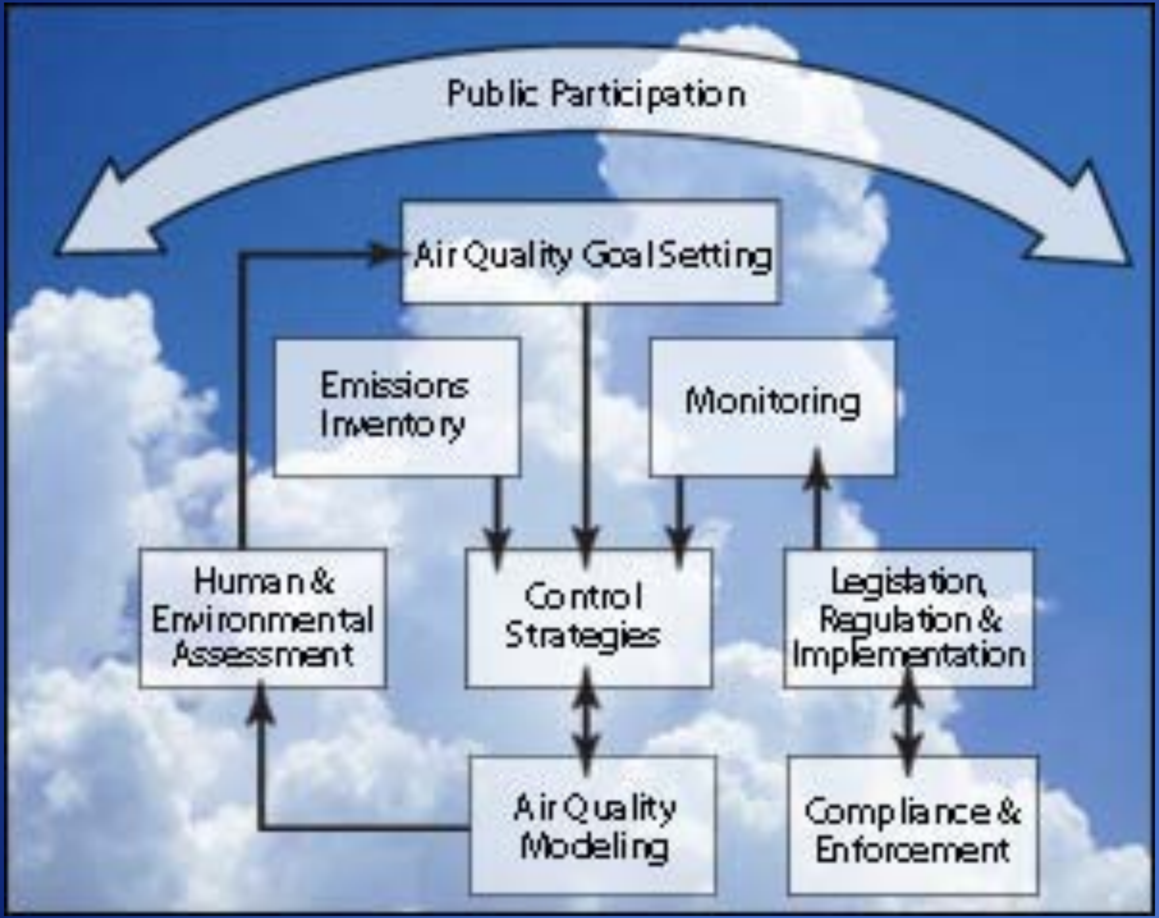
3 - Air Quality Management

The US EPA Approach



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Key Air Quality Management Activities

1. Air Quality Goal Setting
2. Control Strategies
3. Air Quality Modeling
4. Human & Environmental Assessment
5. Legislation, Regulation & Implementation
6. Compliance & Enforcement
7. Public Participation
8. Monitoring
9. Emissions Inventory

A Good Synopsis

- A good synopsis to help understand the air quality management processes in the U.S. is described in the Citizens' Guide to Air Quality in Montana

http://deq.mt.gov/Air/2017Air/citguide/understanding

- Basic description of the federal and Montana state ambient air quality standards, regional ambient air quality concerns, and case histories for four areas in Montana that highlight the success of their state implementation plans.

1. Air Quality Goal Setting

- Air Quality Goal Setting is the activity of establishing standards based on scientific or technical assessment with the aim of mitigating the harmful health and environmental effects of various air pollutants.
- The United States controls air pollutants through two main programs: (1) the National Ambient Air Quality Standards (NAAQS) program,

https://www.epa.gov/criteria-air-pollutants/naaqs-table

and (2) the Hazardous Air Pollutants (HAP) program.

- NAAQS are established for six pollutants: ozone, carbon monoxide, sulfur dioxide, nitrogen dioxide, lead, and particulate matter. The standards are required by general national legislation to protect public health; the specific levels are set by regulations or rules developed by the U.S. Environmental Protection Agency (EPA).

National Ambient Air Quality Standard

Pollutant	Primary Standards: Level	Primary Standards: Averaging Time	Secondary Standards: Level	Secondary Standards: Averaging Time
Carbon Monoxide	9 ppm ($10\ mg/m^3$)	8-hour	None	
	35 ppm ($40\ mg/m^3$)	1-hour		
Lead	$0.15\ \mu g/m^3$	Rolling 3-Month Average	Same as Primary	
Nitrogen Dioxide	53 ppb	Annual (Arithmetic Average)	Same as Primary	
	100 ppb	1-hour	None	
Particulate Matter (PM_{10})	$150\ \mu g/m^3$	24-hour	Same as Primary	
Particulate Matter ($PM_{2.5}$)	$15.0\ \mu g/m^3$	Annual (Arithmetic Average)	Same as Primary	
	$35\ \mu g/m^3$	24-hour	Same as Primary	
Ozone	0.075 ppm (2008 std)	8-hour	Same as Primary	
	0.08 ppm (1997 std)	8-hour	Same as Primary	
	0.12 ppm	1-hour	Same as Primary	
Sulfur Dioxide	0.03 ppm	Annual (Arithmetic Average)	0.5 ppm	3-hour
	0.14 ppm	24-hour		
	75 ppb	1-hour	None	

Some Recent Changes

- SO_2 1-hour: Final rule signed June 2, 2010. To attain this standard, the 3-year average of the 99th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 75 ppb
- O_3 8-hour: To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. (effective May 27, 2008)
- NO_2 1-hour: To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb (effective January 22, 2010).

HAPs

- HAPs are those pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects. In the United States, goal setting for air toxics is a two-staged process.
- **First stage** - U.S. EPA sets technology-based national emission standards to address air toxic pollution. These standards require major stationary sources to meet emission limitations by using maximum achievable control technology.
- **Second stage** - U.S. EPA is then required to evaluate the health risks that may remain after the technological controls have been implemented. Some sources may be subject to additional control requirements if they pose an unacceptable health risk to populations living near the facility.

How do I set air quality goals?

- In the US: EPA's Clean Air Act (CAA)
- In Europe:
  - the WHO Air Quality Guidelines

  https://apps.who.int/iris/bitstream/handle/10665/69477/WHO_SDE_PHE_OEH_06.02_eng.pdf?sequence=1
  - the European Union's directives

    https://ec.europa.eu/environment/air/quality/existing_leg.htm
- In New Zealand:
  - New Zealand's guidelines

    https://www.health.govt.nz/our-work/environmental-health/air-quality

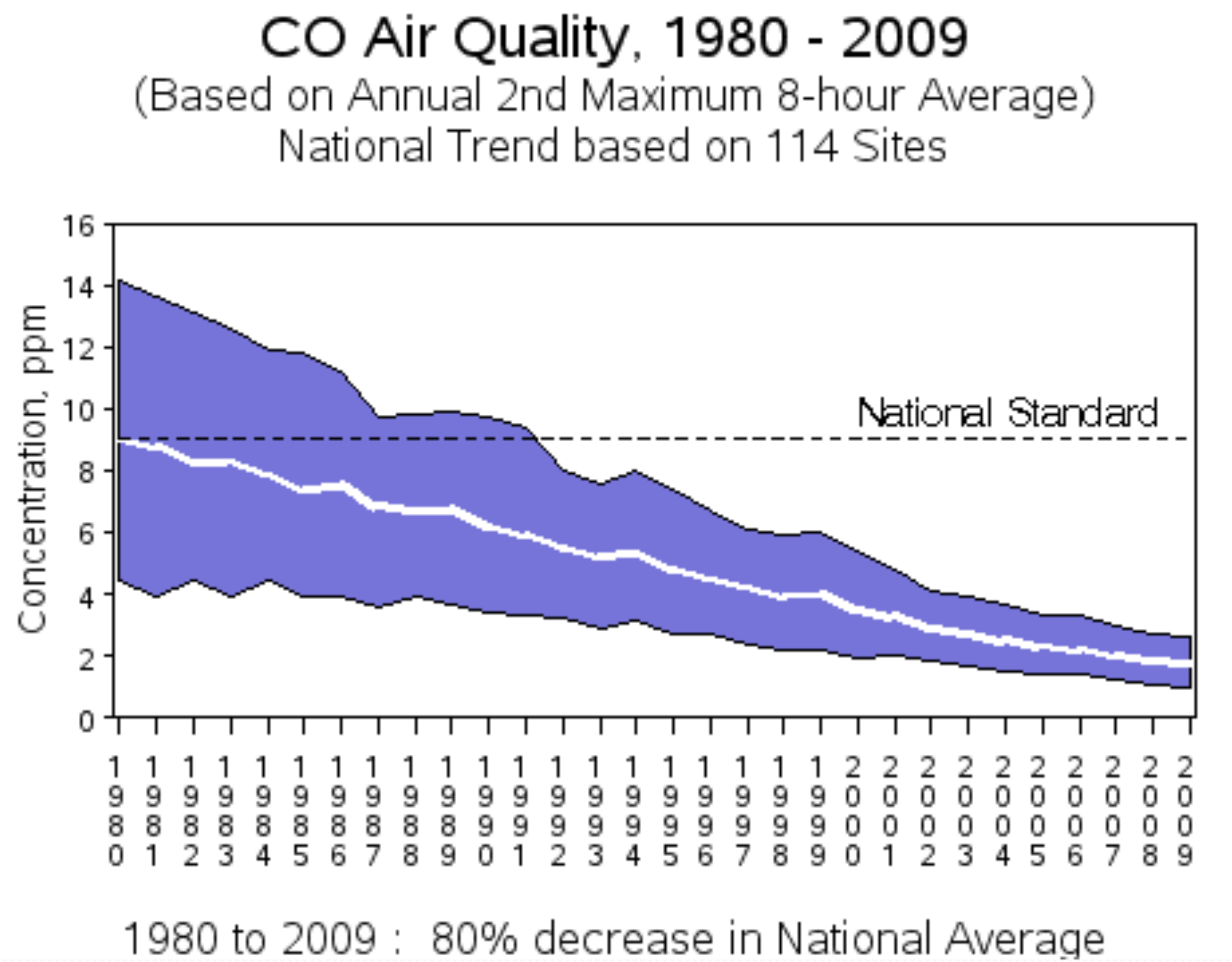
[...]

Understanding the US EPA Clean Air Act

- **Brief History of the Clean Air Act**
  - In October 1948, a thick cloud of air pollution formed above the industrial town of Donora, Pennsylvania. The cloud which lingered for five days, killed 20 people and caused sickness in 6,000 of the town's 14,000 people. In 1952, over 3,000 people died in what became known as London's "Killer Fog." The smog was so thick that buses could not run without guides walking ahead of them carrying lanterns.
  - Events like these alerted us to the dangers that air pollution poses to public health. Several federal and state laws were passed, including the original Clean Air Act of 1963, which established funding for the study and the cleanup of air pollution. But there was no comprehensive federal response to address air pollution until Congress passed a much stronger Clean Air Act in 1970. That same year Congress created the EPA and gave it the primary role in carrying out the law. Since 1970, EPA has been responsible for a variety of Clean Air Act programs to reduce air pollution nationwide.
  - In 1990, Congress dramatically revised and expanded the Clean Air Act, providing EPA even broader authority to implement and enforce regulations reducing air pollutant emissions. The 1990 Amendments also placed an increased emphasis on more cost-effective approaches to reduce air pollution.

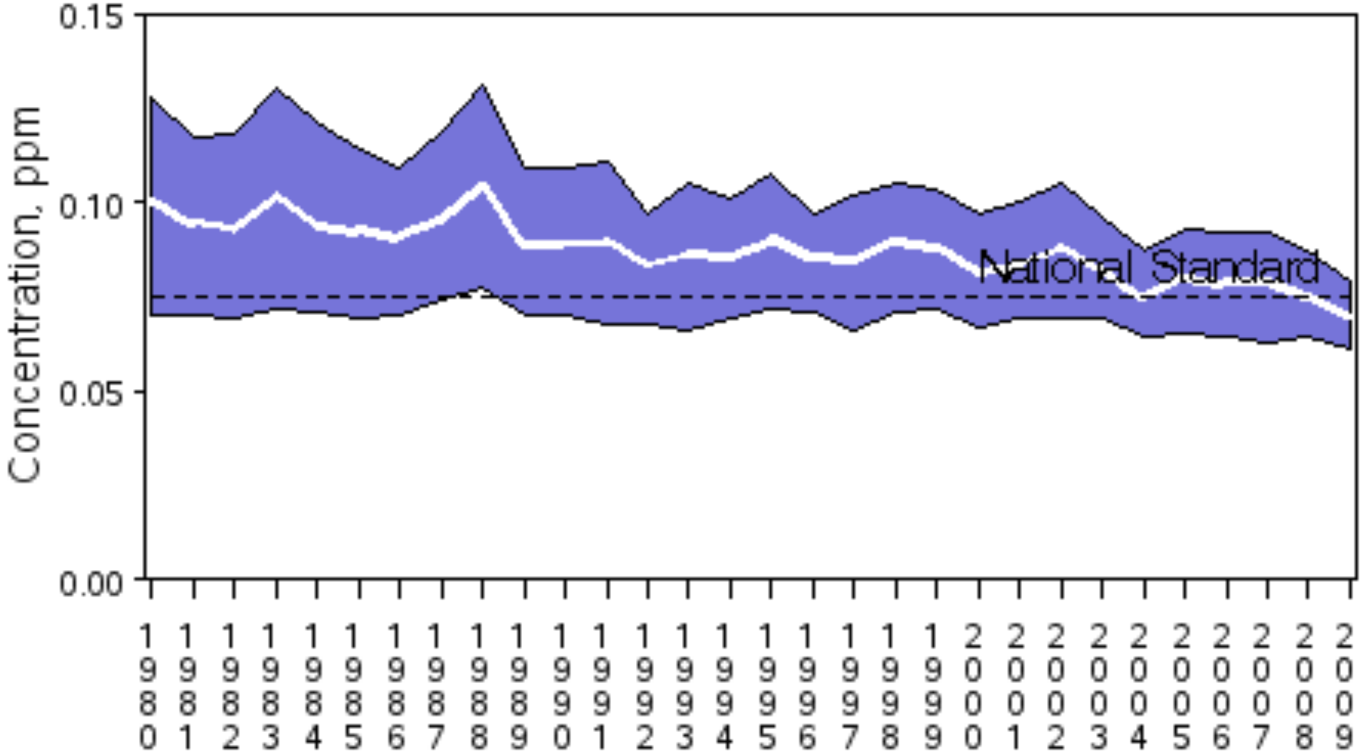
Key Elements of the Clean Air Act

- **Cleaning Up Commonly Found Air Pollutants**
  - Six common air pollutants (also known as "criteria pollutants") are found all over the United States. They are particle pollution (often referred to as particulate matter), ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead.
  - EPA calls these pollutants "criteria" air pollutants because it regulates them by developing human health-based and/or environmentally-based criteria (science-based guidelines) for setting permissible levels.
  - The set of limits based on human health is called primary standards. Another set of limits intended to prevent environmental and property damage is called secondary standards.
  - A geographic area with air quality that is cleaner than the primary standard is called an "attainment" area; areas that do not meet the primary standard are called "nonattainment" areas.
- **Achievements ➔**

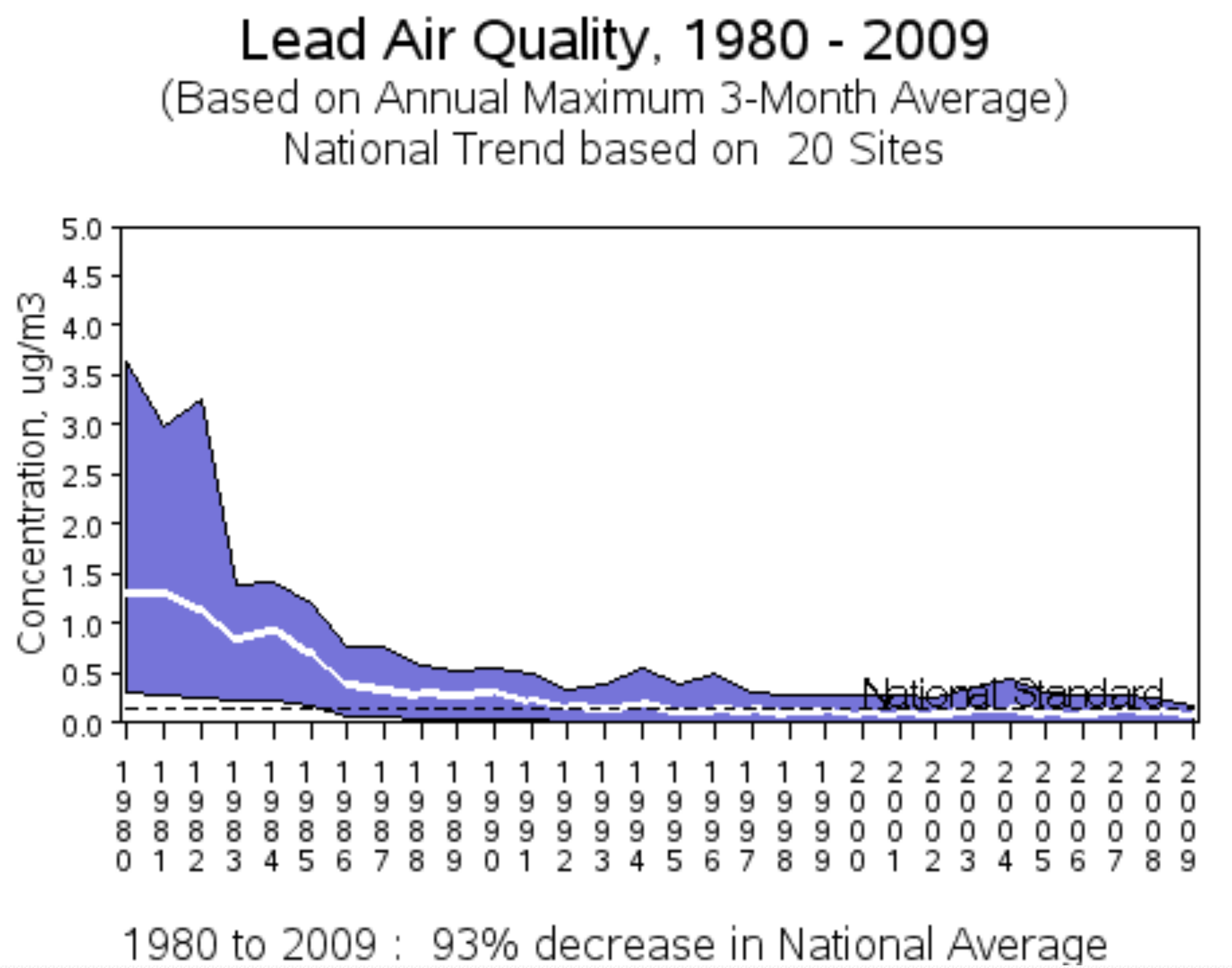

CO Air Quality, 1980 - 2009
(Based on Annual 2nd Maximum 8-hour Average)
National Trend based on 114 Sites
Concentration, ppm
16
14
12
10
8
6
4
2
0
National Standard
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
1980 to 2009 : 80% decrease in National Average

Ozone Air Quality, 1980 - 2009

(Based on Annual 4th Maximum 8-Hour Average)
National Trend based on 255 Sites

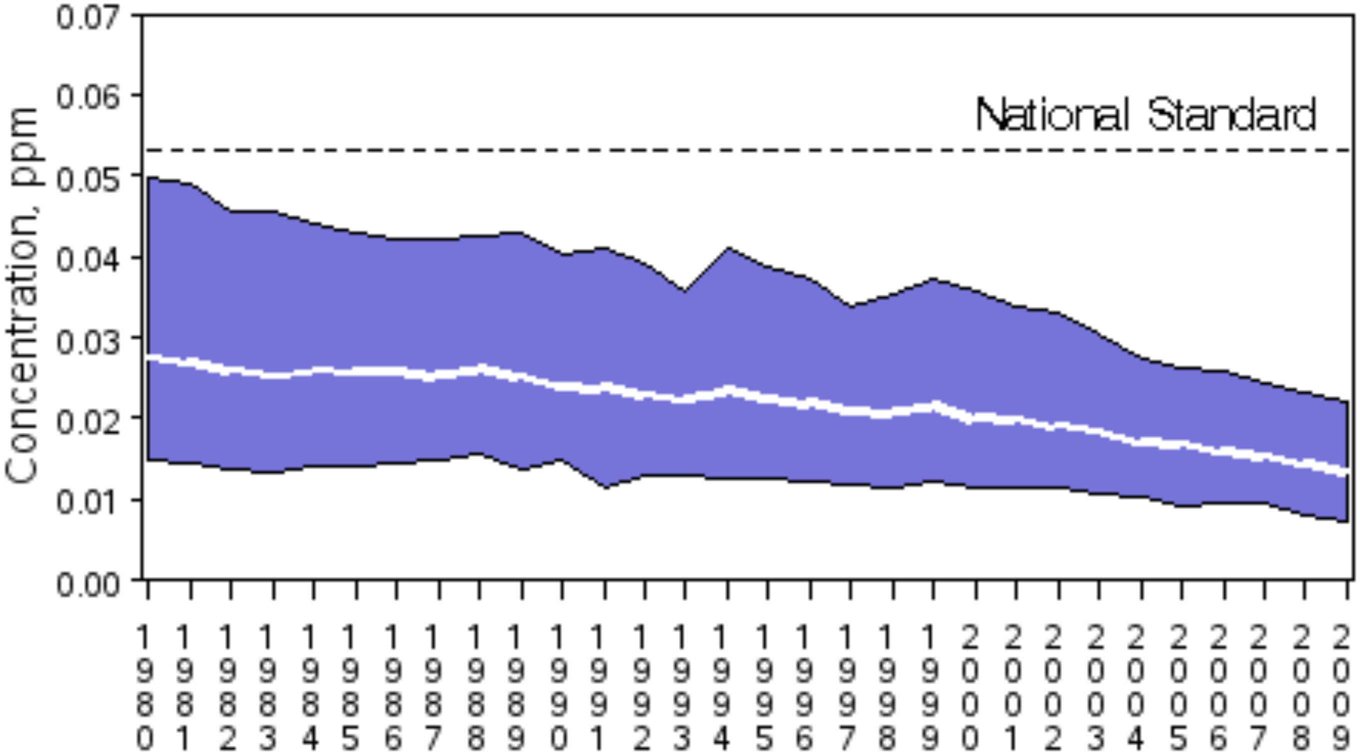


1980 to 2009 : 30% decrease in National Average


Lead Air Quality, 1980 - 2009
(Based on Annual Maximum 3-Month Average)
National Trend based on 20 Sites
Concentration, ug/m3
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
National Standard
1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
1980 to 2009 : 93% decrease in National Average

NO2 Air Quality, 1980 - 2009

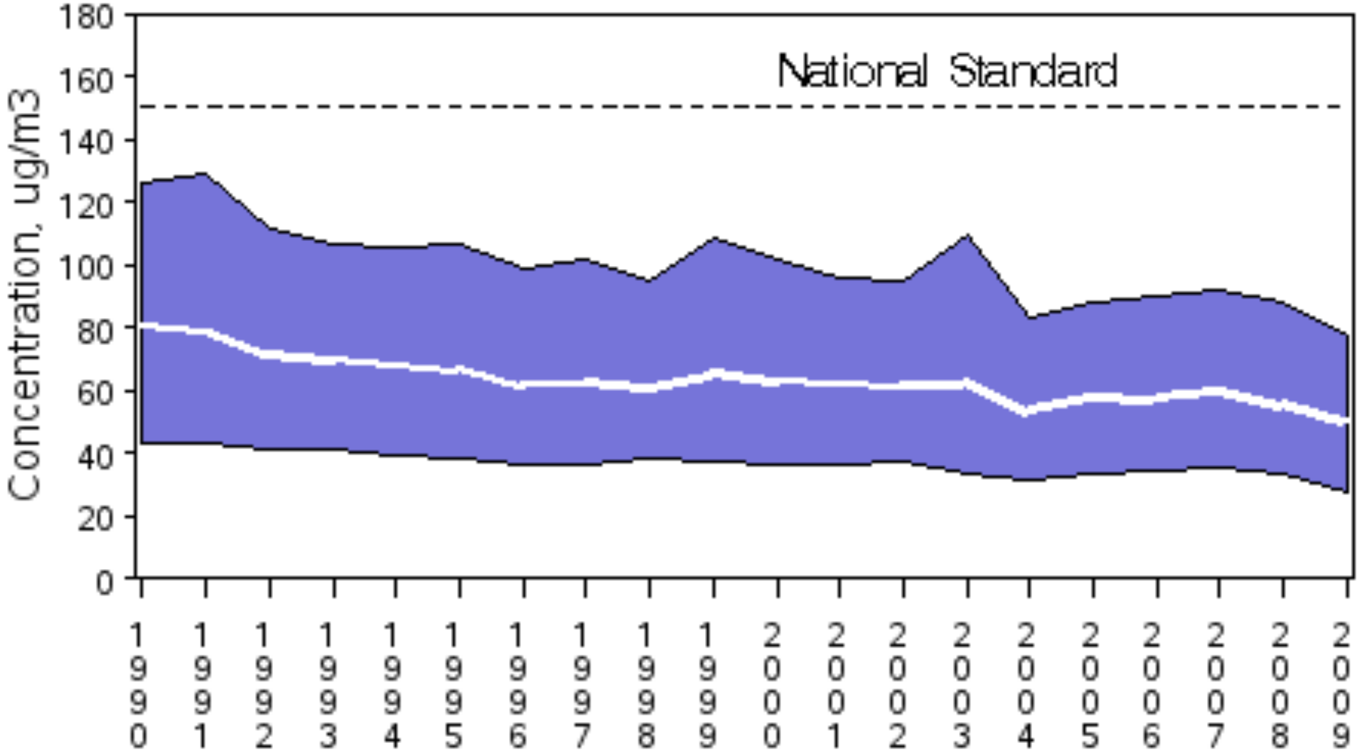
(Based on Annual Arithmetic Average)
National Trend based on 81 Sites



1980 to 2009 : 48% decrease in National Average

PM10 Air Quality, 1990 - 2009

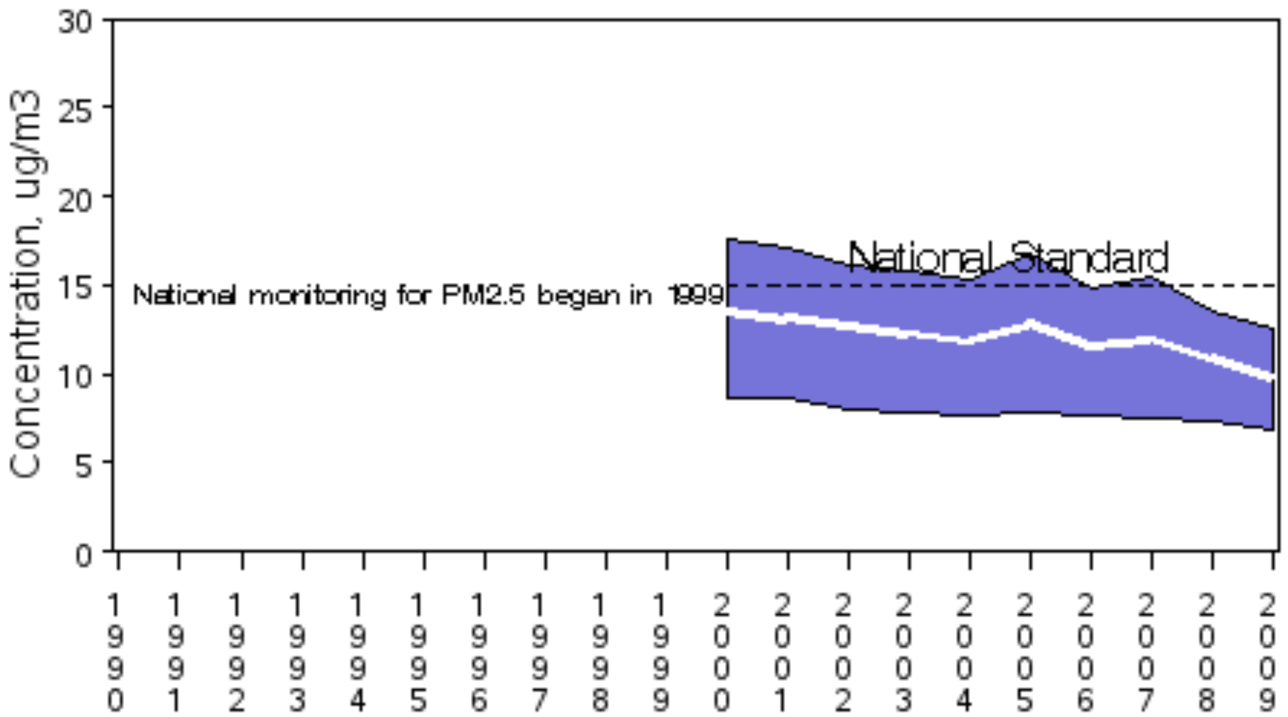
(Based on Annual 2nd Maximum 24-Hour Average)
National Trend based on 310 Sites



1990 to 2009 : 38% decrease in National Average

PM2.5 Air Quality, 2000 - 2009

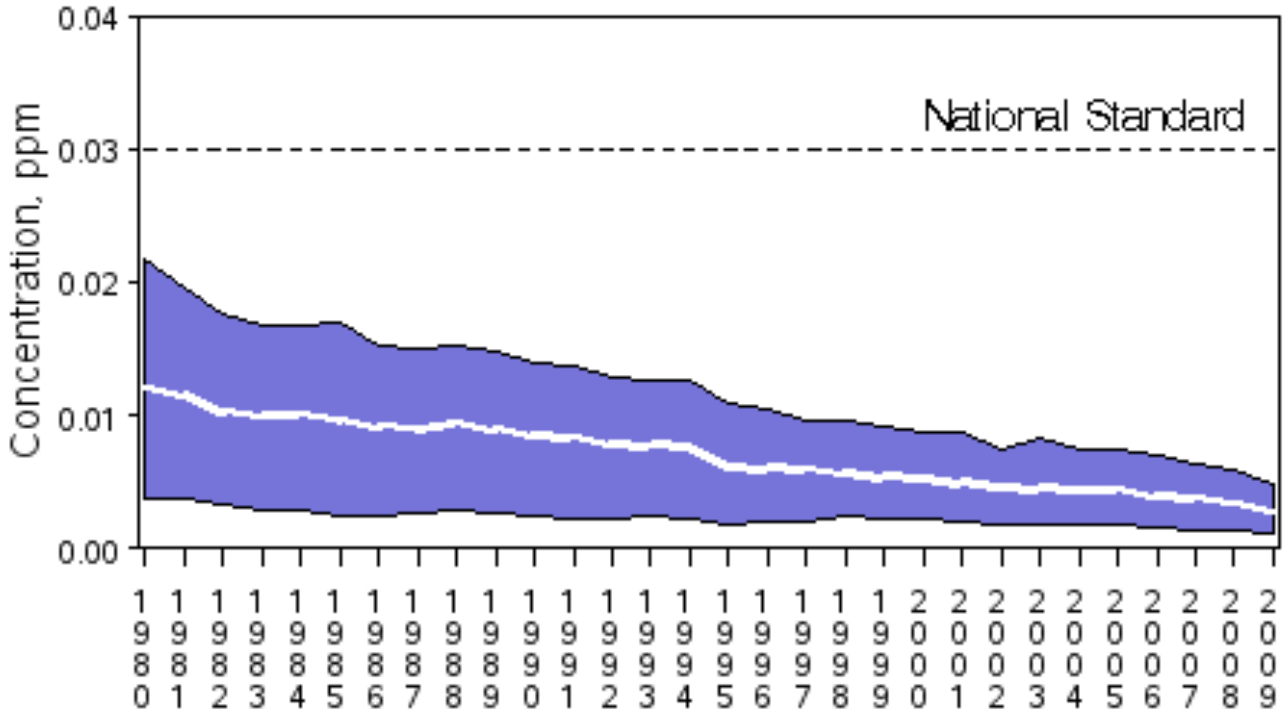
(Based on Seasonally-Weighted Annual Average)
National Trend based on 724 Sites



2000 to 2009 : 27% decrease in National Average

SO2 Air Quality, 1980 - 2009

(Based on Annual Arithmetic Average)
National Trend based on 134 Sites



1980 to 2009 : 76% decrease in National Average

Key Elements of the Clean Air Act – Cont.

- **Cars, Trucks, Buses, and Nonroad Equipment**
  - The Clean Air Act takes a comprehensive approach to reducing pollution from these sources by requiring manufacturers to build cleaner engines; refiners to produce cleaner fuels; and certain areas with air pollution problems to adopt and run passenger vehicle inspection and maintenance programs.
  - EPA has issued a series of regulations affecting passenger cars, diesel trucks and buses, and so-called "nonroad" equipment (recreational vehicles, lawn and garden equipment, etc.) that will dramatically reduce emissions as people buy new vehicles and equipment.
- **Interstate and International Air Pollution**
  - The Clean Air Act has a number of programs designed to reduce long-range transport of pollution from one area to another. The Act has provisions designed to ensure that emissions from one state are not contributing to public health problems in downwind states.
  - It does this, in part, by requiring that each state's implementation plan contain provisions to prevent the emissions from the facilities or sources within its borders from contributing significantly to air pollution problems "downwind" - specifically in those areas that fail to meet EPA's national air quality standards.
  - The Clean Air Act also requires EPA to work with states to reduce the regional haze that affects visibility in 156 national parks and wilderness areas, including the Grand Canyon, Yosemite, the Great Smokies, and Shenandoah National Parks.

Key Elements of the Clean Air Act – Cont.

- **Clearing the Air in Our National Parks**
  - The Clean Air Act has provisions for reducing "regional haze," air pollution that reduces visibility in the national parks.
- **Great Smoky Mountains National Park, an example of one area with haze**

Clear Day

Hazy Day

Key Elements of the Clean Air Act – Cont.

- **Reducing Acid Rain (better: Acid Precipitation)**
  - Acid precipitation is produced when certain types of air pollutants mix with the moisture in the air to form an acid.
  - These acids then fall to Earth as rain, snow, or fog.
  - Even when the weather is dry, acid pollutants may fall to Earth in gases or particles.
  - The initial phase of EPA's Acid Rain Program went into effect in 1995. The law required the highest emitting units at 110 power plants in 21 Midwest, Appalachian, and Northeastern states to reduce emissions of SO_2.
  - The second phase of the program went into effect in 2000, further reducing SO_2 emissions from big coal-burning power plants. Some smaller plants were also included in the second phase of the program.
  - Total SO_2 releases for the nation's power plants are permanently limited to the level set by the 1990 Clean Air Act - about 50 percent of the levels emitted in 1980.

Key Elements of the Clean Air Act – Cont.

- **Reducing Toxic Air Pollutants**
  - Toxic air pollutants, or air toxics, are known to cause or are suspected of causing cancer, birth defects, reproduction problems, and other serious illnesses.
  - Before the 1990 Clean Air Act Amendments, EPA regulated air toxics one chemical at a time. This approach did not work well. Between 1970 and 1990, EPA established regulations for only seven pollutants.
  - The 1990 Clean Air Act Amendments took a completely different approach to reducing toxic air pollutants. The Amendments required EPA to identify categories of industrial sources for 187 listed toxic air pollutants and to take steps to reduce pollution by requiring sources to install controls or change production processes.
  - EPA has published regulations covering a wide range of industrial categories, including chemical plants, incinerators, dry cleaners, and manufacturers of wood furniture.
  - Harmful air toxics from large industrial sources, such as chemical plants, petroleum refineries, and paper mills, have been reduced by nearly 70 percent.

Key Elements of the Clean Air Act – Cont.

- **Protecting the Stratospheric Ozone Layer**
  - Ozone can be good or bad depending on where it is located. Close to the Earth's surface, ground-level ozone is a harmful air pollutant. Ozone in the stratosphere, high above the Earth, protects human health and the environment from the sun's harmful ultraviolet radiation.
  - This natural shield has been gradually depleted by manmade chemicals. So, in 1990, Congress added provisions to the Clean Air Act for protecting the stratospheric ozone layer.
  - Over 190 countries, including the major industrialized nations such as the United States, have signed the 1987 Montreal Protocol, which calls for elimination of chemicals that destroy stratospheric ozone - chlorofluorocarbons (CFCs).

Key Elements of the Clean Air Act – Cont.

- **Permits**
  - Operating permits include information on which pollutants are being released, how much may be released, and what kinds of steps the source's owner or operator is required to take to reduce the pollution.
  - Permits must include plans to measure and report the air pollution emitted.
  - States and tribe issue operating permits. If those governments do not do a satisfactory job of carrying out the Clean Air Act permitting requirements, EPA can take over issuing permits.
- **Enforcement**
  - The 1990 Amendments strengthened EPA's power to enforce the Act, increasing the range of civil and criminal sanctions available. In general, when EPA finds that a violation has occurred, the agency can issue an order requiring the violator to comply, issue an administrative penalty order (use EPA administrative authority to force payment of a penalty), or bring a civil judicial action (sue the violator in court).

Key Elements of the Clean Air Act – Cont.

- **Public Participation**
  - Public participation is a very important part of the 1990 Clean Air Act. Throughout the Act, different provisions give the public opportunities to take part in determining how the law is carried out.
  - Often, when EPA is working on a major rule, the Agency will hold hearings in various cities across the country, at which the public can comment.
  - One can also submit written comments directly to EPA for inclusion in the public record associated with that rule.

Environmental Information to the Public by the US EPA

- AIRNow Ozone and Particulate Matter Monitoring and Forecasting
  - http://airnow.gov/
  - the AIRNow site provides the public with easy access to national air quality information by offering daily air quality index (AQI) forecasts as well as real-time AQI conditions for over 300 cities across the U.S., and provides links to more detailed State and local air quality web sites.
- MyEnvironment - environmental information for my area
  - http://www.epa.gov/myenvironment/
  - The MyEnvironment search application is designed to provide a cross-section of environmental information based on the user's location.
- Envirofacts
  - http://www.epa.gov/enviro/
  - Envirofacts offers a single point of access to select U.S. EPA environmental data. This web site provides access to several EPA databases to provide you with information about environmental activities that may affect air, water, and land anywhere in the United States.

2. Control Strategies

- A control strategy is a set of discrete and specific measures identified and implemented to achieve reductions in air pollution.
- Controls on major stationary, mobile, and area sources are part of a successful control strategy. These controls should utilize reasonably available control technology.
- Examples include:
  - controls on volatile organic compounds from solvent and paint usage as well as controls on nitrogen oxide emissions from combustion units.
  - For mobile sources: tighter emission controls for vehicles and low-sulfur fuel standards.
  - For major stationary sources: permits including emission limitations for any major sources, new and existing.
- The basic types of emission control technology are mechanical collectors, wet scrubbers, bag houses, electrostatic precipitators, combustion systems (thermal oxidizers), condensers, absorbers, adsorbers, and biological degradation. The selection procedure should be based on environmental, engineering, and economic considerations.

Developing a Control Strategy

- Four main steps in developing a control strategy.
  1. Determine priority pollutants based on health effects and the severity of the air quality problem.
  2. Identify control measures. For specific source categories, choose the appropriate controls based on the priority pollutants identified. A good source for control technologies is U.S. EPA's Clean Air Technology Center. Also, the National Association of Clean Air Agencies (NACAA) has developed several documents that provide a menu of control options.
  3. Incorporate the control measures into a written plan. It is important to adopt a regulatory program and include it in the plan so that control measures will be enforceable.
  4. Involve the public. It is critical to contact the regulated community and other affected parties. This early consultation reduces later challenges (e.g., litigation) and streamlines implementation.

3. **Air Quality Modeling**

- Air Quality modeling is the mathematical simulation/prediction of ambient concentrations/depositions of air pollution, based on measured/calculated inputs.
- Air quality modeling is the necessary substitute for ubiquitous air quality monitoring, which is impossible.
- More importantly:
  - measurements cannot distinguish between the contributions of different emissions. Models can.
  - Models can simulate the past, present, and future air pollution
  - Models incorporate best deterministic/statistical science

Modeling for air quality management purposes

- Two broad categories:
  - dispersion modeling - used to predict ambient concentrations
  - receptor-based (or source apportionment) models - use ambient data to determine the sources.
- Other categorization:
  - on the required model inputs (i.e., meteorological data);
  - on the spatial scale (global; regional-to-continental; local-to-regional; local);
  - on the temporal scale (episodic models, long-term models);
  - on the treatment of the transport equations (Eulerian, Lagrangian models);
  - on the treatment of various processes (chemistry, wet and dry deposition);
  - and on the complexity of the approach.
- The choice of model depends on a combination of the available data and the needs of the researcher

Choice of Models

- U.S. EPA's detailed recommendations
  http://www.epa.gov/scram001/guidance/guide/appw_03.pdf
- Many of the models are available for direct download at the U.S. EPA Support Center for Regulatory Air Models (SCRAM)
  http://www.epa.gov/scram001/
- On-line course offered by the Air Pollution Training Institute
  https://www.epa.gov/air-quality-data-and-tools/air-pollution-training-institute-public-training-site
- Advanced courses on air quality modeling
  http://www.shodor.org/os411/
  http://www.weblakes.com/training/index.html
  http://trinityconsultants.com/Training/
- 1990 book: http://www.envirocomp.com/pops/airpollution.html
- Comprehensive book series: http://envirocomp.org/books/aqm.html

4. Human & Environmental Assessment

- Health and environmental assessments are conducted as part of an Air Quality Management program to quantify and monetize:
  1. the impact of the existing or current state of emissions and air quality; and
  2. the incremental impact of a specific policy or program to reduce emissions and improve the current state of air quality.
- Effects directly on human health can include
  - increases in the risk of death (mortality) or
  - increases in the risk of experiencing an adverse health effect (morbidity).
- Adverse health effects can be divided into
  - acute effects such as headaches or eye irritation which generally last only a few days, and
  - chronic effects such as emphysema or asthma which are generally associated with long-term illness.

Human Health Effects

- U.S. EPA database Integrated Risk Information System (IRIS) of human health effects that may result from exposure to various substances found in the environment

  https://www.epa.gov/iris

  - IRIS helps provide information on chemical substances for use in risk assessments, decision-making and regulatory activities.
  - The information in IRIS is intended for those without extensive training in toxicology, but with some knowledge of health sciences.

IRIS

- EPA's Integrated Risk Information System (IRIS) is a human health assessment program that evaluates risk information on effects that may result from exposure to environmental contaminants.
- The IRIS database contains information for more than 540 chemical substances containing information on human health effects that may result from exposure to various substances in the environment.
- The heart of the IRIS system is its collection of searchable documents that describe the health effects of individual substances and that contain descriptive and quantitative information in the following categories:
  - **Noncancer effects:** Oral reference doses and inhalation reference concentrations (RfDs and RfCs, respectively) for effects known or assumed to be produced through a nonlinear (possibly threshold) mode of action. In most instances, RfDs and RfCs are developed for the noncarcinogenic effects of substances.
  - **Cancer effects:** Descriptors that characterize the weight of evidence for human carcinogenicity, oral slope factors, and oral and inhalation unit risks for carcinogenic effects. Where a nonlinear mode of action is established, RfD and RfC values may be used.
- IRIS Guidance Documents: http://www.epa.gov/iris/backgrd.html

RfDs and RfCs

- The oral reference dose (RfD) and inhalation reference concentration (RfC) provide quantitative information for use in risk assessments for health effects known or assumed to be produced through a nonlinear (possibly threshold) mode of action.
- The RfD (expressed in units of mg of substance/kg body weight-day) is defined as an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.
- An RfD can be derived from a no-observed-adverse-effect level (NOAEL), lowest-observed-adverse-effect level (LOAEL), or benchmark dose, with uncertainty factors generally applied to reflect limitations of the data used.
- The inhalation RfC (expressed in units of mg of substance/m^3 air) is analogous to the oral RfD but provides a continuous inhalation exposure estimate.
- The inhalation RfC considers toxic effects for both the respiratory system (portal of entry) and effects peripheral to the respiratory system (extrarespiratory or systemic effects).
- Reference values may also be derived for acute (≤24 hours), short-term (>24 hours, up to 30 days), and subchronic (>30 days, up to approximately 10% of the life span) exposure durations, all of which are derived based on an assumption of continuous exposure throughout the duration specified.
- RfDs and RfCs are generally used in noncancer health assessments.

Cancer weight-of-evidence (WOE) descriptor

- A cancer weight-of-evidence (WOE) descriptor is used by IRIS to describe a substance's potential to cause cancer in humans and the conditions under which the carcinogenic effects may be expressed.
- This judgment is independent of consideration of the agent's carcinogenic potency.
- Under the EPA's 2005 guidelines for carcinogen risk assessment, a narrative approach, rather than categories, is used to characterize carcinogenicity. Five standard weight-of-evidence descriptors:
  1. Carcinogenic to Humans,
  2. Likely to Be Carcinogenic to Humans,
  3. Suggestive Evidence of Carcinogenic Potential,
  4. Inadequate Information to Assess Carcinogenic Potential, and
  5. Not Likely to Be Carcinogenic to Humans

Cancer slope factors and unit risks

- Cancer slope factors and unit risks are used to estimate the risk of cancer associated with exposure to a carcinogenic or potentially carcinogenic substance.
- A slope factor is an upper bound (conservative), approximating a 95% confidence limit, on the increased cancer risk from a lifetime exposure to an agent by ingestion.
- This estimate, usually expressed in units of proportion (of a population) affected per mg of substance/kg body weight-day, is generally reserved for use in the low-dose region of the dose-response relationship, that is, for exposures corresponding to risks less than 1 in 100.
- A unit risk is an upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 µg/L in water or 1 µg/m3 in air.
- **The interpretation of unit risk for a substance in drinking water would be as follows: if unit risk = 2 x 10-6 per µg/L, 2 excess cancer cases (upper bound estimate) are expected to develop per 1,000,000 people if exposed daily for a lifetime to 1 µg of the substance in 1 liter of drinking water.**

Environmental Effects

- Indirect damages to humans
- Aesthetic damages
  - contamination of the physical environment
  - odor
  - noise
  - poor visibility
- Productivity damages
  - reduced productivity of farmland, forests, and commercial fisheries
- Intrinsic or non-use damages including
  - losses in the value people associate with preserving, protecting, and improving the quality of ecological resources

Risk Assessment

- The U.S. EPA has several risk assessment guidelines that set forth recommended principles and procedures to guide scientists in assessing the risks from chemicals or other agents in the environment.
- For environmental impacts, the EPA has published Guidelines for Ecological Risk Assessment (currently unavailable) that are meant to be internal guidance for EPA and to inform the public and the regulated community regarding the EPA's approach to ecological risk assessment.
- In addition, U.S. EPA has prepared two citizen's guides on risk assessment:
  - Risk Assessment for Toxic Air Pollutants https://www3.epa.gov/airtoxics/3_90_024.html
  - Evaluating Exposures to Toxic Air Pollutants https://www3.epa.gov/ttn/atw/3_90_023.html

Economic Analysis

- The U.S. EPA's Guidelines for Preparing Economic Analyses establish a sound scientific framework for performing economic analyses of environmental regulations and policies.

https://www.epa.gov/environmental-economics/guidelines-preparing-economic-analyses

The Guidelines address major analytical issues on key topics, including:

- Estimating the value of reduced health risks and improved environment quality
- Defining baseline conditions (i.e., contrasting the state of the economy and environment with and without a proposed regulatory policy).
- Discounting and comparing differences in the timing of benefits, costs, and impacts
- Assessing and describing who pays the costs and receives the benefits of regulations
- Locating available data sources for conducting economic analyses.
- Presenting the results of economic analysis, including non-monetary information

5. Legislation, Regulation & Implementation

- Legislation: Air quality legislation generally contains broad program goals and objectives as well as roles and responsibilities for achieving national air quality protection. In the U.S., national legislation is developed and finalized within the U.S. Congress and signed by the President.
- Regulation: In the U.S., national environmental regulations are developed primarily by the Environmental Protection Agency (EPA).
- Implementation: In the U.S., though much legislation is passed nationally, individual States are the primary implementers of air quality management programs.
- More info: https://www.epa.gov/laws-regulations

6. Compliance & Enforcement

- Compliance Assistance: The U.S. EPA as well as states and local agencies have developed numerous industry specific documents available to assist in the development of a compliance program.

  http://www.epa.gov/compliance/assistance/index.html
- Compliance Inspections are a key element of a compliance program.
- Civil Enforcement encompasses the investigations and cases brought to address the most significant violations, and includes EPA administrative actions and judicial cases referred to the Department of Justice.
- Criminal Enforcement is designed to identify, apprehend, and assist prosecutors in successfully convicting those who are responsible for the most significant and egregious violations of environmental law that pose substantial risks to human health and the environment.

  https://www.epa.gov/enforcement/criminal-enforcement

7. Public Participation

- Public opportunities (e.g. multiple public hearings)
- Environmental Information to the Public by the US EPA
  - AIRNow Ozone and Particulate Matter Monitoring and Forecasting
    - http://airnow.gov/
  - MyEnvironment - environmental information for my area
    - http://www.epa.gov/myenvironment/
  - Envirofacts
    - http://www.epa.gov/enviro/
- States' activities

8. Monitoring

- Ambient Monitoring is the systematic, long-term assessment of pollutant levels by measuring the quantity and types of certain pollutants in the surrounding, outdoor air.
  - assess the extent of pollution
  - ensure compliance with national legislation
  - evaluate control options, and provide data for air quality modeling
- Emissions Measurement is the process of monitoring particulate and gaseous emissions from a specific source.
  - The measurement of both *type* and *quantity* of these contaminants is an important part of obtaining the data needed to implement a meaningful control program.
  - The process of monitoring particulate and gaseous emissions from a stationary source is often referred to as *source sampling* or *source testing*

Air Quality Subsystem (AQS)

- Once data are collected from a monitoring system, they must be stored in data management systems and databases.
- Subsequently, the data must be retrieved and analyzed to see what they reveal about the effectiveness of regulatory standards, the accuracy of modeling, impacts on health endpoints, and as an overall way of assessing.
- In the U.S. these data are collected and housed in the Air Quality Subsystem (AQS) http://www.epa.gov/ttn/airs/airsaqs/
  - The AQS contains ambient air pollution data collected by EPA, state, local, and tribal air pollution control agencies from thousands of monitoring stations.
  - AQS also contains meteorological data, descriptive information about each monitoring station (including its geographic location and its operator), and data quality assurance/quality control information.
  - AQS data can be obtained from http://www.epa.gov/ttn/airs/airsaqs/detaildata/

9. Emissions Inventory

- An emissions inventory is a database that lists, by source, the amount of air pollutants discharged into the atmosphere of a community during a given time period.
- Different methods for calculating the emissions inventories are available, e.g.:
  - continuous monitoring to measure actual emissions;
  - extrapolating the results from short-term source emissions tests; and
  - combining published emission factors with known activity levels.

General emission factors (AP-42)

- An **emissions factor** is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant.
- These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kilograms of particulate emitted per megagram of coal burned).
- Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages for all facilities in the source category (i.e., a population average).
- The general equation for emissions estimation is:

  $$E = A \times EF \times (1 - ER/100)$$, where:

  - E = emissions;
  - A = activity rate;
  - EF = emission factor, and
  - ER =overall emission reduction efficiency, %
- https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors

Other Resources for Emission Inventory

- In Europe, the third edition of the emission inventory guidebook (prepared by the United Nations European Environment Agency Task Force on Emissions Inventories and Projections) provides a comprehensive guide to state-of-the-art atmospheric emissions inventory methodology to support reporting under the UNECE Convention on Long-Range Transboundary Air Pollution and the EU directive on national emission ceilings.

  http://www.eea.europa.eu/publications/EMEPCORINAIR4
- In the U.S., the EPA Clearinghouse for Inventories & Emission Factors contains information on emissions inventories, emissions factors, software and tools used for emissions inventories, and emissions modeling.

  http://www.epa.gov/ttn/chief/
- For an overview of the mobile source category and specific methods to identify and inventory sources, estimate emissions, and establish and maintain a useful, current mobile source emissions inventory, one may access Procedures for Emission Inventory Preparation, Chapter IV: Mobile Sources that was prepared by the U.S. Department of Transportation and U.S. EPA.

  https://www3.epa.gov/ttn/naaqs/aqmguide/collection/cp2/19921201_oaqps_epa-420_r-92-009_ei_preparation_mobile_sources.pdf