Today decides tomorrow!!!

Environmental Issues of Waste Tires in Civil Engineering

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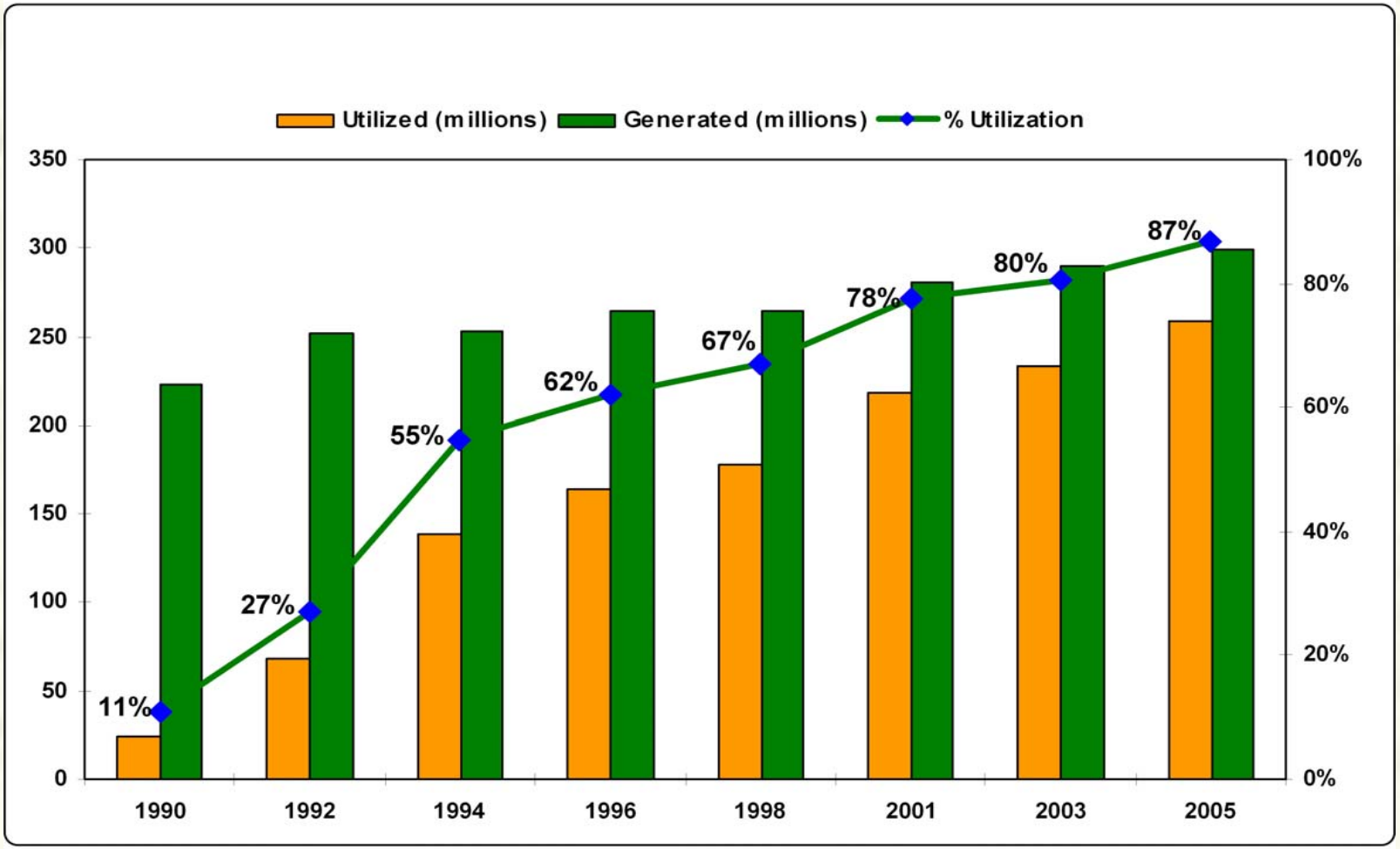
Outlines

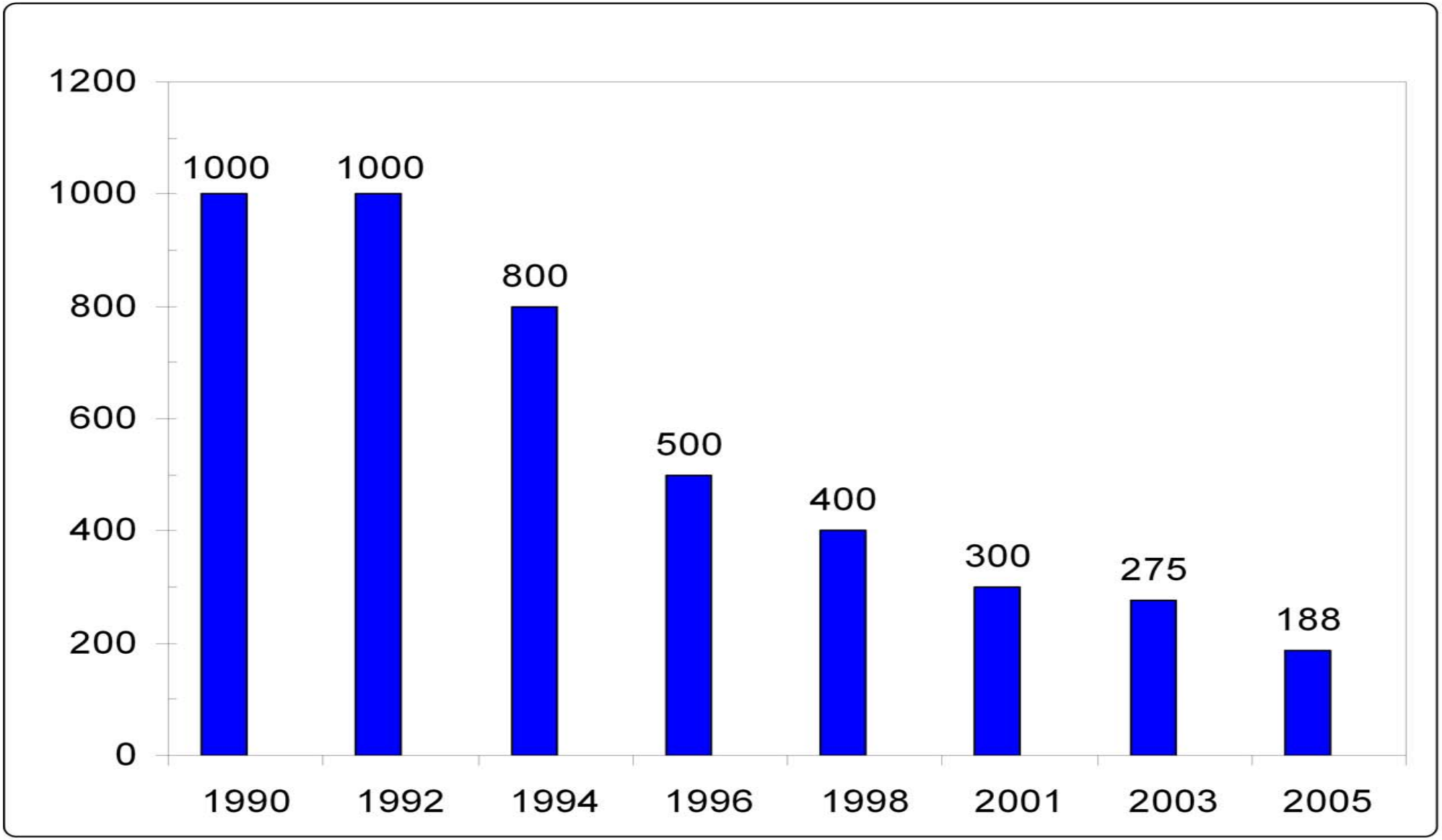
- Introduction
  - Stockpiles
  - Tire Fires
- Waste Tire CE Applications
- Environmental Assessment Research
  - Lab Evaluations
  - Field Tests
- Conclusions and Recommendations

Background

U.S. Scrap Tire Management Trends, 1990 - 2005



Millions of Scrap Tires Remaining in U.S. Stockpiles, 1990 - 2005



Tire fires are an environmental nightmare

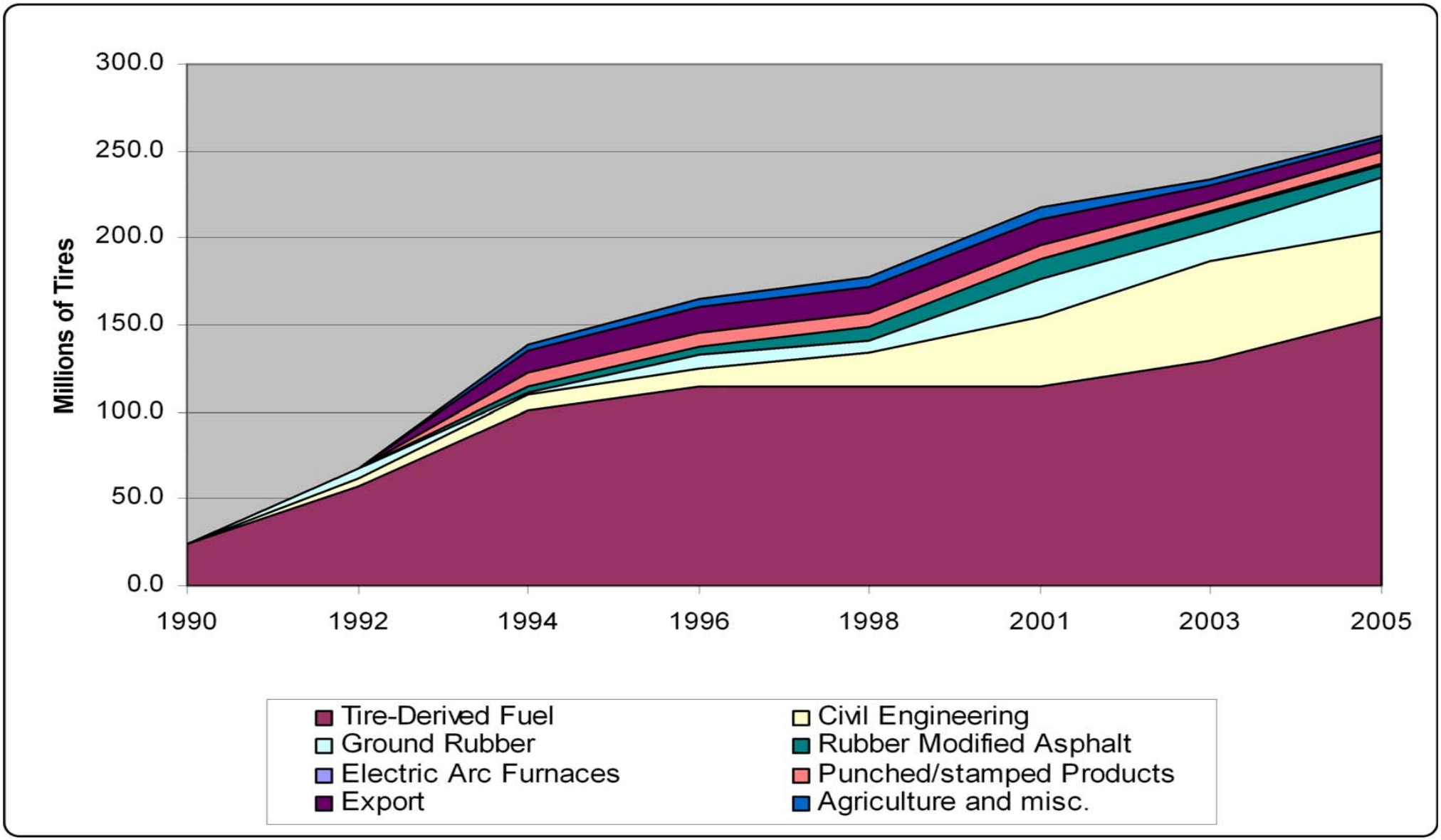

Tire Fires
The energy content of an average passenger car tire is the equivalent of over 2 gallons of oil


Tire Fire in Westley, CA burned three months,
Took seven years to clean up,
Cost about 20 millions dollars.

Toxins Released During Tire Fires

- Tire fires release heavy metals and other hazardous compounds that run into streams and seep into shallow wells
  - Arsenic
  - Chromium
  - Lead
  - Manganese
  - Nickel
  - Mercury
  - Cadmium
  - Pyrolytic Oil

U.S. Scrap Tire Market Trends, 1990-2005



Properties of TDA in Civil Engineering Applications

Size	*2 to 12 inches*
Weight	*1/3 to 1/2 weight of soil*
Volume	*1 cubic yard ≈75 tires*
Drainage	*10 times better than well graded soil*
Insulation	*8 times better than gravel*
Lateral Foundation Wall Pressure	*1/2 that of soil*

Civil Engineering Applications

- Lightweight Fill
- Retaining Wall Back Fill
- Embankment Fill and Slope Repairs
- Subgrade Insulation Layer
- Landfill Applications
- Septic System Drain Field
- Vibration Damping

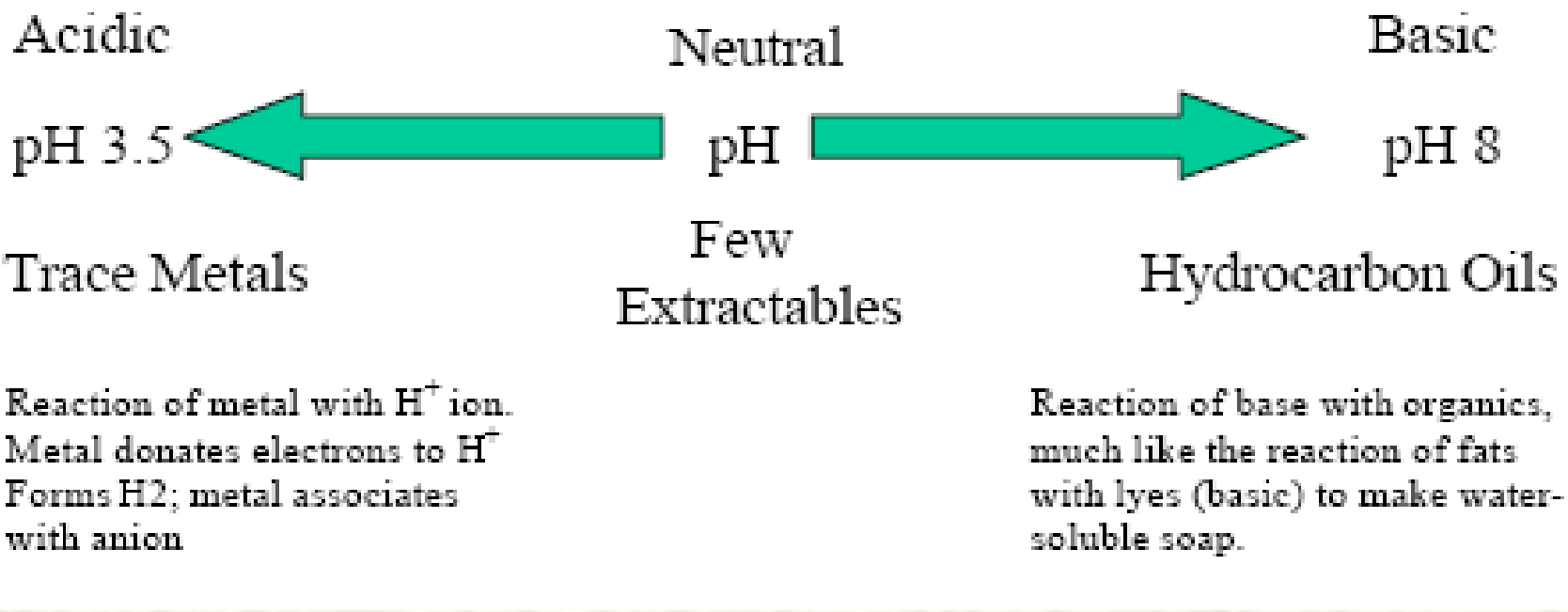
Environmental Concerns of CE Applications

- Groundwater Contamination
- Fire Hazard
- Long Term Performance
- Lab Test Results
- Field Test Results

Lab Testing on Tire Leaches

- Toxicity Characterization Leaching Procedure (TCLP)
- Extraction Procedure Toxicity (EP Tox)
- Scrap tires are usually pre-cut into a designated dimension and submerged into different solutions, then the leachate is analyzed
- Lab tests can be used as an indicator of the types of contaminants that a scrap tire may produce

Minnesota Pollution Control Agency



Results of the Study

- None of the laboratory leachate samples exceed the EP toxicity criteria or the TCLP criteria
- For some samples and some leaching conditions, arsenic, cadmium, chromium, selenium, and zinc exceeded the Recommended Allowable Limits (RALs) set by the Minnesota Department of Health for drinking water

Recommendation From the Study

- The study recommended that use of scrap tires in roadway construction be limited to the unsaturated zone
- The roadway design should limit infiltration of water through the scrap tires and should promote surface water drainage away from the scrap tire subgrade

Virginia Department of Transportation Final Report on Leachable Metals in Scrap Tires

- The study consisted of two parts: one-year leaching and TCLP testing
- Leaching for two weeks results in a leachate that is approximately seven times more concentrated than usual TCLP extracts
- However, the stronger leach may be wholly or partially offset by the use of larger particles than the method calls for
- The concentrations of metals in the leachate were well below the TCLP regulatory limits

Illinois Department of Energy and Natural Resources Study

- Shredded tires were subjected to EP toxicity testing by DTC Laboratories Inc.
- In their results, levels of the organic compounds analyzed were below the detection limits in all cases
- None of the metals were above the EP toxicity limits for the EP TOX test

Conclusions from Lab Tests

- All lab results with various leaching conditions showed that higher concentrations of metals tend to appear at lower pH (acidic) conditions
- Higher levels of organics appear under high pH (basic) conditions
- Both the metallic components and the organics were well below the TCLP standards and the EP standards
- In total, these laboratory tests indicate scrap tires are not a hazardous waste.

Field Studies

- Scrap tires cut into various sizes, were used in designated positions in the road
- The soil and water were sampled at various times
- Studied the impact of scrap tires on the environment

Field Studies for Scrap Tire Applications

- **Impact on Air**
  - **Releases volatile and semi-volatile organic compounds (VOC and SVOC) when hot**
  - **However, similar or less than that of asphalt**
  - **Slows down once the asphalt-rubber cools to the service temperature**
  - **Latex allergens may also be released from tire chips, but it should be a manageable amount**

Impact on Soil

Minnesota Pollution Control Agency (1991)

- **Field studies did not identify significant differences between waste tire areas and control areas for soil samples and for a biological survey**
- **No evidence was reported of the extractables found in previous laboratory tests under extreme pH conditions**

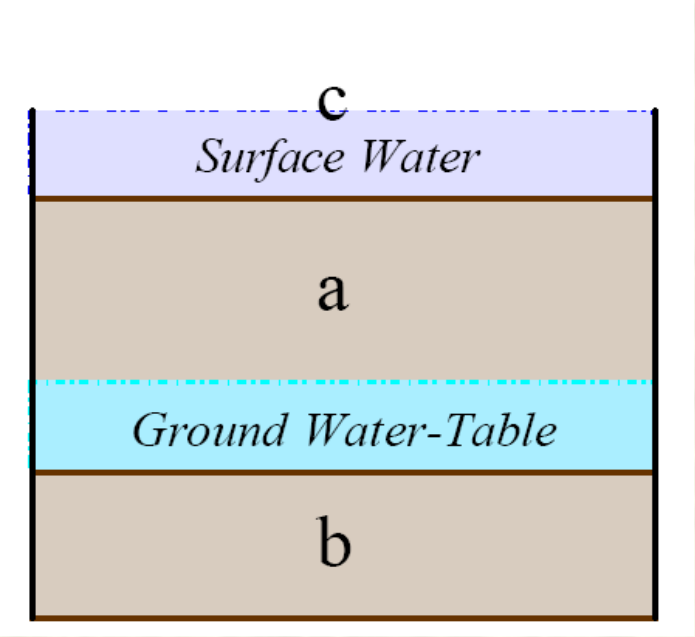
Impact on Soil

Department of Geology, Kent State University (1997)

- **Soil-tire mixtures can be safely used as a light-weight fill material and in situations where improvement in drainage characteristics is required**

Impact on Water

- **When considering the impact of scrap tires on water, three locations for the tire chips are traditionally considered.**



- **a: above ground water table**
- **b: below ground water table**
- **c: surface water**

Above Groundwater Table

Wisconsin Department of Transportation Study

- **There is little or no likelihood of significant leaching of tire chips for substances that are of specific public health concern, such as lead or barium**
- **The lead, zinc, and manganese levels were elevated**

Above Groundwater Table

Chenette Engineering, Inc.

- **Shredded tires were installed in place of crushed stone in a replacement on-site disposal system**
- **This system was installed in December 1991 and a two-year follow-up was reported on in 1993**
- **As anticipated, iron and lead started out at elevated levels; both metal concentrations quickly dropped below Vermont groundwater standards**

Above Groundwater Table

University of Maine (1997)

- **Better monitored by control wells**
- **There was no evidence that tire chips increased the level of substances above the primary drinking water standard**
- **There was no evidence that tire chips increased the levels of aluminum, zinc, chloride or sulfate, which are included in the secondary (aesthetic) drinking water standards**
- **Iron and magnesium may exceed their secondary standards under some cases**
- **Results were below the detection limit for all compounds**

Below Groundwater Table

- Increased the iron concentration at three test sites
- Within the tire chip trench, iron content was up to two orders of magnitude higher than the secondary drinking water standard
- The iron did not appear to have migrated downward at any of the sites

Below Groundwater Table

- Manganese content was also increased by the tire chips
- Manganese levels consistently exceeded the secondary drinking water standard in the test well within the tire chip trench
- Unlike iron, the manganese was observed to migrate downwards with groundwater flow

Below Groundwater Table

- Zinc content was also increased by the tire chip installations, however, the concentration was well below the drinking water standard
- Chromium concentrations were increased by the tire chips, but only at the peat site
  - The chromium levels were all below the primary drinking water standard

Conclusions on Groundwater Contamination

- Iron levels exceeded the Recommended Allowable Level (RAL). However, considering that iron is a secondary allowable drinking water element, it does not pose severe problems to the environment
- Among other metallic and organic compounds, there seems to be some disagreement; it may depend on the local soil pH conditions, the water infiltration conditions, and other pedological factors
- A maximum allowable steel content for recycled tire rubber should be established

Biological Survey

Minnesota Pollution Control Agency Biological Surveys (1990)

- **No observable difference in either of the study areas when compared to the control areas**
- **Toxicity Characteristics Tests (TCT) concluded that future biological surveys would likely indicate no observable differences at tire sites when compared to background sites**

Toxicity Survey

- Abernethy (1994)
  - Zinc levels were found to be 0.023~0.025 mg/L, which is consistent with the chemical makeup of tires
- Nelson (1994)
  - Zinc was found to be present at potentially toxic levels
  - Cadmium, copper and lead were also present at levels significantly above background sites

Conclusions

- Generally, recycled rubber derived from scrap tires is a safe recyclable material
- A common concern is that the Fe and Mn levels are often elevated. These elements are specified in the secondary drinking water standard based on aesthetic reasons (taste)
- Levels of metallic contaminants tend to increase under low pH values, while the level of organic compounds increases under high pH value

Recommendations

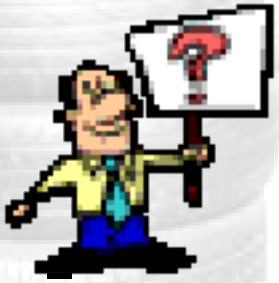
- Generally, reasonable to recommend use of recycled scrap tires in civil engineering applications
- It is important to recognize that the impact of scrap tires on the environment varies according to the local water and soil conditions, especially pH values

Environmental Benefits of Waste Tire Applications

- Prevents pollution and waste generation
- Saves money through prevention of waste tire disposal
- Creates new recycling industries
- Reduces landfill disposal and expansion

Summary

- Environmental Advantages



THANK YOU

The Beginning

Keeping roads good with asphalt rubber

http://www.cp2info.org/center