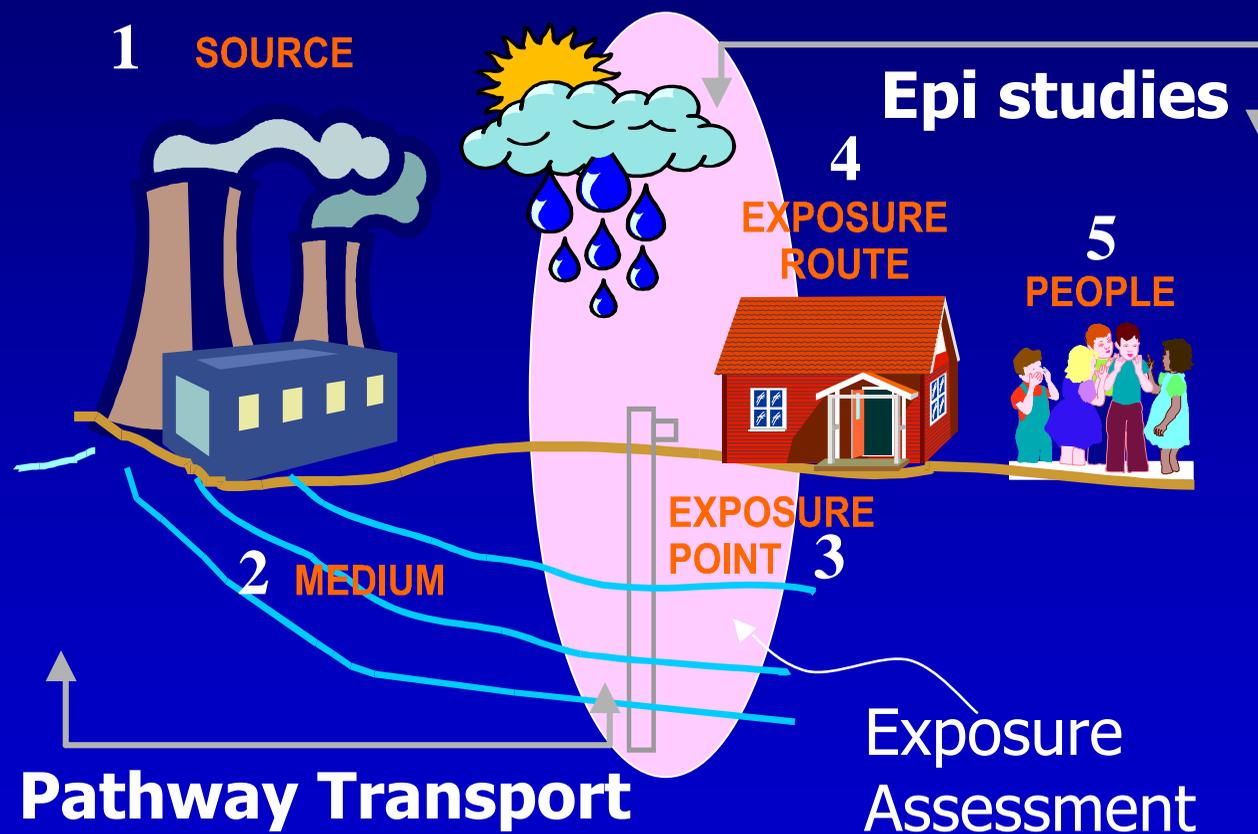
ATSDR philosophy on use of models

- Models (computational tools) are a critical component of human exposure assessment and should be used in support of public health decision making when data are limited, unavailable, or nonexistent

- Models allow ATSDR's scientists and engineers to propose, consider, and **test** a variety of exposure scenarios and hypotheses

- ATSDR **does not** use models to assign guilt to, or provide vindication for, site stakeholders

Model applications

- **Screening-level analysis**
  - Simplified (analytical) models
  - Used to help identify key focus areas or parameters of importance

- **Detailed evaluations**
  - Used to improve understanding of the functioning of real systems - Complex environmental systems

- **Assessment and decision making**
  - Used as tools for decision making and regulatory compliance – Uncertainty analysis (Monte Carlo)

Generalized approach for modeling at View-Master site

- Characterize aquifer properties using "present-day" information
- Reconstruct temporal and spatial distributions of TCE based on "estimated" or "synthesized" supply-well operations
- Will need to use three-dimensional numerical groundwater flow and transport code (calibration and simulation)

What "value added" benefit could modeling contribute?

- **Possible results of modeling**
  - Estimate/confirmation of historical supply-well operation
  - Estimate/confirmation of source concentration
  - Estimate of exposure length
  - Estimate of exposure concentration through time

- **Importance of results**
  - Might allow division of employees into sub-cohorts based on exposure
  - Potentially more sensitive epidemiologic analysis

The Cohort

- **Methods for reconstructing the population of former workers of the View-Master factory**

- **Preliminary review of mortality**

Succession of Employers at the Hall Street Factory

CORPORATION	IRS	YEARS
Sawyer's, Inc	GAF Period	1951 to 1967
GAF		1967 to May 1981
View-Master	Mattel Period	June 1981 to 1989
Tyco Toys		1989 to 1997
Matchbox Collectibles (Tyco & Mattel)		1997
Mattel		1997 to 1998

List of 13,700 employees

- **Provides names, SSNs, and limited address information**

- **Contains incomplete information on hire and termination dates**

- **Mattel asserts that the list of names is complete for Mattel period (1981-1998). N=6,841**

- **List contains 6,856 names from GAF period (1951-1981) but this period is known to be incomplete.**

Number of employees per year
at the Hall Street View-Master plant
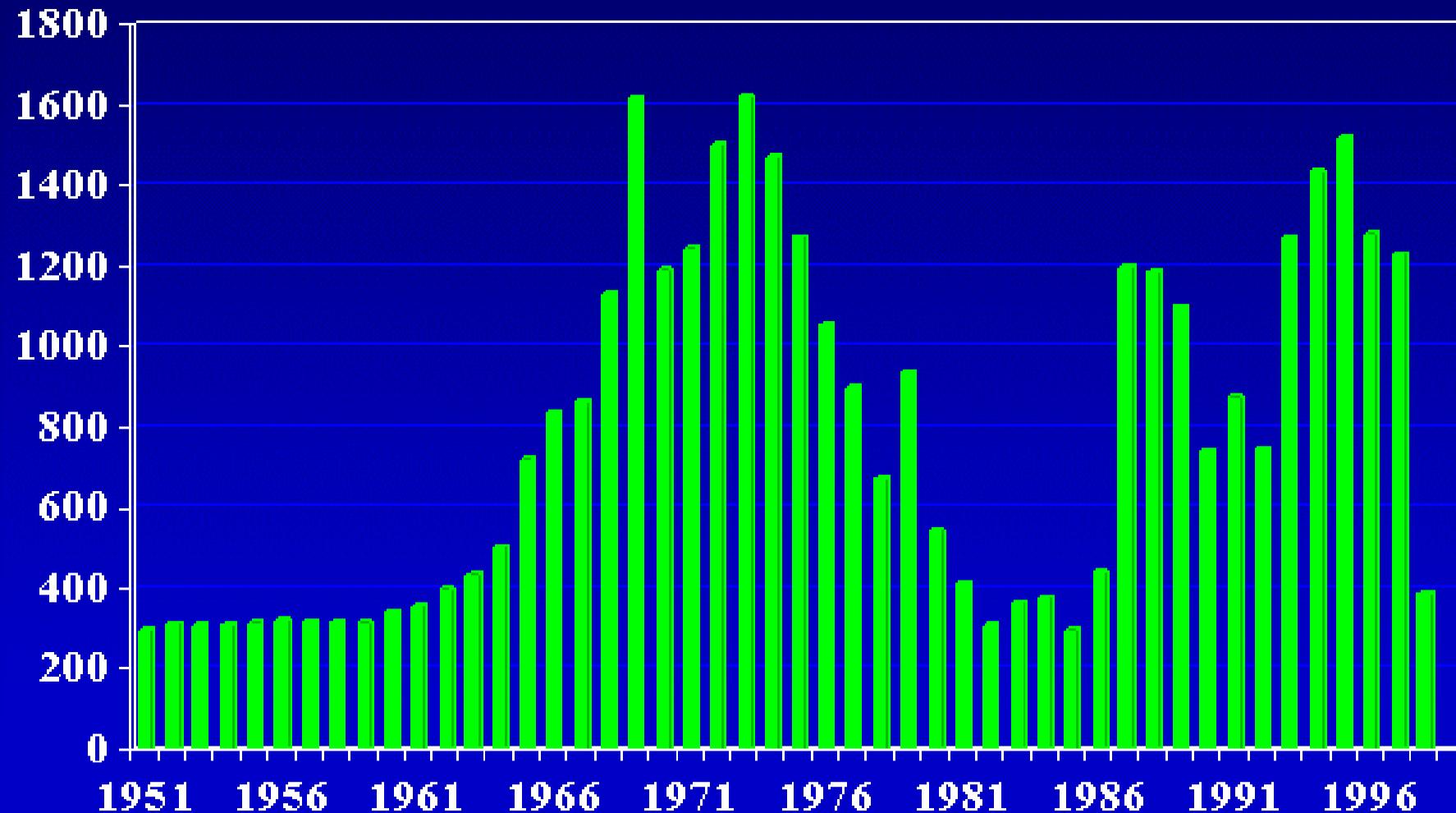
Number of factory workers by year & final employer
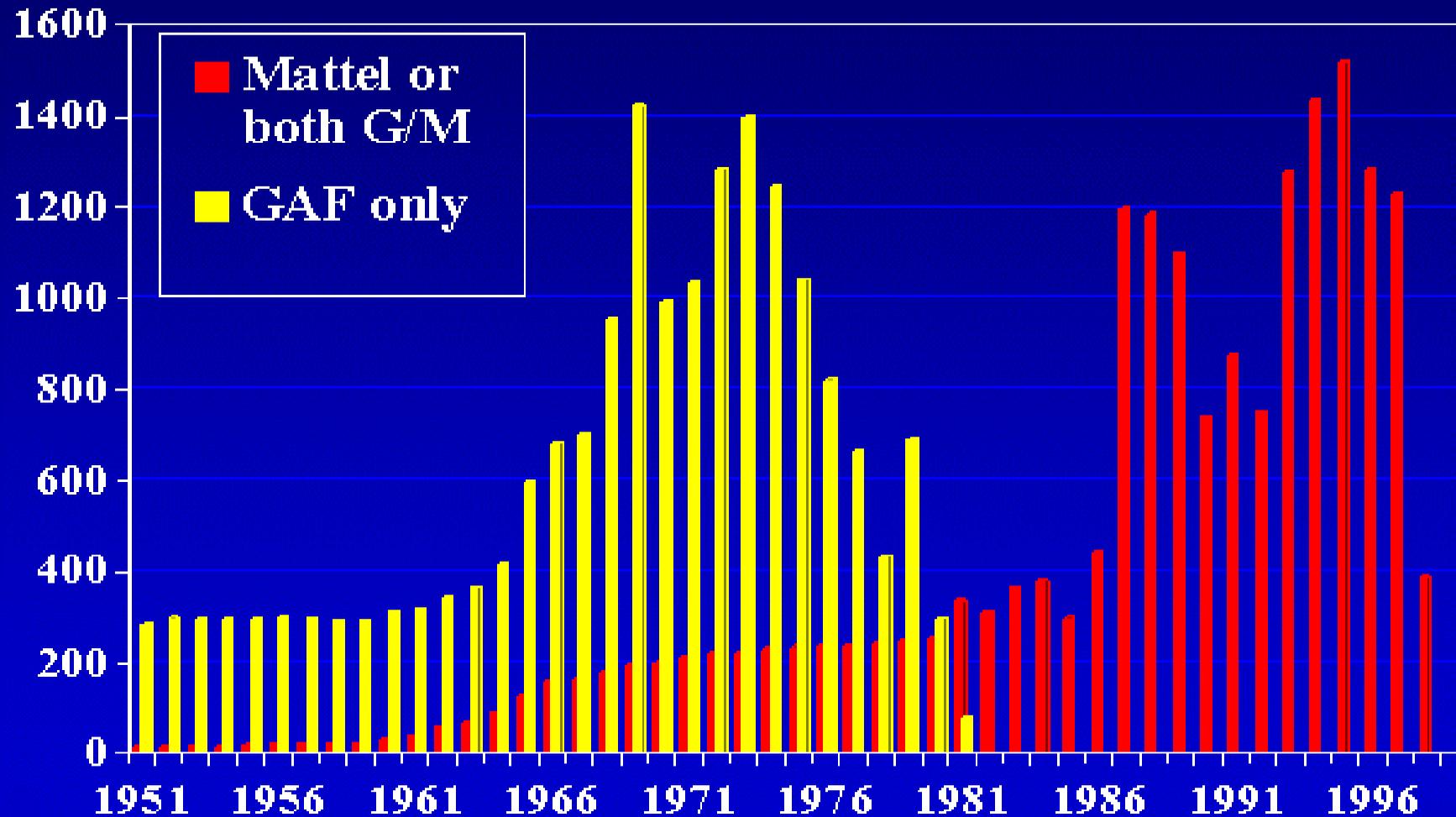
The GAF cohort (1951-1981) N 6,856
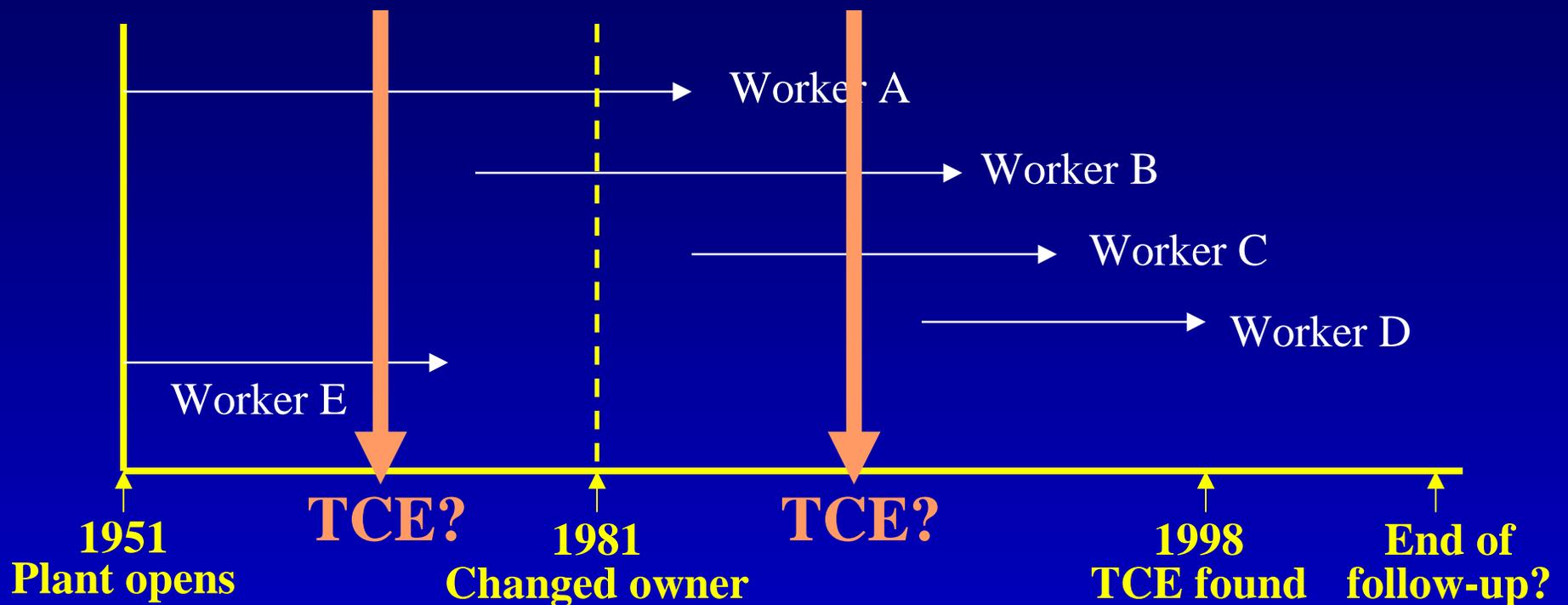
- **Cohort is incomplete; % missing is unknown**
- **Is the GAF list a representative sample?**
- **GAF cohort can potentially be confirmed by IRS archives**
  - Quarterly reports use employer's federal tax ID.
  - GAF used the same federal tax ID for >200 sites.
  - IRS requires employer's authorization to release tax records.
  - GAF refuses to assist DHS, citing bankruptcy.

Sub-cohort analyses

Worker A

Worker B

Worker C

Worker D

Worker E

TCE? **TCE?**

1951
Plant opens

1981
Changed owner

1998
TCE found

End of
follow-up?

GAF **MATTEL**

Large but incomplete
cohort: 6,856

Potentially complete
cohort: 6,841

Review of mortality data

- ATSDR linked the employee list with the National Death Index (NDI).

- The NDI search identified 973 deaths, 1952-2001. ODHS found 63 additional deaths in Oregon, 2001-2002.

- ODHS conducted a preliminary analysis of the death data for the years 1995-2001.

- Examined outcomes linked to TCE exposure: cancers of the liver, pancreas, kidney, blood, and lymphatic system.

Proportions of deaths due to selected causes among View-Master workers, 1995-2001

CAUSE OF DEATH	View-Master %[a]	Oregon %[b]	Crude PMR[c]
Kidney cancer	1.53	0.53	2.88
Liver cancer	0	0.71	–--
Lympho/hematopoietic cancers	1.74	2.20	0.79
Pancreatic cancer	2.61	1.24	2.10

[a] Percent, attributed to selected cause, of deaths among View-Master workers
[b] Percent, attributed to selected cause, of all deaths in Oregon
[c] Crude proportional mortality ratio = %VM / %OR

ATSDR

DHS

Limitations

- **Exposure information is lacking**
  - No information about individual exposure
  - Single point concentration of TCE, March 1998
- **Former workers may not be comparable to general Oregon population with respect to other risk factors for disease**
- **Information on the population at risk (years of follow-up, person time at risk) is not available.**

Case-control approach to analyzing proportional mortality

(Miettinen and Wang, 1981)

Cases: Deaths due to cause of interest

Controls: Deaths from reference cause

(presumed to be unrelated to exposure)

Exposed: Former View-Master factory workers

Unexposed:General population of Oregon

Conclusions

- **The contamination in the View-Master well constitutes a past public health hazard.**
- **Preliminary review of mortality revealed proportional excesses of kidney cancer and pancreatic cancer.**
- **More thorough investigation of the impact of this hazard on the local community is needed.**
  + Historical reconstruction analysis
  + Health evaluation interview
  + Cancer incidence analysis