SYRACUSE UNIVERSITY
ENGINEERING & COMPUTER SCIENCE

October 29, 2016

Re: Call for submission of information by Governments and others in response to the request from the seventh session of the intergovernmental negotiations committee to prepare global legally binding document on mercury (INC 7)

To the Primary Coordinator of the Interim Secretariat of the Minamata Convention on Mercury:

In response to the request of the Interim Secretariat of the Minamata Convention on Mercury to provide input to Articles 7, 10, 11, 12, and 22, Syracuse University, Department of Civil and Environmental Engineering, is submitting information for the management of contaminated sites (Article 12) and providing additional information on monitoring activities and the way we can contribute to future monitoring efforts (Article 22).

The document is organized into two sections. In Section I we provide a description of the activities of the research group at Syracuse University related to Article 12 and 22. In Section II bibliographic information is provided of documents published by the mercury research group at Syracuse University, organized by relevance to the Articles in the Minamata Convention.

We would welcome the opportunity to work with the Interim Secretariat of the Minamata Convention and to provide any assistance necessary for successful implementation of the Minamata Convention on Mercury.

Sincerely,

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Section I. Description of the Activities of the Syracuse University's Research Group

The mercury research group at the Department of Civil and Environmental Engineering has a track record of studying the consequences of mercury pollution in remote ecosystems contaminated by atmospheric deposition and contaminated ecosystems, as well as understanding the linkages leading to bioaccumulation of mercury in terrestrial, freshwater, and marine ecosystems. The scientific findings of the group have been published in peer-reviewed journals, white papers, and policy booklets.

Article 12 - Contaminated Sites. Point-source mercury contamination of terrestrial and aquatic ecosystems is a result of uncontrolled direct or indirect releases from industrial activities. The contamination is rarely contained within the immediate areas and affects ecosystems and populations downstream or down-gradient of the contaminated site.

The Syracuse University mercury group has active research in contaminated sites and participated in management programs for remediation of mercury contamination. We have monitored and evaluated sites contaminated with mercury, and worked with industry partners to develop and implement in-situ remediation technologies. Examples of remediation sites we worked on are provided below:

- Onondaga Lake, Syracuse, NY, USA - Onondaga Lake was contaminated with mercury from a former chlor-alkali facility. We were involved in the long-term monitoring of sediments, water, and fish and worked on the development of a novel remedial technology for *in-situ* treatment. Remediation activities included removal of mercury from an upland site; groundwater treatment; dredging, sediment treatment, and capping; in-situ treatment for methylation; and habitat restoration.
- Lake Pena Blanca, Arizona, USA – Lake Pena Blanca was contaminated with mercury from gold-mining activities in the watershed which ceased more than 50 years ago. We were involved in site evaluation following unsuccessful remedial actions performed by others.
- Syracuse brownfield, Syracuse NY, USA - The site was contaminated with a mixture of metals and organic compounds. We monitored mercury re-emissions from the brownfield site prior and after the removal of the contaminated soil and documented decreases in atmospheric mercury evasion.
- Penobscot River/Estuary Maine, USA - The Penobscot River and Estuary was contaminated with mercury from a former chlor-alkali facility. We worked on documenting the extent of contamination. Clean-up remediation options are currently being evaluated.
- Artisanal gold mining, Senegal and Peru- We are evaluating the extend of mercury contamination in soil, drainage waters, and fish downstream from artisanal gold mining sites in the Tambopata region, Peru and in Kharakhenna mine in Senegal. We provide technical expertise and offer capacity building in terms of educating local students and community members on sampling and analytical procedures, as well as educating indigenous people about the consequences of mercury pollution. This work is in progress.

An international methodology for evaluation of contaminated sites and selection of effective remediation technologies does not exist. Our experience shows that site-specific conditions and regulatory goals determine the selection of proper, cost-effective, and environmentally-sound remediation techniques.

We have the capacity and experience to help with the development of a systematic approach for evaluation of mercury-contaminated sites and for selection of proper remediation techniques. This may include a document outlining best available techniques (BATs) and best environmental practices (BEPs) for remediation of contaminated sites and development of matrix-based screening process for selection of BATs and BEPs based on desired performance criteria.

Article 22 - Effectiveness Evaluation. Atmospheric deposition has resulted in widespread contamination of mercury in remote ecosystems, including natural lands and marine environments. Work conducted by the Syracuse University group has helped document rates of atmospheric mercury deposition across complex landscapes, the transport and fate of mercury from atmospheric deposition, the influence of landscape characteristics in sensitivity to atmospheric mercury deposition, and bioavailability and exposure of organisms to atmospheric mercury deposition. The Syracuse University group is also interested in the recovery of ecosystems and organisms to decreases in mercury emissions and atmospheric deposition and has been documenting these effects. Some of the terrestrial and aquatic ecosystems the group has worked on are:

- Adirondack Mountain in NY, USA – more than 15 years of time series data on atmospheric mercury concentrations, mercury deposition, surface water concentrations and fluxes at Huntington Forest, and data on water column mercury concentrations and fish for 25 lakes in the Adirondack Park since the early 1990s.
- New York and New England region, USA - Data on soil mercury from a regional survey of 100 sites in the early 2000s.

The research data from these sites are available for use by the Interim Secretariat of the Minamata Convention for the development of a baseline for evaluation of the Convention. We can provide input for the interpretation of the data as well as to participate in the evaluation of future monitoring efforts. The Syracuse University group is well positioned to provide an expert advice for the development of harmonized methodologies and quality assurance protocols for monitoring.

Section II. Examples of relevant output from Syracuse University's group

Article 12 - Contaminated Sites

Blackwell, B., C. T. Driscoll, M. Spada, S. Todorova, and M. Montesdeoca. 2013. Evaluation of zebra mussels (Dreissena polymorpha) as biomonitors of mercury contamination in aquatic ecosystems. Environmental Toxicology and Chemistry 32:638-643.

Matthews, D. A., D. B. Babcock, J. G. Nolan, A. R. Prestigiacomo, S. W. Effler, C. T. Driscoll, S. Todorova, and K. M. Kuhr. 2013. Whole-lake nitrate addition for control of methylmercury in mercury-contaminated Onondaga Lake, NY. Environmental Research 125:52-60.

Todorova, S. and Beutel. M. 2015. Conceptual model for recovery of eutrophic freshwater ecosystems from mercury contamination. International Conference of Mercury as a Global Pollutant, Jeju, South Korea.

Todorova, S., C. T. Driscoll, D. A. Matthews, and S. W. Effler. 2015. Zooplankton community changes confound the biodilution theory of methylmercury accumulation in a recovering mercury-contaminated lake. Environmental Science & Technology 49:4066-4071.

Todorova, S., C. T. Driscoll, S. W. Effler, S. O'Donnell, D. A. Matthews, D. L. Todorov, and S. Gindlesperger. 2014. Changes in the long-term supply of mercury species to the upper mixed waters of a recovering lake. Environmental Pollution 185:314-321.

Todorova, S. G., C. T. Driscoll, D. A. Matthews, S. W. Effler, M. E. Hines, and E. A. Henry. 2009. Evidence for regulation of monomethyl mercury by nitrate in a seasonally stratified, eutrophic lake. Environmental Science & Technology 43:6572-6578.

Article 22 - Effectiveness Evaluation

Blackwell, B. D., C. T. Driscoll, J. A. Maxwell, and T. M. Holsen. 2014. Changing climate alters inputs and pathways of mercury deposition to forested ecosystems. Biogeochemistry 119:215-228.

Chen, C. Y., C. T. Driscoll, and N. C. Kamman. 2012. Mercury hotspots in freshwater ecosystems: Drivers, processes, and patterns. Page 352 in M. S. Bank, editor. Mercury in the Environment: Pattern and Process University of California Press, Berkeley, CA.

Chen, C. Y., C. T. Driscoll, K. F. Lambert, R. P. Mason, L. Rardin, C. V. Schmitt, N. S. Serrell, and E. M. Sunderland. 2012. Sources to Seafood: Mercury Pollution in the Marine Environment. Dartmouth College, Hanover, NH: Toxic Metals Superfund Research Program.

Drevnick, P. E., D. R. Engstrom, C. T. Driscoll, S. J. Balogh, N. C. Kamman, D. T. Long, D. G. C. Muir, M. J. Parsons, K. R. Rolfhus, R. Rossmann, and E. B. Swain. 2012. Spatial and temporal patterns of mercury accumulation in lacustrine sediments across the Laurentian Great Lakes region. Environmental Pollution 161:252-260.

Driscoll, C. T., R. P. Mason, H. M. Chan, D. J. Jacob, and N. Pirrone. 2013. Mercury as a global pollutant: Sources, pathways, and effects. Environmental Science & Technology 47:4967-4983.

Driscoll, C. T., C. Y. Chen, C. H. Hammerschmidt, R. P. Mason, C. C. Gilmour, E. M. Sunderland, B. Greenfield, and C. H. Lamborg. 2012. Nutrient supply and mercury dynamics in marine ecosystems: A conceptual model. Environmental Research 119:118-131.

Evers, D. C., J. G. Wiener, C. T. Driscoll, D. A. Gay, N. Basu, B. A. Monson, K. F. Lambert, H. A. Morrison, J. T. Morgan, K. A. Williams, and A. G. Soehl. 2011. Great Lakes Mercury Connections: The Extent and Effects of Mercury Pollution in the Great Lakes Region. Biodiversity Research Institute. Gorham, Maine. Report BRI 2011-18. 44 pages.

Gerson, J. R., C. T. Driscoll. 2016. Is mercury in remote forested watershed of the Adirondack Mountains responding to recent decreases in emissions? Environmental Science and Technology, 50, 10943-10950. doi:10.1021/acs.est.6b02127

Gustin, M.S., D. C. Evers, M. S. Bank, A. Hammerschmidt, A. Pierce, N. Basu, J. D. Blum, P. Bustamante, C. Chen, C. T. Driscoll, M. Horvat, D. Jaffe, J. Pacnya, N. Pirrone and N. E. Selin. 2016. Importance of Integration and Implementation of Emerging and Future Mercury Research into the Minamata Convention. Environmental Science and Technology 50: 2767-2770.

Luo, Y., L. Duan, C. T. Driscoll, G. Xu, M. Shao, M. Taylor, S. Wang, and J. Hao. 2016. Foliage/atmosphere exchange of mercury in a subtropical coniferous forest in south China, Journal of Geophysical Research: Biogeosciences, 121, doi:10.1002/2016JG003388.

Pinkney, A. E., C. T. Driscoll, D. C. Evers, M. J. Hooper, J. Horan, J. W. Jones, R. S. Lazarus, H. G. Marshall, A. Milliken, B. A. Rattner, J. Schmerfeld, and D. W. Sparling. 2014. Interactive effects of climate change with nutrients, mercury, and freshwater acidification on key taxa in the North Atlantic Landscape Conservation Cooperative region. Integrated Environmental Assessment and Management 11:355-369.

Schmeltz, D., D. C. Evers, C. T. Driscoll, R. Artz, M. Cohen, D. Gay, R. Haeuber, D. P. Krabbenhoft, R. Mason, K. Morris, and J. G. Wiener. 2011. MercNet: A national monitoring network to assess responses to changing mercury emissions in the United States. Ecotoxicology 20:1713-1725

Schoch, N., M. J. Glennon, D. C. Evers, M. Duron, A. K. Jackson, C. T. Driscoll, J. W. Ozard, and A. K. Sauer. 2014. The impact of mercury exposure on the common loon (Gavia immer) population in the Adirondack Park, New York, USA. Waterbirds 37:133-146.

Sunderland, E., C. T. Driscoll, J. Hammitt, P. Grandjean, J. Evans, J. D. Blum, C. Chen, D. C. Evers, D. Jaffe, R. Mason, S. Goho, and W. Jacobs. 2016. Benefits of regulating hazardous air pollutants from coal and oil-fired utilities in the United States. Environmental Science & Technology 50: 2117 -2120.

Townsend, J., C. T. Driscoll, C. Rimmer, and K. McFarland. 2014. Avian, salamander and forest floor mercury concentrations increase with elevation in a terrestrial ecosystem. Environmental Toxicology and Chemistry 33:208-215.

Townsend, J. M., C. C. Rimmer, C. T. Driscoll, K. P. McFarland, and E. Inigo-Elias. 2013. Mercury concentrations in tropical resident and migrant songbirds on Hispaniola. Ecotoxicology 22:86-93.

Yu, X., C. T. Driscoll, R. A. F. Warby, M. Montesdeoca, and C. E. Johnson. 2014. Soil mercury and its response to atmospheric mercury deposition across the northeastern United States. Ecological Applications 24:812-822.