Basis for recommended groundwater standards – Metals and Metalloids

Sarah Yang, Ph.D.

Groundwater Toxicologist

Gavin Dehnert, Ph.D.

Groundwater Fellow

WISCONSIN DEPARTMENT of HEALTH SERVICES

Today's presentation

Groundwater standard process

Recommended groundwater standards for:

- Aluminum
- Barium
- Cobalt
- Molybdenum
- Boron
- Strontium
- Hexavalent Chromium

Two-thirds of Wisconsin residents use groundwater.

Wisconsin's groundwater standards have 2 parts.

Enforcement Standard

Preventive Action Limit

The enforcement standard is established from available health information.

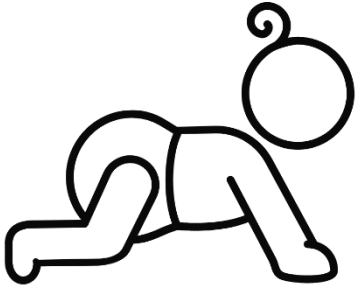
Enforcement standards can be based on:

- Federal number
- State drinking water standard
- EPA value
- Technical information
- Cancer risk

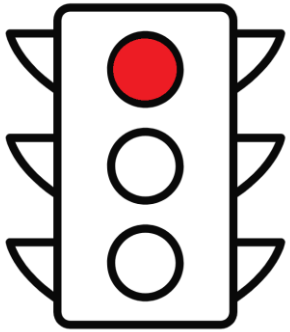
Enforcement standards based on

EPA value

Technical information

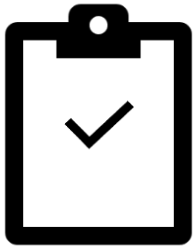


Set to protect a young child



Enforcement Standard

=

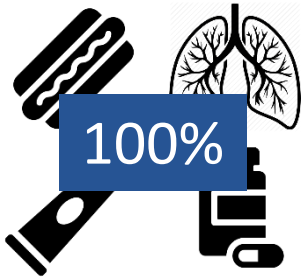


Acceptable daily intake

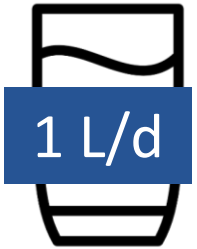
×

Body weight

×



Relative source contribution

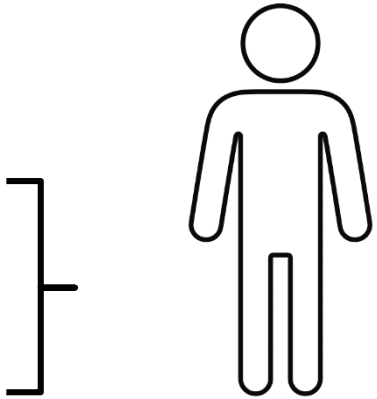


Water consumption

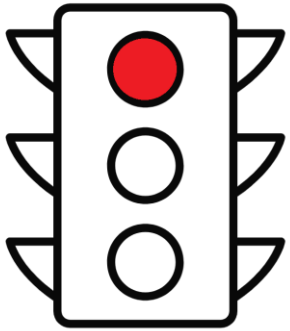
Specified in Statute

Enforcement standards based on

Cancer risk

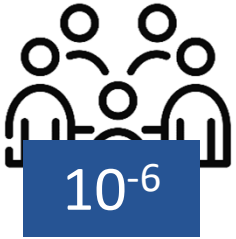


Set to protect from a lifetime of exposure



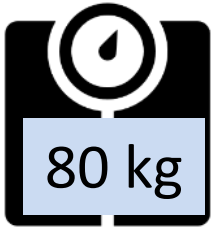
Enforcement Standard

=

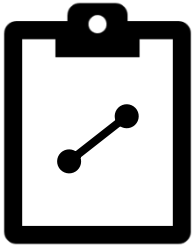


Risk level

×

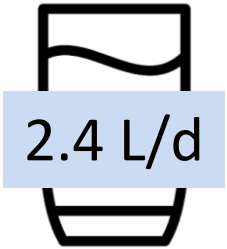


Body weight



Cancer slope factor

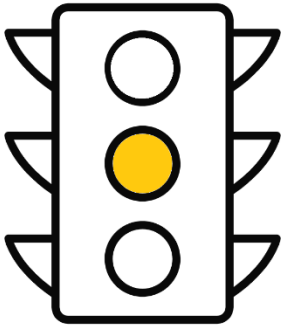
×



Water consumption

Specified in Statute | Recommended by EPA

The preventive action limit is set at a percentage of the enforcement standard.

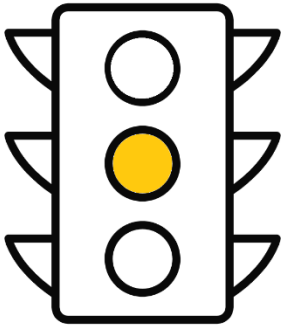


Preventive action limit

= 10%

of the enforcement standard

Substances that cause carcinogenic, mutagenic, teratogenic, or interactive effects



Preventive action limit

= 20%

of the enforcement standard

All other substances

Aluminum

Wisconsin has groundwater standards for **aluminum**.

The current enforcement standard is based on:

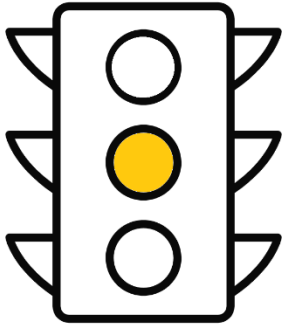
Technical information

200 µg/L for aluminum

Established in 2010

Based on research study in rabbits

The current preventive action limit for **aluminum** is set at:



Preventive action limit

=

10%

of the enforcement standard

Aluminum has been shown to have carcinogenic properties in rats

Available scientific information for **aluminum**:

Federal number

State drinking water standard

EPA value

Technical information

Cancer risk

Available scientific information for **aluminum**:

Technical information

Secondary maximum contaminant level (SMCL)

50 to 200 µg/L for aluminum

Established in 2018

Available scientific information for **aluminum**:

Technical information

Food and Drug Administration

200 µg/L for aluminum in bottled drinking water

Available scientific information for **aluminum**:

Technical information

World Health Organization

100 to 200 µg/L for aluminum in drinking water

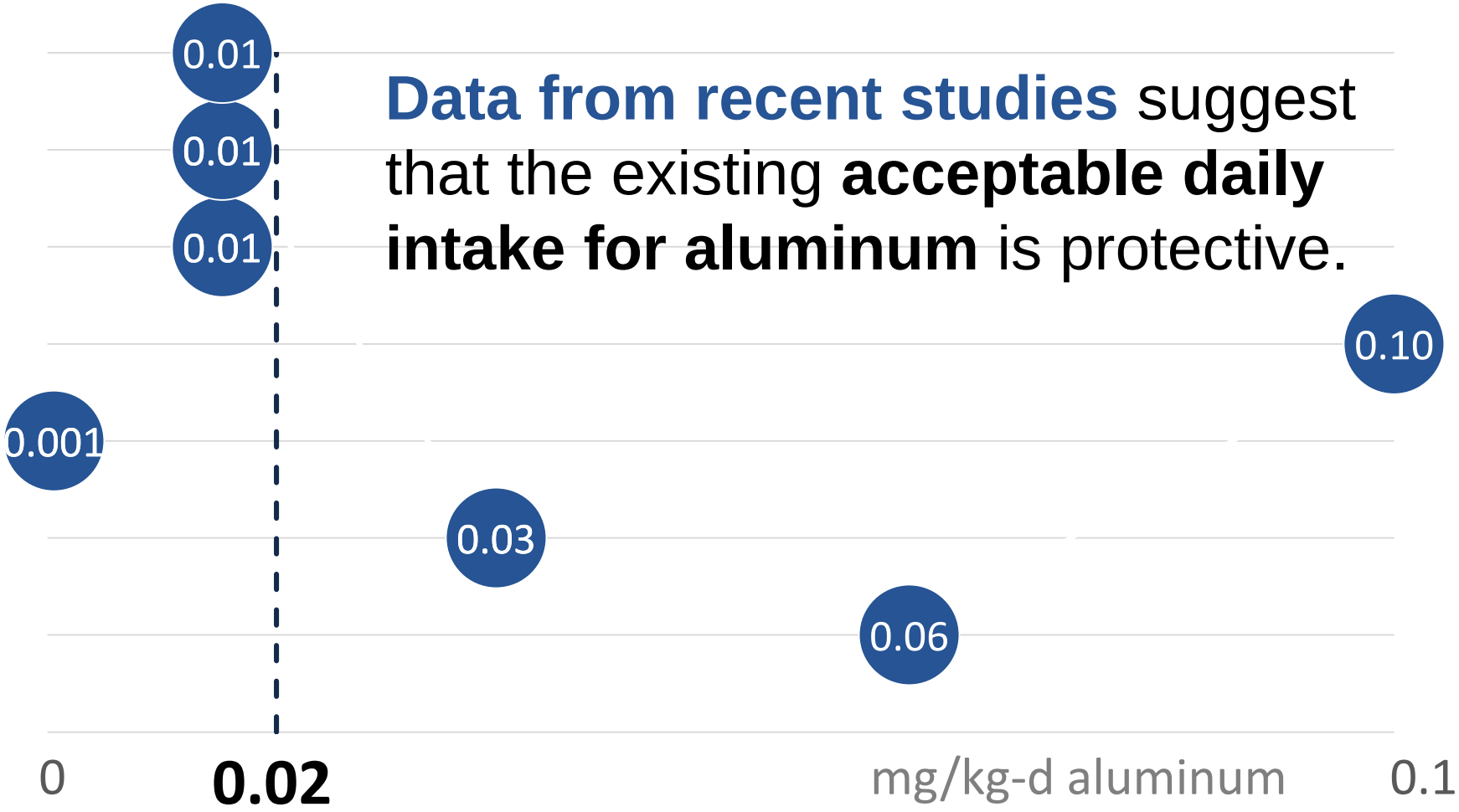
Available scientific information for **aluminum**:

Technical information

Critical studies

Toxicity studies (7) evaluating effects on development and reproduction in mice and rats

DHS recommends **no change** to the **enforcement standard** for **aluminum**.



Data from recent studies suggest that the existing **acceptable daily intake for aluminum** is protective.

DHS recommends **no change** to the **preventive action limit** for **aluminum**.

Barium

Wisconsin has groundwater standards for **barium**.

The current enforcement standard is based on:

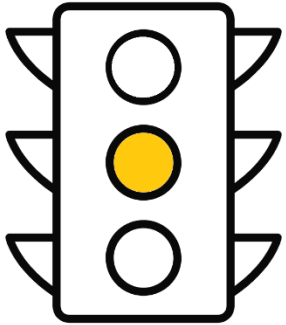
Federal number

Maximum contaminant level

2000 µg/L

Established in 1992

The current preventive action limit for **barium** is set at:



Preventive action limit

=

20%

of the enforcement standard

No evidence of carcinogenic, mutagenic, teratogenic, or interactive effects.

Available scientific information for **barium**:

Federal number

State drinking water standard

EPA value

Technical information

Cancer risk

Available scientific information for **barium**:

Federal number

Maximum contaminant level

2000 µg/L for barium

Reviewed in 2003

Available scientific information for **barium**:

State standard

Maximum contaminant level

Based on federal MCL

2000 µg/L

Established in 2016

Available scientific information for **barium**:

EPA value

Oral reference dose

0.2 mg/kg-d for barium

Established in 2005

Based on kidney damage in mice

Available scientific information for **barium**:

Technical information

Chronic oral minimum reference level

0.2 mg/kg-d for barium

Established by ATSDR in 2007

Based on same study as EPA's oral reference dose

ATSDR = Agency for Toxic Substances and Disease Registry

DHS recommends **no change** to the **enforcement standard** for **barium**.

DHS recommends **no change** to the **preventive action limit** for **barium**.

Cobalt

Wisconsin has groundwater standards for **cobalt**.

The current enforcement standard is based on:

Technical information

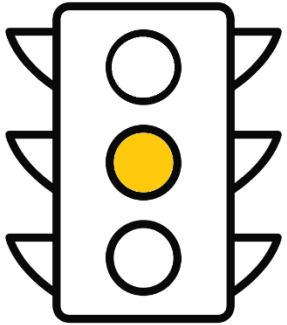
40 µg/L

Established in 1997

Based on a toxicity value from ATSDR

ATSDR = Agency for Toxic Substances and Disease Registry

The current preventive action limit for **cobalt** is set at:



Preventive action limit

=

20%

of the enforcement standard

No evidence of carcinogenic, mutagenic, teratogenic, or interactive effects.

Available scientific information for **cobalt**:

Federal number

State drinking water standard

EPA value

Technical information

Cancer risk

Available scientific information for **cobalt**:

Technical information

Oral maximum contaminant level

0.01 mg/kg-d for cobalt

Established by ATSDR in 2004

Based on effects on blood in people

ATSDR = Agency for Toxic Substances and Disease Registry

Available scientific information for **cobalt**:

Technical information

Critical studies

Toxicity studies (2) evaluating effects on development and reproduction in mice, rats, and rabbits

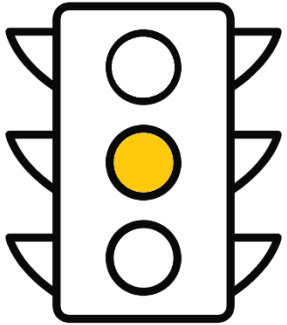
DHS recommends **no change** to the **enforcement standard** for **cobalt**.

Data from recent studies suggest that the existing **acceptable daily intake for cobalt** is protective.

0 mg/kg-d cobalt 0.1

DHS recommends **lowering** the **preventive action limit** for **cobalt**.

DHS recommends that the preventive action limit for **cobalt** be set at:



Preventive action limit

=

10%

of the enforcement standard

New studies shown that cobalt can cause birth defects in mice and rats.

Molybdenum

Wisconsin has groundwater standards for **molybdenum**.

The current enforcement standard is based on:

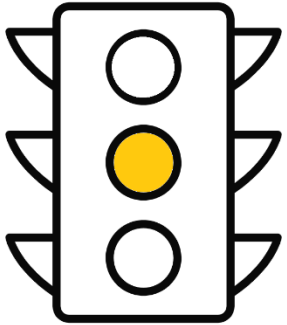
Federal number

40 µg/L

Established in 1993

EPA lifetime health advisory

The current preventive action limit for **molybdenum** is set at:



Preventive action limit

=

20%

of the enforcement standard

No evidence of carcinogenic, mutagenic, teratogenic, or interactive effects.

Available scientific information for **molybdenum**:

- Federal number
- State drinking water standard
- EPA value
- Technical information
- Cancer risk

Available scientific information for **molybdenum**:

Federal number

10-Day child health advisory

80 µg/L for molybdenum

Established in 1993

Based on development effects in rats

Available scientific information for **molybdenum**:

Federal number

Lifetime health advisory

40 µg/L for molybdenum

Established in 1993

Based on oral reference dose

Available scientific information for **molybdenum**:

EPA value

Oral reference dose

0.005 mg/kg-d for molybdenum

Established in 1992

Based on increased incidence of gout in Armenian community

Available scientific information for **molybdenum**:

Technical information

Intermediate oral minimum reference level

0.008 mg/kg-d for molybdenum

Established by ATSDR in 2017

Based on effects on reproduction in rats

ATSDR = Agency for Toxic Substances and Disease Registry

Available scientific information for **molybdenum**:

Technical information

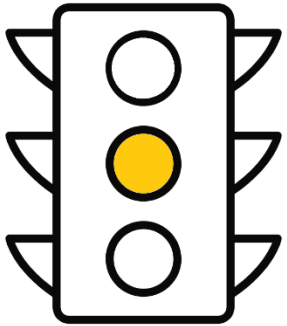
Critical studies

Toxicity studies (2) evaluating effects on reproduction in rats

DHS recommends **no change** to the **enforcement standard** for **molybdenum**.

DHS recommends **lowering** the **preventive action limit** for **molybdenum**.

DHS recommends that the preventive action limit for **molybdenum** be set at:



Preventive action limit

=

10%

of the enforcement standard

Molybdenum can cause interactive effects with copper and birth defects in rats.

Boron

Wisconsin has groundwater standards for **boron**.

The current enforcement standard is based on:

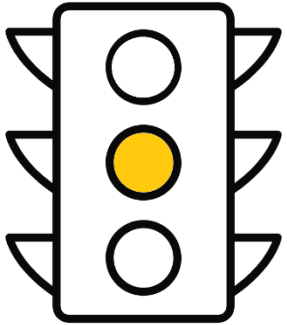
Federal number

1000 µg/L for boron

Established in 2010

EPA lifetime health advisory

The current preventive action limit for **boron** is set at:



Preventive action limit

=

20%

of the enforcement standard

No evidence of carcinogenic, mutagenic, teratogenic, or interactive effects.

Available scientific information for **boron**:

- Federal number
- State drinking water standard
- EPA value
- Technical information
- Cancer risk

Available scientific information for **boron**:

Federal number

10-Day child health advisory

3000 µg/L for boron

Established in 2008

Based on effects on sperm in rats

Available scientific information for **boron**:

Federal number

Longer-term child health advisory

2000 µg/L for boron

Established in 2008

Based on effects on testes in rats

Available scientific information for **boron**:

Federal number

Longer-term adult health advisory

5000 µg/L for boron

Established in 2008

Based on effects on development in rats

Available scientific information for **boron**:

Federal number

Lifetime health advisory

5000 µg/L for boron

Established in 2008

Based on same study as longer-term adult health advisory

Available scientific information for **boron**:

EPA value

Oral reference dose

0.2 mg/kg-d for boron

Established in 2004

Based on effects on development in rats (used to set the adult/lifetime health advisories)

Available scientific information for **boron**:

Technical information

Chronic oral minimum reference level

0.2 mg/kg-d for boron

Established by ATSDR in 2017

Based on same study as EPA's oral reference dose

ATSDR = Agency for Toxic Substances and Disease Registry

Available scientific information for **boron**:

Technical information

WHO drinking water guideline value

2400 µg/L for boron

Established in 2009

Based on effects on development in rats

WHO = World Health Organization

Available scientific information for **boron**:

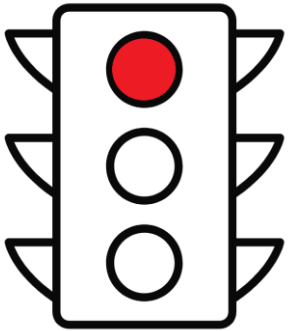
Technical information

Critical study

Toxicity study (1) evaluating effects on immune function in rats

DHS recommends **raising** the **enforcement standard** for **boron**.

DHS recommends that the enforcement standard for **boron** be set at:



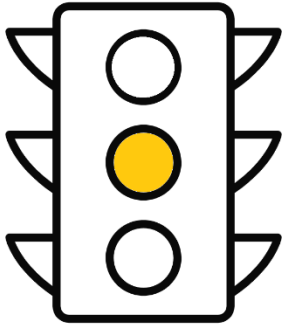
Enforcement Standard

= 2000 µg/L

based on EPA's longer-term child health advisory

DHS recommends **no change to** the **preventive action limit** for **boron**.

DHS recommends that the preventive action limit for **boron** be set at:



Preventive action limit

=

20%

of the enforcement standard

No evidence of carcinogenic, mutagenic, teratogenic, and interactive effects.

Strontium

Wisconsin currently does not have groundwater standards for **strontium**.

Available scientific information for **strontium**:

- Federal number
- State drinking water standard
- EPA value
- Technical information
- Cancer risk

Available scientific information for **strontium**:

Federal number

1- and 10-Day child health advisories

25000 µg/L for strontium

Established in 1993

Based on effects of strontium supplementation in people

Available scientific information for **strontium**:

Federal number

Lifetime health advisory

4000 µg/L for strontium

Established in 1993

Based on oral reference dose set by IRIS

IRIS = Integrated Risk Information System

Available scientific information for **strontium**:

Federal number

Health reference level

1500 µg/L for strontium

Established by EPA

Based on oral reference dose set by the Office of Water

UCMR3 = unregulated contaminant monitoring rule 3 (2014)

Available scientific information for **strontium**:

EPA value

Oral reference dose

0.6 mg/kg-d for strontium

Established in 1993 by IRIS

Based on effects on bone calcification in rats (20 day study)

IRIS = Integrated Risk Information System

Available scientific information for **strontium**:

EPA value

Oral reference dose

0.3 mg/kg-d

Established in 2014 by the Office of Water

Based on effects on bone calcification in rats (60 day study)

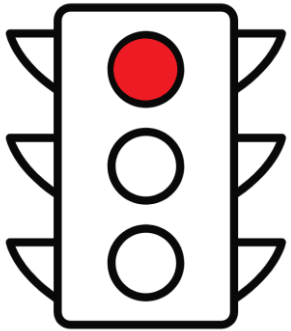
Available scientific information for **strontium**:

Technical information

Critical study

Toxicity study (1) evaluating effects on development in rats

DHS recommends that the enforcement standard for **strontium** be set at:

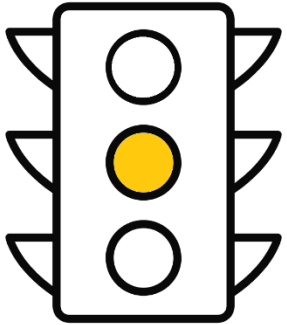


Enforcement Standard

= 1500 µg/L

based on EPA's health reference level

DHS recommends that the preventive action limit for **strontium** be set at:



Preventive action limit

=

10%

of the enforcement standard

Strontium can cause birth defects in rats.

Hexavalent chromium

Wisconsin currently does not have a groundwater standard for **chromium (VI)**.

Wisconsin has groundwater standards for total chromium.

Available scientific information for **chromium (VI)**:

Federal number

State drinking water standard

EPA value

Technical information

Cancer risk

Available scientific information for **chromium (VI):**

EPA value

Oral reference dose

2.5 mg/kg-d for chromium (VI)

Established in 1998

Based on one year rat study that did not see adverse effects

Available scientific information for **chromium (VI):**

EPA value

Draft oral reference dose

0.0009 mg/kg-d for chromium (VI)

Established in 2010

Based on intestinal damage in mice

Available scientific information for **chromium (VI):**

Technical information

Chronic minimum risk level

0.0009 mg/kg-d for chromium (VI)

Established in 2012 by ATSDR

Based on same study as EPA's oral reference dose

ATSDR = Agency for Toxic Substances and Disease Registry

Available scientific information for **chromium (VI):**

Technical information

Critical study

Toxicity studies (3) evaluating non-cancer effects in rodents

Available scientific information for **chromium (VI):**

Cancer risk

Cancer slope factor

0.0791 $(mg/kg\text{-}d)^{-1}$

Established by EPA's pesticide program in 2008

Available scientific information for **chromium (VI):**

Cancer risk

Draft cancer slope factor

0.05 $(mg/kg\text{-}d)^{-1}$

Established by EPA's IRIS program in 2010

DHS recommends establishing a
an **enforcement standard** for
chromium (VI) based on
cancer risk.

Carcinogens cause cancer through one of two ways.

Genotoxic chemicals

Directly alter DNA

Default approach

No safe level of exposure

- Use cancer slope factor

Non-genotoxic chemicals

Do not directly cause gene damage

Safe level of exposure

- Use acceptable daily intake

Recent study found that **chromium (VI)** caused cancer in mice and rats.

Small intestine tumors

Oral mucosa tumors

Chromium (VI) is treated as genotoxic because the mode of action is unclear.

Pesticide Program

$0.791\ (mg/kg\text{-}d)^{-1}$

Adenomas and carcinomas in the small intestines of **female** mice

Pesticide Program	$0.791\ (mg/kg\text{-}d)^{-1}$ Adenomas and carcinomas in the small intestines of **female** mice
IRIS	$0.5\ (mg/kg\text{-}d)^{-1}$ Adenomas and carcinomas in the small intestines of **male** mice

IRIS = integrated risk information system

Used by EPA, ATSDR, and California to evaluate cancer risk

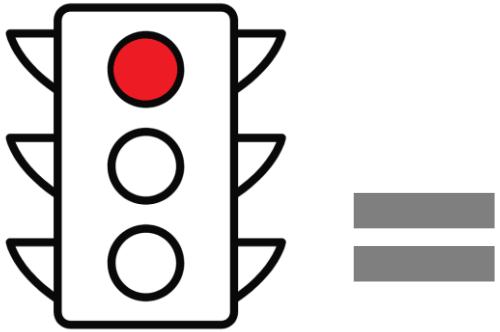
IRIS

$0.5\ (mg/kg\text{-}d)^{-1}$

Adenomas and carcinomas in the small intestines of **male** mice

IRIS = integrated risk information system

DHS recommends that the enforcement standard for **chromium (VI)** be set at:

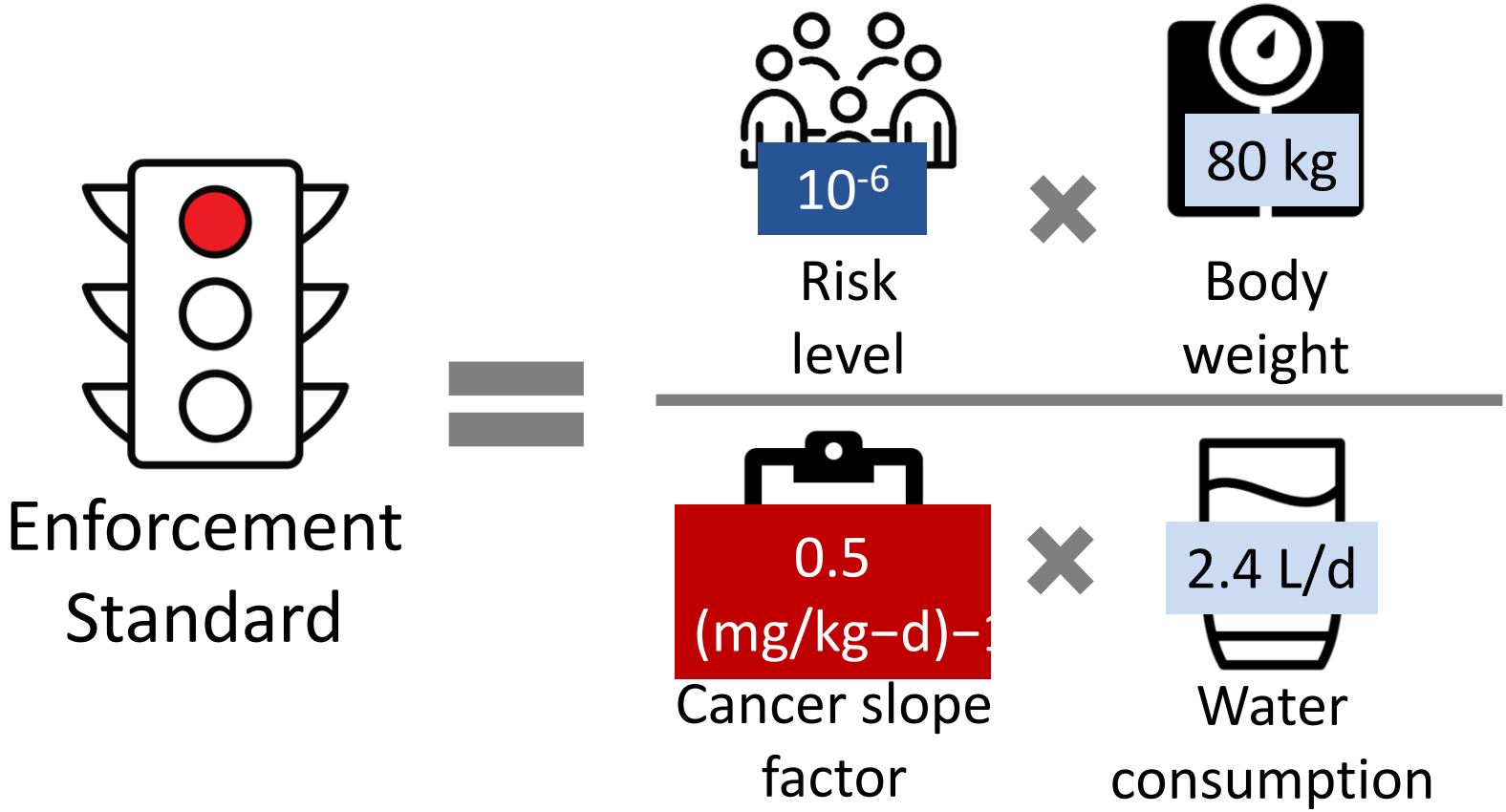


Enforcement Standard

=

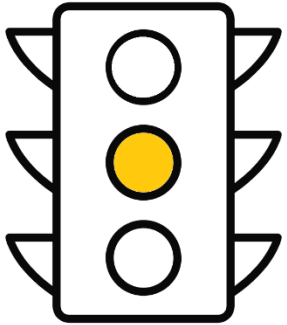
70 ng/L

based on cancer risk



Specified in Statute | Recommended by EPA

DHS recommends that the preventive action limit for **chromium (VI)** be set at:



Preventive action limit

=

10%

of the enforcement standard

Chromium (VI) causes carcinogenic effects in mice and rats.

In summary, DHS recommends

Aluminum	No change
Barium	No change
Boron	Higher standard
Chromium (VI)	New standard
Cobalt	Lower preventive action limit
Molybdenum	Lower preventive action limit
Strontium	New standard

Thanks!

Sarah Yang, Ph.D.
Groundwater Toxicologist
Bureau of Environmental and Occupational Health
Division of Public Health
Wisconsin Department of Health Services

sarahp.yang@wi.gov
608-266-9337

Additional information can be found on DHS' webpage: dhs.wisconsin.gov\water\gws.htm

The full scientific support document for all of the Cycle 10 compounds is available here: dhs.wisconsin.gov\publications\p02434v.pdf.