

Identifying “Greener” Analytical Methods in NEMI for More Environmentally Friendly Monitoring

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National Monitoring Conference - May 10, 2006





Overview



- Background
 - ACS Green Chemistry Institute
 - Methods and Data Comparability Board
 - NEMI
- Applying Green Chemistry to Methods
 - Green Chemistry and the 12 Principles
 - “Greener” analytical method
 - Selection Criteria
 - Examples
- How to develop “greener” methods
- Status and Outlook



Green Chemistry Institute



Green
Chemistry
Institute

- ❑ Founded in 1997 as an independent, nonprofit organization
- ❑ Formed an alliance with the American Chemical Society in 2001
- ❑ Mission: to advance the implementation of green chemistry principles into all aspects of the chemical enterprise.
 - Research
 - Education
 - Policy Advocacy
 - Industrial Implementation
 - International Cooperation
 - Conferences & Awards

www.greenchemistryinstitute.org



Methods and Data Comparability Board



Green
Chemistry
Institute

- ❑ A partnership of water-quality and environmental monitoring experts facilitating collaborations of nationwide environmental monitoring
- ❑ Chartered under the National Water Quality Monitoring Council
- ❑ Workgroups
 - **National Environmental Methods Index**
(+ green chemistry profiles of methods)
 - Water Quality Data Elements
 - Lab and Field Accreditation
 - Biology and Microbiology
 - Performance Based Systems & Nutrients (PBS/Nutrients)
 - New Technologies

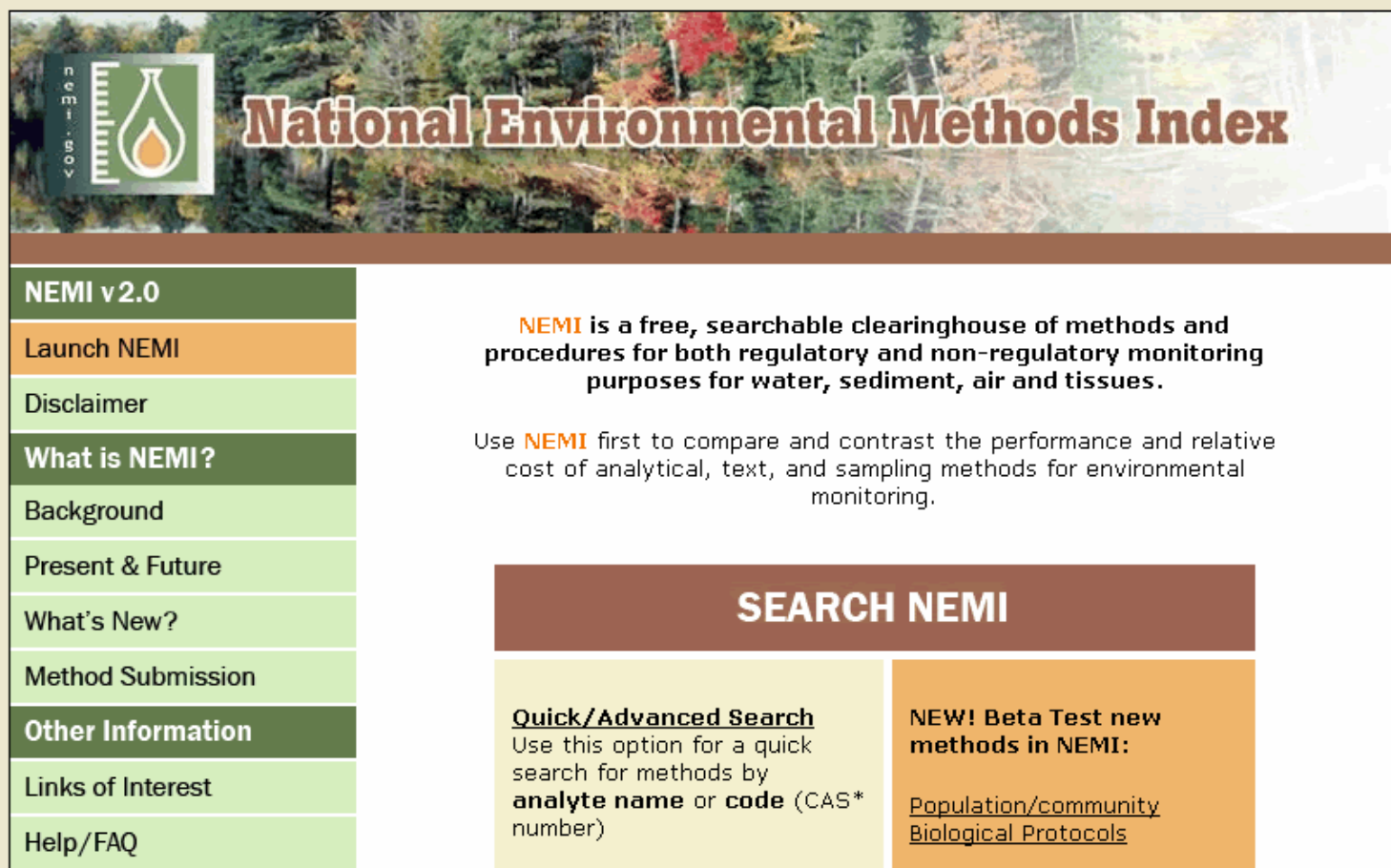


NEMI Homepage

www.nemi.gov



- Searchable, free, online database
- Contains 800+ methods
- Dynamic
- Useful for searching & comparing methods



The screenshot shows the NEMI homepage with a header image of a forest. The main title is "National Environmental Methods Index". Below the title is a navigation menu with links: NEMI v2.0, Launch NEMI, Disclaimer, What is NEMI?, Background, Present & Future, What's New?, Method Submission, Other Information, Links of Interest, and Help/FAQ. The main content area describes NEMI as a free, searchable clearinghouse of methods and procedures for both regulatory and non-regulatory monitoring purposes for water, sediment, air and tissues. It also includes a search section with a "SEARCH NEMI" button and two options: "Quick/Advanced Search" and "NEW! Beta Test new methods in NEMI:". The "Quick/Advanced Search" option allows users to search by analyte name or code (CAS* number). The "Beta Test" option includes links for "Population/community" and "Biological Protocols".

National Environmental Methods Index

NEMI v2.0

- Launch NEMI
- Disclaimer
- What is NEMI?
- Background
- Present & Future
- What's New?
- Method Submission
- Other Information
- Links of Interest
- Help/FAQ

NEMI is a free, searchable clearinghouse of methods and procedures for both regulatory and non-regulatory monitoring purposes for water, sediment, air and tissues.

Use **NEMI** first to compare and contrast the performance and relative cost of analytical, text, and sampling methods for environmental monitoring.

SEARCH NEMI

Quick/Advanced Search
Use this option for a quick search for methods by **analyte name** or **code** (CAS* number)

NEW! Beta Test new methods in NEMI:

Population/community
Biological Protocols



“Greener” Analytical Methods in NEMI



- **Why:** Many methods used to analyze environmental samples are themselves harmful to the environment.
- **What:** GCI is working with NEMI/MDCB to define and identify “Greener” Analytical Methods within NEMI that:
 - use fewer hazardous solvents
 - use safer chemicals
 - prevent waste
- **Goal:** To provide “greenness” profiles so NEMI users can make more informed decisions when selecting a method. The method selected must also meet the desired performance criteria.
- Funded by the ACS Petroleum Research Fund.



What is Green Chemistry?



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- Green chemistry is the **design** of chemical products and processes that **reduce or eliminate** the **use and/or generation** of hazardous substances.



Principles of Green Chemistry



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12 Principles of Green Chemistry can be used as guidelines for defining a “Greener” Analytical Method (abbreviated list*), especially the principles in **bold**:

- 1) **Prevent waste**
- 2) Maximize atom economy
- 3) Design less hazardous chemical syntheses
- 4) **Design safer chemicals and products**
- 5) **Use safer solvents and reaction conditions**
- 6) **Increase energy efficiency**
- 7) Use renewable feedstocks
- 8) **Avoid chemical derivatives**
- 9) Use catalysts, not stoichiometric reagents
- 10) Design chemicals and products that degrade after use
- 11) **Analyze in real time to prevent pollution**
- 12) **Minimize the potential for accidents**

* Anastas, P. T. and Warner, J. C. *Green Chemistry: Theory and Practice*, Oxford University Press: New York, 2000.



Definition of a “Greener” Analytical Method

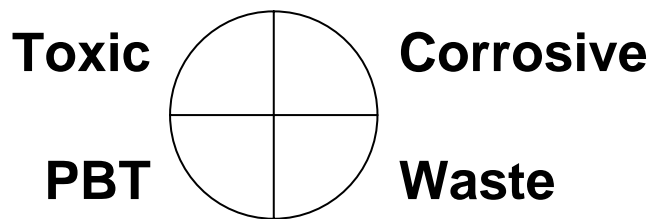


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- An analytical method that **meets the selection criteria** that were developed **based on the 12 Principles of Green Chemistry.**



Selection Criteria and Symbol



Brown-filled quadrant = the method is “less green” as defined by the selection criteria related to that quadrant.

□ Selection Criteria

- PBT, Toxic, Corrosive, and Waste
- Translate data from methods into “greenness” profile
- Identify what is “less green”
- Not arbitrary but not set in stone
- Developed in collaboration with 25+ methods experts from 5+ Federal agencies and private labs

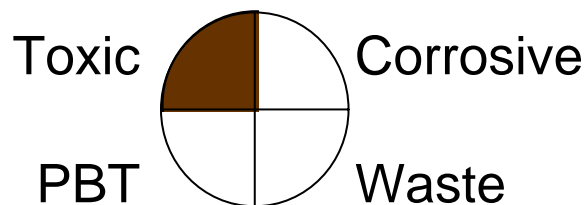
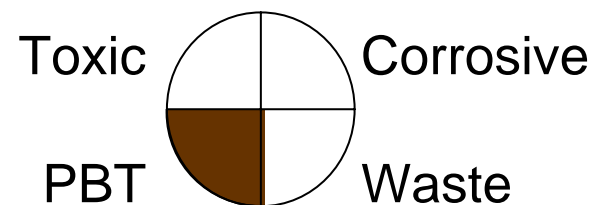


Selection Criteria



A method is “less green” if:

1. **PBT** – A chemical is listed as persistent, bioaccumulative, and toxic (PBT).
2. **Toxic** – A chemical is listed on the **TRI** or **RCRA's D, F, P or U lists**.



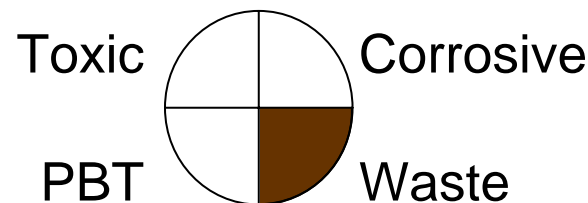
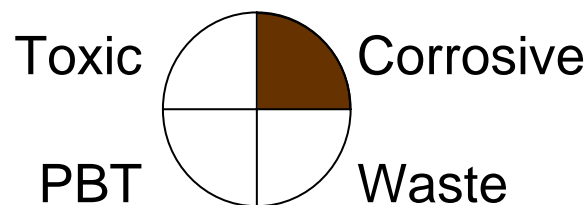


Selection Criteria Continued



A method is “less green” if:

3. **Corrosive** – pH is < 2 or > 12 , or if $> 1\%$ concentrated mineral acids or bases are used.
4. **Waste** – > 50 g total waste, or the ratio of work-up materials to **solid** sample > 1 .
5. **Waste** – > 50 g total waste, or the ratio of work-up materials to **liquid** sample > 0.2 .





NEMI Quick/Advanced (Analyte) Search



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National Environmental Methods Index

<< Back Analyte (main) Search Regulatory Search General Search NEMI Home

For this search, you must select an analyte, either by name or by code.

Type the exact analyte name or code into the appropriate field to the right. You may enter a name or code, but not both.

--OR--

If you are unsure of the spelling of an analyte name, press 'Find an Analyte by name or code'

Select Search Criteria

Analyte Name or Code (required)

Find an Analyte by Name or Code...

Analyte Name: aldrin

- OR -

Analyte Code:

Media Name*: Any

Source*: U.S. EPA National Exposure Research Laboratory (NERL) [formerly EMSL]

Instrumentation*: Any

Method Subcategory*: Any

* optional

Search NEMI

View Results in a New Window (Printable Format)

Export results for Microsoft Excel

Export results as a tab separated text file (can be opened in any text editor or spreadsheet)

We will add a new column in the search results. For example:

Analyte: Aldrin (309-00-2) [Click for list of synonyms](#)

3 methods were found in NEMI that match your criteria for the analyte aldrin.

Criteria Summary:

- Method Source equals U.S. EPA National Exposure Research Laboratory (NERL) [formerly EMSL]

Method Number (Sort)	Source (sorted)	Method Descriptive Name (Sort)	Detection Level	Detection Level Type	Bias	Precision	Spiking Level	Instrumentation (Sort)	Relative Cost (Sort)	"Greenness" Profile
525.2	EPA-NERL	Organics in Water Using GCMS	.11 ug/L	MDL	80 % Rec (SL)	9 RSD (SL)	.5 ug/L	GC-MS	\$\$\$	
505	EPA-NERL	Pesticides and PCBs in Water GC-ECD	.007 ug/L	MDL	106 % Rec (SL)	20 RSD (SL)	.05 ug/L	GC-ECD	\$\$\$	

Do Not Cite or Quote

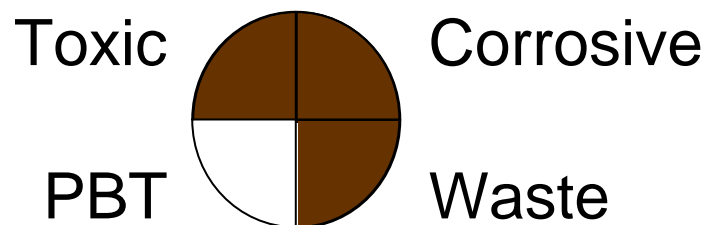


“Greenness” Profiles



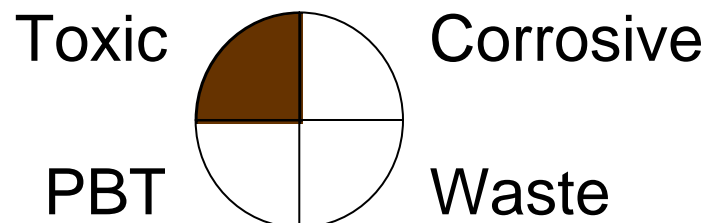
□ Method 525.5

- PBT – no PBT
- Toxic – “less green” (ethyl acetate, methylene chloride, methanol)
- Corrosive – “less green” (pH <2)
- Waste – “less green” (> 50g waste)



□ Method 505

- PBT – no PBT
- Toxic – “less green” (hexane)
- Corrosive – no acid/base
- Waste – < 50g waste



* “Greenness” profiles will be available through the [Method Summary screen in NEMI](#), with detailed chemicals, amounts, pH, and waste, to inform the user’s decision.



How to Develop “Greener” Methods



- Develop “greener”, innovative methods without reducing the integrity of the analytical method
- Use “greenness” profiles and selection criteria as guidelines to develop “greener” methods
- Use alternatives to:
 - PBTs
 - Chemicals on the TRI or RCRA lists
 - Extremes in pH, < 2 or > 12
 - Generating more than 50 g of waste or the ratio of work-up materials to sample > 1 for solid sample and > 0.2 for liquid sample



Status and Outlook



- Rajender Brahman (intern) is developing the “greenness” profiles for the 800+ methods in NEMI
- Summer 2006: “Greenness” profiles will go “live” on www.nemi.gov
- Future opportunities
 - Encourage new “greener” methods development
 - Bring “greener” methods into NEMI
 - Develop into teaching tool for relating green chemistry to analytical methods



Upcoming Green Chemistry Conference



10th Annual Green Chemistry & Engineering Conference

June 26-30, 2006
Capital Hilton
Washington, DC

Register early to receive discounts

To learn more and to register, visit:

www.GreenChem2006.org

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