Assessing NTP’s Effectiveness: A Case Study on Hexavalent Chromium

Yun Xie, Ph.D. and Mary S. Wolfe, Ph.D.
Office of Liaison, Policy and Review
National Institute of Environmental Health Sciences

NTP Board of Scientific Counselors Meeting
December 10, 2014
Establishment of A National Toxicology Program

The Department of Health, Education, and Welfare announces the establishment of a National Toxicology Program within the Public Health Service (PHS). The broad goal of this Program is to strengthen the Department’s activities in the testing of chemicals of public health concern, as well as in the development and validation of new and better integrated test methods.

To accomplish this goal, the Program is established as a Department-wide effort to provide needed information to regulatory and research agencies and to strengthen the science base. The Program is at present composed of:

- Assistant Secretary for Occupational Safety and Health, Department of Labor;
- Chairman, Consumer Product Safety Commission;
- Administrator, Environmental Protection Agency;
- Director, National Institute for Occupational Safety and Health;
- Director, National Institutes of Health;
- Director, National Cancer Institute;
- Director, National Institute of Environmental Health Sciences;
- Assistant Secretary for Health and Surgeon General (nonvoting).

3. A Toxicology Program Board of Scientific Counselors (a public advisory group), which is responsible for reviewing the scientific merit of the Program. The Board is composed of governmental and nongovernmental scientists, appointed by the Secretary.

4. A Program Development Committee to develop the Annual Program Plan.
“NTP exists to develop the information and the tools that both agencies of government and industry need so that we can all live together safely in the same world.”

David P. Rall, 1981
Since Its Establishment, NTP Has

• Studied >2500 substances for variety of cancer and noncancer health effects

• Developed new methods, tools, and approaches

• Prepared and published
  – 580 NTP Technical Reports (~200 from NCI cancer bioassay program)
  – 79 NTP Toxicity Reports
  – 16 Genetically Modified Models Reports
  – 13 editions of Report on Carcinogens
  – 23 NTP Monographs (Center for Evaluation of Risks to Human Reproduction and Office of Health Assessment and Translation)
  – 1000s of journal publications
NTP Is Recognized as Authoritative by

- EPA Toxic Substances Control Act for ocean dumping permits and export notification requirements: Report on Carcinogens
- California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65)
  - Report on Carcinogens and NTP Technical Reports for identification of chemicals causing cancer
  - CERHR Monographs for identification of chemicals causing reproductive toxicity
- NTP Website: http://ntp.niehs.nih.gov/go/regact
What We Hoped to Gain

• Develop a useful approach
  – Identify methods that will yield comprehensive and credible assessments of NTP’s effectiveness.
  – Demonstrate the feasibility of assessing NTP’s impacts in multiple sectors:
    • Academia, industry, non-government groups, and federal, state, and international agencies
  – Identify strategies to improve existing methods for assessing research impacts.

• Successfully test the approach with a pilot project

• Hexavalent chromium case study
  – Demonstrate the effectiveness of NTP’s science at advancing toxicology and being translated to public health decision-making.
Acknowledgements

Contributors

• Yun Xie, PhD
• Stephanie Holmgren, MSLS, MBA
• Danica Andrews
• Mary Wolfe, PhD

Expert Advisers

• Christina Drew, PhD
• Michelle Hooth, PhD
• Matt Stout, PhD
• James Stojan
• Sylvia Richardson
• Background information for assessing research impact.
• Our logic model to assess NTP’s research effectiveness.
• The results from our hexavalent chromium case study.
Impact of NTP Research Is Dynamic

- NTP studies can impact different groups of people.
- Impact changes over time.
- How do we measure impact?
Challenges to Measuring Impact

• Attribution
  – Must show connection between our work and impact.
  – Must work without a counterfactual (i.e., what would happen without NTP research).

• Lag Time
  – Time from research to publication can be years.
  – Time from publication to citation is on average 3+ years.
  – Time from research to policy impact can be 10+ years.
  – Time from policy change to health impact can be many years.

• External Factors
  – We have no direct control over regulations, public health, etc.
  – External factors influence how our research leads to impact.
Identified strategies that will yield impact assessments that are:

- Comprehensive
- Credible
- Responsive
- Rigorous
NTP Mission and Goals

• NTP mission:
  – Evaluate agents of public health concern by developing and applying the tools of modern toxicology and molecular biology.

• NTP goals:
  – Coordinate toxicology testing programs within the federal government.
  – Strengthen the science base in toxicology.
  – Develop and validate improved testing methods.
  – Provide information about potentially toxic chemicals to health, regulatory, and research agencies, scientific and medical communities, and the public.
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  – Develop and validate improved testing methods.
  – **Provide information about potentially toxic chemicals to health, regulatory, and research agencies, scientific and medical communities, and the public.**
Logic Model for NTP Studies

INPUTS
- Money
- Time
- Staff

OUTPUTS
- Activities: Nomination, concept, studies, peer review, etc.
- Products: NTP reports, journal publications, etc.

OUTCOMES
- Proximal: Awareness of NTP products
- Intermediate: Inform science in stakeholder groups*
- Distal: Inform decision-making to effect a change
  - Improve public health

External Factors

MEDIA

*Stakeholder groups include academia, industry, federal regulatory and non-regulatory agencies, state agencies, non-government groups, and international agencies.
Logic Model for NTP Studies

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---

**OUTPUTS**
- Activities & Products
  - Number and dates of milestones of what NTP did and produced

---

*Stakeholder groups include academia, industry, federal regulatory and non-regulatory agencies, state agencies, non-government groups, and international agencies.
Logic Model for NTP Studies

**INPUTS**  | **OUTPUTS**  | **OUTCOMES**
---|---|---
Money  | Activities | Proximal  
Time  | Products | Intermediate  
Staff  | NTP reports, journal publications, etc. | Distal

- **Nomination, concept, studies, peer review, etc.**
- **NTP reports, journal publications, etc.**

**OUTCOMES (Impacts)**

<table>
<thead>
<tr>
<th>Activities &amp; Products</th>
<th>Proximal</th>
<th>Intermediate</th>
<th>Distal</th>
</tr>
</thead>
</table>
| Number and dates of milestones of what NTP did and produced | Number of downloads and requests for NTP products | **Awareness of NTP products** | **Inform science in stakeholder groups**
|  |  | **Inform decision-making to effect a change** | **Improve public health** |

*Stakeholder groups include academia, industry, federal regulatory and non-regulatory agencies, state agencies, non-government groups, and international agencies.*
**Logic Model for NTP Studies**

### Inputs
- Money
- Time
- Staff

### Outputs
- Activities
  - Nomination, concept, studies, peer review, etc.
- Products
  - NTP reports, journal publications, etc.

### Outcomes
- Proximal
  - Awareness of NTP products
- Intermediate
  - Inform science in stakeholder groups*
  - Inform decision-making to effect a change
- Distal
  - Improve public health

### Outputs (Impacts)

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<tr>
<td>Number and dates of milestones of what NTP did and produced</td>
<td>Number of downloads and requests for NTP products</td>
<td>Number and nature of citations in science publications, grants, and reports from stakeholder groups*</td>
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*Stakeholder groups include academia, industry, federal regulatory and non-regulatory agencies, state agencies, non-government groups, and international agencies.
Logic Model for NTP Studies

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<td>Awareness of NTP products</td>
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<tr>
<td>Time</td>
<td>NTP reports, journal publications, etc.</td>
<td>Inform science in stakeholder groups*</td>
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<tr>
<td>Staff</td>
<td>Activities</td>
<td>Inform decision-making to effect a change and improve public health</td>
</tr>
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<th>OUTPUTS</th>
<th>OUTCOMES (Impacts)</th>
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*Stakeholder groups include academia, industry, federal regulatory and non-regulatory agencies, state agencies, non-government groups, and international agencies.
• This impact evaluation focuses on chromium (VI).

• NTP’s work on chromium (VI) was completed several years ago with presumably sufficient time to identify its use by stakeholders and evaluate impacts.
NTP Outputs: Activities and Products

**Inputs**
- Money
- Time
- Staff

**Outputs**
- Activities
  - Nomination, concept, studies, peer review, etc.
  - NTP reports, journal publications, etc.

**Products**

**Outcomes**
- Proximal
  - Awareness of NTP products
- Intermediate
  - Inform science in stakeholder groups
- Distal
  - Inform decision-making to effect a change in public health

**Diagram**
- Flowchart showing the relationship between inputs, outputs, and outcomes.
Outputs: A Timeline of Main Activities

Nomination of hexavalent chromium compounds from NCI (inhalation)

Start of NTP studies on potassium dichromate (diet)

Expert panel meeting: Design of proposed carcinogenesis and toxicokinetic studies of hexavalent chromium (drinking water)

Start of NTP studies for sodium dichromate dihydrate (drinking water)

Nomination of sodium dichromate dihydrate (VI) by CA State Senator (drinking water)

Nomination of sodium dichromate dihydrate (VI) by CA EPA (drinking water)

Nomination of sodium dichromate dihydrate (VI) by US Congressional Delegation from CA (drinking water)

TR Review Subcommittee evaluated draft NTP TR on sodium dichromate dihydrate

Nomination of sodium dichromate dihydrate (VI) by US Congressional Delegation from CA (drinking water)

'80 '81 '82 '83 '84 '85 '86 '87 '88 '89 '90 '91 '92 '93 '94 '95 '96 '97 '98 '99 '00 '01 '02 '03 '04 '05 '06 '07 '08 '09 '10 '11 '12 '13
CrVI compounds first listed in the First Annual Report on Carcinogens

Final report. Effects of potassium dichromate on Sprague-Dawley rats when administered in the diet

Final report. Effects of potassium dichromate in BALB/c mice when administered in the diet

Final report. Reproductive assessment by continuous breeding when administered to BALB/c mice in the diet

NTP TOX 72 sodium dichromate dihydrate

NTP TR 546 sodium dichromate dihydrate

Environ. Health Perspect. publication
Arch. Environ. Contam. Toxicol. publication
Analytical Lett. publication
Toxicol. Sci. publication
Toxicol. Pathol. publication
Outcomes

**Inputs**
- Money
- Time
- Staff

**Outputs**
- Activities
- Products

**Outputs**
- Nomination, concept, studies, peer review, etc.
- NTP reports, journal publications, etc.

**Outcomes**
- Proximal
  - Awareness of NTP products
  - Inform science in stakeholder groups
  - Inform decision-making to effect a change
- Intermediate
  - Improve public health

- Distal
Webpage Views for TR 546: July 2011 – October 2014

- **External**
- **Internal**

### Month and Year
- Jul-11
- Aug-11
- Sep-11
- Oct-11
- Nov-11
- Dec-11
- Jan-12
- Feb-12
- Mar-12
- Apr-12
- May-12
- Jun-12
- Jul-12
- Aug-12
- Sep-12
- Oct-12
- Nov-12
- Dec-12
- Jan-13
- Feb-13
- Mar-13
- Apr-13
- May-13
- Jun-13
- Jul-13
- Aug-13
- Sep-13
- Oct-13
- Nov-13
- Dec-13
- Jan-14
- Feb-14
- Mar-14
- Apr-14
- May-14
- Jun-14
- Jul-14
- Aug-14
- Sep-14
- Oct-14

### Number of Views
- 0
- 200
- 400
- 600
- 800
- 1000
- 1200
- 1400
- 1600

Proximal Outcomes
Proximal Outcomes

Webpage Views for TOX 72: July 2011 – October 2014

Number of Views

- External
- Internal

Month and Year

Number of Views

- 0
- 500
- 1000
- 1500
- 2000
- 2500
- 2500
Requests to NTP’s Document Management Team

• 15 Total requests for chromium (VI):
  – 2 Related to RoC
  – 13 Related to TR 546 or TOX 72

• Requests came from multiple groups:
  – Industry
  – U.S. EPA
  – U.S. House staff
  – NJ state agency
  – Academia
Intermediate Outcomes

NTP goal:

**Strengthen the science base in toxicology.**
Bibliometrics

Citations in Scientific Literature

(Journal Articles, Book Chapters, and Reviews)
Intermediate Outcomes

Citations of NTP Journal Publications
Searched by Web of Science and Scopus

**Context/Informative**: Cited NTP product to provide context for their study or to inform experimental design and/or data interpretation.

**Significant**: Used NTP data and/or method in their study.

<table>
<thead>
<tr>
<th>NTP Publication</th>
<th>Context/Informative</th>
<th>Significant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stout et al., Environ Health Perspect (2009)</td>
<td>53</td>
<td>11</td>
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<tr>
<td>Levine et al. Anal Lett (2009)</td>
<td>1</td>
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</tr>
<tr>
<td>Collins et al., Toxicol Sci (2010)</td>
<td>21</td>
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</tr>
<tr>
<td>Levine et al., Arch Environ Contam Toxicol (2010)</td>
<td>1</td>
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<tr>
<td>Witt et al., Toxicol Pathol (2013)</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

*Citations through Oct. 2014*
**Intermediate Outcomes**

**Citations of NTP Technical Report and Toxicity Report**

**Searched by PubMed**

**Context/Informative**: Cited NTP product to provide context for their study or to inform experimental design and/or data interpretation.

**Significant**: Used NTP data and/or method in their study.

*TOX 72: Sodium Dichromate Dihydrate (2007)*

*TR 546: Sodium Dichromate Dihydrate (2008)*

*Citations through Oct. 2014*
Bibliometrics

Citations in Grants
Intermediate Outcomes

**NIH-Funded Grants that Cite NTP’s Work**

- References from grants are not searchable on NIH database.
- Searches were performed for grants that related to chromium.
  - Available references were checked for NTP products.
  - 4 grants were found that reference TR 546 or RoC:
    - **NIEHS**: Zhitkovich, Anatoly. *Genotoxicity of Chromium Compounds* (TR 546 Sodium Dichromate Dihydrate).
    - **NIEHS**: Chang, Howard Y. *LncRNA regulation of environmental response* (RoC).
Bibliometrics

Citations in State, Federal, and Non-Government Reports
Search Strategies

Searched for NTP product references in

- Regulations
- Policy documents
- Science reports from other agencies
- Legal documents

Searches were done for

- All 50 states
- U.S. federal agencies
- U.S. non-government groups
- International community
Intermediate Outcomes

Impact of NTP’s Work in Individual States

- Legislation, reports, and/or news
- News
Intermediate Outcomes

Bibliometric Data: States

<table>
<thead>
<tr>
<th>State</th>
<th>Number of Reports</th>
<th>Number of Citations of NTP Product</th>
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<tr>
<td>California</td>
<td>5</td>
<td>10</td>
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<tr>
<td>Missouri</td>
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<td>1</td>
</tr>
<tr>
<td>New Jersey</td>
<td>5</td>
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<td>New York</td>
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<td>6</td>
</tr>
<tr>
<td>Texas</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Washington</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

- RoC
- 3 Final Reports on Potassium Dichromate
- Toxicity Report (TOX 72) on Sodium Dichromate
- Technical Report (TR 546) on Sodium Dichromate
- Journal Article by NTP Staff
- Fact Sheet
- NIEHS News Release
Intermediate Outcomes

Bibliometric Data: Federal Agencies

Federal Agency (Number of Reports)

- NIOSH (1)
- CDC/ATSDR (1)
- EPA (7)

Number of Citations of NTP’s Work

0 5 10 15 20

- RoC
- 3 Final Reports on Potassium Dichromate
- Toxicity Report (TOX 72) on Sodium Dichromate
- Technical Report (TR 546) on Sodium Dichromate
- Journal Article by NTP Staff
Intermediate Outcomes

Bibliometric Data: International Agencies

<table>
<thead>
<tr>
<th>International Agency (Number of Reports)</th>
<th>Number of Citations of NTP’s Work</th>
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<tbody>
<tr>
<td>WHO IARC (1)</td>
<td>0 1 2 3</td>
</tr>
<tr>
<td>WHO IPCS (1)</td>
<td>RoC</td>
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- 3 Final Reports on Potassium Dichromate
- Toxicity Report (TOX 72) on Sodium Dichromate
- Technical Report (TR 546) on Sodium Dichromate
Bibliometric Data: Non-Government Groups

- **Water Research Foundation (1)**
  - Technical Report (TR 546) on Sodium Dichromate
  - Journal Article by NTP Staff
- **Earth Justice (1)**
- **Environmental Working Group (1)**
- **Natural Resources Defense Council (1)**

Number of Citations of NTP’s Work

Non-Government Groups (Number of Reports)

- Water Research Foundation: 2 citations
- Earth Justice: 1 citation
- Environmental Working Group: 2 citations
- Natural Resources Defense Council: 1 citation
Congressional Hearings

**Joan Claybrook**, President of Public Citizen
U.S. House Committee on Oversight and Government Reform; House Subcommittee on Energy Policy, Health Care, and Entitlements; Impact of Regulation on U.S. Manufacturing

**Linda Birnbaum**, NIEHS Director
Senate Environment and Public Works Subcommittee on Superfund, Toxics and Environmental Health Hearing

**Senator Barbara Boxer** to Lisa Jackson
Senate Committee on Environment and Public Works, Nomination of Lisa Jackson to be the EPA Administrator

**Lisa Jackson**, EPA Administrator
**Linda Birnbaum**, NIEHS Director
**Barbara Boxer**, Senator
**Kenneth Cook**, Environmental Working Group
**Thomas Burke**, Johns Hopkins
U.S. Senate Committee on Environment and Public Works

**Steven R. Patierno**, George Washington University
U.S. Senate Committee on Environment and Public Works; Oversight Hearing on the EPA’s Implementation of the Safe Drinking Water Act’s Unregulated Drinking Water Contaminants Program

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**RoC**
**Journal publication**
**TR 546 Sodium Dichromate Dihydrate**
Petition asks the California Department of Public Health to promulgate an enforceable hexavalent chromium drinking water standard.

Public Citizen Health Research Group filed suit against OSHA for delay in setting rulemaking on hexavalent chromium.

Plaintiff sued defendant alleging manufacturer contributed to chromium waste and wanted stricter remediation than what was granted previously.

Senate Bill to amend the Safe Drinking Water Act

House Bill to amend the Safe Drinking Water Act

RoC

TR 546 Sodium Dichromate Dihydrate

Federal Legislative and Judicial Impact

Intermediate Outcomes

Nov'02 Jun'03 Jan'04 Aug'04 Mar'05 Oct'05 May'06 Dec'06 Jul'07 Feb'08 Sep'08 Apr'09 Nov'09 Jun'10 Jan'11 Aug'11 Mar'12 Oct'12
NTP goals:

Provide information about potentially toxic chemicals to health, regulatory, and research agencies, scientific and medical communities, and the public.
In May 2014, the regulation for a maximum contaminant level (MCL) of chromium-6 was approved by the Office of Administrative Law.

The 0.010-milligram per liter MCL became effective on July 1, 2014.

NTP’s research was key to California’s drinking water standard for chromium (VI).
Nomination of sodium dichromate dihydrate (VI) by CA State Senator
Nomination of sodium dichromate dihydrate (VI) by CA EPA
Nomination of sodium dichromate dihydrate (VI) by US Congressional Delegation from CA

Outputs: Nomination Activity
Path to Distal Outcomes in CA: TR 546

- Nomination of sodium dichromate dihydrate (VI) by US Congressional Delegation from CA
- Nomination of sodium dichromate dihydrate (VI) by CA EPA
- Nomination of sodium dichromate dihydrate (VI) by CA State Senator

Outputs: Nomination Activity
- NTP TR546
- NTP BSC Technical Reports Review Subcommittee
- NTP Release draft TR546 sodium dichromate dihydrate
- NTP FRN for NTP BSC Technical Reports Review Subcommittee

Outputs: Activities/Products
Path to Distal Outcomes in CA: TR 546

Rep. Adam Schiff announced the release of draft TR546

Asking for conclusions of studies. Legislative Fellow for Office of Rep. Adam Schiff

NOMINATION OF SODIUM DICHROMATE DIHYDRATE (VI) BY:
- CA State Senator
- CA EPA
- US Congressional Delegation from CA

NOMINATION ACTIVITY:
- NTP FRN for NTP BSC Technical Reports Review Subcommittee
- NTP Release draft TR546 sodium dichromate dihydrate

OUTCOMES: PROXIMAL

OUTCOMES: ACTIVITIES/PRODUCTS
Nomination of sodium dichromate dihydrate (VI) by CA State Senator
Nomination of sodium dichromate dihydrate (VI) by CA EPA
Nomination of sodium dichromate dihydrate (VI) by US Congressional Delegation from CA
Rep. Adam Schiff announced the release of draft TR546
Asking for conclusions of studies. Legislative Fellow for Office of Rep. Adam Schiff
Science Report: Evidence on the Developmental and Reproductive Toxicity of Chromium (hexavalent compounds)
Public Health Goals for Chemicals in Drinking Water: Hexavalent Chromium (Cr VI)
Proposed Regulation Initial Statement of Reasons
NTP TR546
NTP BSC Technical Reports Review Subcommittee
NTP Release draft TR546 sodium dichromate dihydrate
NTP FRN for NTP BSC Technical Reports Review Subcommittee

Outputs: Nomination Activity
Outputs: Activities/Products

Outcomes: Proximal
Outcomes: Intermediate

Path to Distal Outcomes in CA: TR 546
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Asking for conclusions of studies. Legislative Fellow for Office of Rep. Adam Schiff

Public Health Goals for Chemicals in Drinking Water: Hexavalent Chromium (Cr VI)

Science Report: Evidence on the Developmental and Reproductive Toxicity of Chromium (hexavalent compounds)

NTP TR546

NTP BSC Technical Reports Review Subcommittee

NTP Release draft TR546 sodium dichromate dihydrate

NTP FRN for NTP BSC Technical Reports Review Subcommittee

Proposed Regulation Initial Statement of Reasons

TR 546

TR 546, TOX 72, RoC, 3 Final Reports, 1 Journal Pub

Outputs: Nomination Activity

Outputs: Activities/Products

Outcomes: Proximal

Outcomes: Intermediate
Path to Distal Outcomes in CA: TR 546

- Nomination of sodium dichromate dihydrate (VI) by CA State Senator
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- Rep. Adam Schiff announced the release of draft TR 546
- Asking for conclusions of studies. Legislative Fellow for Office of Rep. Adam Schiff

- Public Health Goals for Chemicals in Drinking Water: Hexavalent Chromium (Cr VI)
- Science Report: Evidence on the Developmental and Reproductive Toxicity of Chromium (hexavalent compounds)

- Proposed Regulations: Initial Statement of Reasons
- Regulation for a maximum contaminant level of chromium-6 was approved by the Office of Administrative Law.
- 0.010-milligram per liter MCL became effective.

Outcomes: Nomination Activity
Outcomes: Activities/Products
Outcomes: Proximal
Outcomes: Intermediate
For distal outcomes, there is increased lag time and reliance on external factors.

“…a protracted timeframe introduces many variables that are difficult to track and are often beyond the control of NIH.”

<table>
<thead>
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<tr>
<td>6/1/10</td>
<td>Draft Revisions Model Toxics Control Act Method A Groundwater Cleanup Levels</td>
<td>TR546</td>
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Department of Ecology began reviewing and updating the Model Toxics Control Act (MTCA) Cleanup Regulation. External advisory groups formed.

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Draft revisions MTCA Method A groundwater cleanup levels (TR546 cited)

1 year suspension of MTCA rulemaking
EPA developed a new schedule for completing the IRIS hexavalent chromium assessment.

Preliminary materials for IRIS review of Cr VI pt1: Experimental animal studies.

Preliminary materials for IRIS review of Cr VI part 2: Human, toxicokinetic, and mechanistic studies.

RoC

TR 546 Sodium Dichromate Dihydrate

TOX 72 Sodium Dichromate Dihydrate

Final reports (set of 3) on the reproductive toxicity of potassium dichromate.
*Stakeholder groups include academia, industry, federal regulatory and non-regulatory agencies, state agencies, non-government groups, and international agencies.
• Analyzed over 400 media articles related to the NTP and chromium.
• Media coverage paralleled NTP outputs and outcomes.
• Analyzed over 400 media articles related to the NTP and chromium.

• Media coverage paralleled NTP outputs and outcomes.

• For example:
• This case study demonstrated NTP’s science on chromium VI had impact in many areas including public health.

• We identified a broad and objective approach for assessing NTP’s effectiveness.

• Discovered data and methodological gaps that need to be addressed for more thorough and efficient assessments in the future.
Actions for Improving Future Evaluations

• Proximal Outcomes
  – Working to better track web trends data in a more timely manner.
  – Exploring methods to obtain journal download numbers.
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  – Ensuring that NTP reports are indexed in Web of Science and Scopus to enable more thorough citation searches.
  – Working with PubMed to make NTP reports more accessible.
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• Distal Outcomes
  – Working with Sciome, Inc. subcontractors on web-mining tools (e.g., search automation and text mining).
Actions for Improving Future Evaluations

Overall Improvements

• Use methods learned from retrospective work to track current NTP projects (e.g., systematic review).
  – Timely tracking of activities, products, and impacts.
  – Ensure NTP work is effectively communicated to the public and stakeholders.
Next Steps

• Develop an approach to conduct a retrospective evaluation that more broadly examines NTP effectiveness:
  – Random selection of NTP reports in a certain time range that accounts for:
    • Lag time.
    • Availability of data.
  – Identify differences in achieving distal impacts.
    • Determine why there are differences in achieving distal impacts if differences are found.
    • Potentially identify additional distal outcomes not currently measured.
Questions