Evaluation of

Detailed Project Report (Final)

Soil Remediation at Kodaikanal HUL Factory site, with offsite disposal of treated soils to Authorized TSDF

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Prepared by:

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QUALIFICATIONS

In 1990, I earned a doctorate in biochemistry from Johns Hopkins University School of Hygiene and Public Health in Baltimore, Maryland, U.S.A. My doctoral thesis centered on the toxicity of metals, principally cadmium and mercury. I am Staff Scientist for the U.S. office of the Environmental Law Alliance Worldwide in Eugene, Oregon, U.S.A. I have held this position since June of 1992. In my current position, I have provided expert advice about mercury toxicity to environmental attorneys throughout the world.

PRIOR INVOLVEMENT

I have been asked to provide technical assistance for the purpose of remediating mercury releases from the Kodaikanal HUL factory site since 2001. In this capacity, I have provided guidance about technical material presented in the following earlier documents pertaining to the remediation of mercury releases in Kodaikanal.

- The October 2007 Detailed Project Report "Soil Remediation at HUL Factory site, Kodaikanal, Tamil Nadu, India" by Environmental Resource Management Pty Ltd.

- The September 2006 Report "Former HLL Mercury Thermometer Factory, Kodaikanal, Tamil Nadu, India: Site-Specific Target Levels" by Environmental Resource Management Pty Ltd.

- The February 2007 Report "Protocol for Remediation of Mercury Contaminated Site at HLL Thermometer Factory, Kodaikanal" by NEERI.

- The May 2002 Report "Environmental Site Assessment and Risk Assessment for Mercury HLL Thermometer Factory Site Kodaikanal, Tamilnadu, India" by URS Dames & Moore.

In March 2010, I prepared a "Critical assessment of documents purporting to support a site-specific target level of 25 mg/kg for the remediation of mercury-contaminated soils at the HUL factory site in Kodaikanal" that provided guidance about the documents listed above. Because the documents listed above are direct antecedents of the "Detailed Project Report (Final) Soil Remediation at Kodaikanal HUL Factory site, with offsite disposal of treated soils to Authorized TSDF, August 2015" I am attaching, for purpose of reference, my critical assessment of these earlier documents.

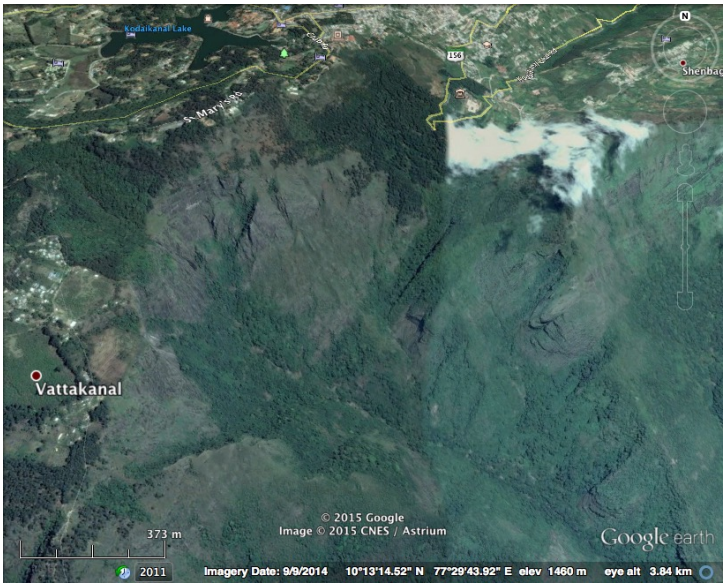
During my involvement, I have emphasized the importance of public participation in the design and implementation of the best remedial options. Successful design and implementation of the best remedial options requires the full support of the community affected by the existing contamination. Therefore, robust procedures for the consultation of the affected community in the design and implementation of the best remedial options should be followed. According to U.S. EPA guidance:

"Section 117 of CERCLA (Public Participation) emphasizes the importance of early, constant, and responsive relations with communities affected by [contamination requiring cleanup]. Specifically, the law requires publication of a notice of any proposed remedial action (proposed plan) in a local newspaper of general circulation and a "reasonable opportunity" for the public to comment on the proposed plan and other contents of the administrative record, particularly the [remedial investigation] RI and the [feasibility study] FS. In addition, the public is to be afforded an opportunity for a public meeting. The proposed plan should include a brief explanation of the alternatives considered. …. Notice of the final plan adopted and an explanation of any significant changes from the proposed plan are also required."[1]

EVALUATION OF THE AUGUST 2015 DETAILED PROJECT REPORT

In my opinion, the August 2015 Detailed Project Report fails to correct a fatal flaw of earlier remediation plans that have been submitted on behalf of HUL, namely that soil and sediment site-specific cleanup target levels ignore the need to protect the ecological integrity of the Pambar Shola, a uniquely important ecosystem that lies downhill of the HUL Factory site.

The geography of the area contains the following features: The factory is located on the southern side of a ridge that divides two watersheds. To the south of the ridge is the Pambar Shola Reserved Forest; to the north is the Bombay Shola, and Kodaikanal lake watershed. A stream that originates in the factory site empties into the Pambar Shola and the Pambar River. All the water that runs off the surface and subsurface of the factory site ends up in the Pambar River. The Pambar River joins the Varaha River in the plains, and empties into the reservoir of the dam on River Vaigai. This reservoir is the source of water and fish for people from at least three southern districts --- Madurai, Theni and Dindigul. The satellite image below shows the extensive aquatic and forested area downhill of the HUL Factory site south of St. Mary's Road.



[1] U.S. Environmental Protection Agency (October 1998) "Guidance for Conducting Remedial Investigations and

Fish-eating (piscivorous) birds and mammals likely inhabit this extensive aquatic and forested area. Piscivorous birds and mammals are more sensitive to mercury in the environment than humans who may in the future reside at the HUL Factory site.

For the protection of future residential land users, the values proposed by M/s Hindustan Unilever are relaxed. One of the earliest Superfund sites in the State of New York contaminated with mercury by The Mercury Refining Company, is being cleaned up to levels that will make it safe for future industrial usage. The target value for clean-up is 5.7 mg/kg, far lower than the 20 mg/kg proposed for Kodaikanal. Please see the attached consent decree dated 6 August 2012.[2]

In my opinion, the remediation of mercury releases in Kodaikanal must follow recent examples of remediation of mercury-contaminated soil and sediment wherein site-specific cleanup target levels approaching background mercury levels were established on the basis of protecting wildlife, as detailed below.

The Fireworks Site in Hanover, Massachusetts

The Fireworks Site[3] is an area of land and water that was contaminated with mercury by more than 50 years of industrial activity. Briefly, the site became contaminated because of:

> "the commercial manufacture of civilian fireworks and research, development and manufacture of munitions and pyrotechnics for the United States Government during the years between 1907 and 1970 …. . Lead, mercury, and some organic solvents (among other chemicals) were used in these manufacturing processes and research and development activities during the facility's operational lifetime."[4]

Mercury is the principal contaminant of concern (COC) at the site:

> "Mercury is the primary COC in the aquatic habitats of the Site. The chemistry of mercury in the environment is complex given that the chemical form of mercury varies by environmental medium and the bioaccumulation potential of each form varies significantly. MeHg and THg are both present at the Site. MeHg is the primary form of mercury that is bioaccumulated by biota. MeHg accounts for >98 percent of the mercury in fish and other aquatic biota, and generally represents the most significant form of mercury contributing to risks to upper trophic levels of the aquatic food chain. Site-specific sediment data show that MeHg constitutes less than 1.5 percent of the THg present. The majority of the mercury present in the sediment is likely to be in inorganic forms (i.e., mercuric salts) and, to a lesser degree, as complex organo-mercury compounds."[5]

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[2] United States of America v. The Gillette Company, et al., Civil No.: v. : 1:12-cv-01247-MAD-TWD, Consent Decree for Remedial Action and Recovery of Response Costs.
[3] http://www.hanover-ma.gov/home/pages/fireworks-site
[4] Fireworks Site Revised Phase III RAP – July 2009.
http://www.hanover-ma.gov/sites/hanoverma/files/file/file/revised_phase_iii_rap072109accepted.pdf
[5] Ibid., at page 1-5.

The Remedial Action Plan for the Fireworks Site established the following remedial objectives:

> "4.1.1 Preliminary Remedial Objectives for Soil
> The preliminary ROs for soil are to:
> • Reduce the concentrations of COCs in soil to levels at or below upper concentration limits (UCLs);
> • Reduce the concentrations or quantity of COCs in soil that may act as a potential on-going source of sediment contamination to the water bodies and aquatic environments (principally mercury); …
> • Minimize or prevent exposure to COCs in soil that are sufficiently contaminated to pose an unacceptable level of potential risk of biological significant harm to each of the environmental endpoints identified in the Environmental Risk Characterization (ERC), including:
> − Insectivorous birds;
> − Insectivorous small mammals;
> − Soil invertebrates and microbial communities; and
> − Terrestrial plants.
> • Reduce, to the extent feasible, the concentrations of COCs in the soil to levels that achieve or approach background."[6]

The Remedial Action Plan sets out the following preliminary remedial goals (PRGs) in which the environmental PRG is 0.1 mg/kg.

TABLE 4-1
SITE-SPECIFIC SOIL PRGs AND BENCHMARK VALUES FOR COMPARISON
FIREWORKS SITE

Chemicals of Potential Concern	Soil Preliminary Remediation Goals (PRGs)		
	Human Health		Environmental
	Recreational Land Use PRG [1,2]	Commercial/Industrial Land Use PRG (Construction Worker and Utility Worker) [1,2]	
	0-3' BGS	0-6' BGS	Surface Soil
	(mg/Kg)	(mg/Kg)	(mg/Kg)
1,1-Dichloroethene	0.011 [No Value]	0.005 [No Value]	–
Benzene	–	0.18 [6,000]	–
Di-n-octylphthalate	–	–	0.5 LOAEL
Hexachlorobenzene	–	–	0.1 LOAEL
Trichloroethene	4.3 [650]	1.6 [5,000]	–
Vinyl Chloride	0.30 [3.6]	0.11 [30]	–
Antimony	–	–	2.2 LOAEL
Arsenic	20 [9]	20 [350]	5.2 LOAEL
Barium	–	–	717 LOAEL
Cadmium	–	15.8 [No Value]	–
Chromium (total)	30 [No Value]	30 [No Value]	0.4 NOEC
Copper	–	–	88 LOAEL
Lead	586 [590]	800	189 LOAEL
Mercury	–	10.5 [11.5]	0.1 NOEC

The Remedial Action Plan then sets out a variety of combined Remedial Alternatives (a combination of groundwater, soil and sediment remedial actions), selecting on alternateive (designated as SWA 4-1) as the recommended alternative:

[6] Ibid., at pages 4-1 to 4-2.

> "Based on this comparative information, SWA 4-1 was selected as the recommended remedial action alternative for the Site because it would achieve satisfactory performance with respect to all of the detailed evaluation criteria and meets all of the ROs identified for the Site at the lowest cost and least impact to the natural resources at the Site compared to the other SWAs. It is, thus, the most cost-effective remedial alternative for the Site."[7]

SWA 4-1 is described with reference to other considered remedial action alternatives:

> "SWA 4-1 – Targeted Source Removal, the Elimination of Soil and Groundwater UCL Exceedances, Meeting Human Health and Ecological PRGs in the Disposal Areas, Meeting Human Health PRGs for all COCs in the Non-Disposal Areas, and Meeting Sediment PRGs for Mercury on a Site-Wide Average Basis.
>
> "SWA 4-1 builds on and adds to SWA 3. In addition to the soil removal associated with SWA 3, SWA 4-1 includes additional soil removal in the non-disposal areas (i.e., the Potential Greenway Area (PGA) and the Southern Conservation Commission Area (SCCA)) to meet the human health PRGs for all of the chemicals of concern (COCs) associated with these two areas (see Figure 8-4). A list of the specific soil, sediment, and groundwater alternatives that were combined to assemble SWA 4-1 is provided in Table 8- 2. SWA 4-1 would result in a Permanent Solution under the MCP."[8]

SWA-3 is defined as:

> "SWA 3 builds on and adds to SWA 2. In addition to the soil removal associated with SWA 2, soil that exceeds the soil upper concentration limits (UCLs) and which is indicated to be causing the groundwater UCL exceedances at the Southern Disposal Area (SDA) and the Marsh Upland Area (MUA) would be removed (see Figure 8-3). If additional soil removal is necessary in these areas to meet the Site-specific human health and **ecological preliminary remediation goals (PRGs)**[9] developed for soil, that removal also would be performed as part of SWA 3."[10]

With respect to sediment, SWA 3 is also defined as:

> "SWA 3 includes sufficient sediment hot spot source removal in the streams and ponds to allow the human health and ecological PRGs for sediment to be met on a Sitewide average basis."[11]

The ecological PRG for sediment is based on protection of piscivorous birds and is set at 0.02 mg/kg, as set out in the Remedial Action Plan.[12]

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[7] Ibid., at page 8-10.
[8] Ibid., at page 8-2.
[9] As noted above, in Table 4.1, the site-specific ecological PRG for soil is 0.1 mg/kg.
[10] Ibid., at page 8-2
[11] Ibid., at page 8-2
[12] Table A2-7 Summary of Sediment PRGs by Environmental COC and Assessment Endpoint Fireworks Site. http://www.hanover-ma.gov/sites/hanoverma/files/file/file/table_a2-4_to_a2-8.pdf

Table A2-4

Calculated PRGs for Sediments and Semi-Aquatic Wildlife
Fireworks Site

Wildlife Receptor	Contaminant	NOAEL (mg/Kg-day)	LOAEL (mg/Kg-day)	Body Weight (Kg)	Ingestion Rate (Kg/day wwt)	Diet fraction (unitless)	Major Dietary Contribution	Diet - PRG NOAEL (mg/Kg wwt)	Sediments - PRG LOAEL (mg/Kg wwt)	Sediments - PRG NOAEL (mg/Kg dwt)	Sediments - PRG LOAEL (mg/Kg dwt)
Mink	Methyl Mercury	0.0171	0.0286	0.59	0.078	1	Forage Fish	0.13	0.22	0.0002	0.0008
Belted Kingfisher	Methyl Mercury	0.0064	0.064	0.15	0.068	1	Forage Fish	0.01	0.14	0.0000003	0.0002
Mallard	Total Mercury	0.45	0.9	1.7	1.15	1	Aquatic Worm	0.67	1.33	70	169
	Methyl Mercury	0.0064	0.064	1.7	1.15	1	Aquatic Worm	0.01	0.09	0.3	5.9
	Lead	1.13	11.3	1.7	1.15	1	Aquatic Plants	1.67	16.70	20	414
Mute Swan	Total Mercury	0.45	0.9	9.7	4.22	1	Aquatic Plants	1.03	2.07	11	27
	Methyl Mercury	0.0064	0.064	9.7	4.22	1	Aquatic Plants	0.01	0.15	0.040	0.82
	Lead	1.13	11.3	9.7	4.22	1	Aquatic Plants	2.60	25.97	36	740
Raccoon	Methyl Mercury	0.00943	0.0157	6.4	0.953	1	Forage Fish	0.06	0.11	0.0003	0.0011
	Antimony	0.0327	0.327	6.4	0.316*	1	Sediment	7.0	70.5	7.0	70
Muskrat	Total Mercury	0.919	9.19	1.4	0.731	1	Aquatic Plants	13.5	135.4	21.4	443
	Methyl Mercury	0.014	0.023	1.4	0.731	1	Aquatic Plants	0.2	0.3	0.1	0.2

Table A2-7

Summary of Sediment PRGs by Environmental COC and Assessment Endpoint
Fireworks Site

Endpoint	Sediment Based PRGs for Aquatic Life and Semi-Aquatic Wildlife (mg/Kg dry wt)								
	Methyl Mercury	Total Mercury	Antimony	Lead	Selenium	Thallium	Zinc	DCE	TCE
Benthic Communities (River[a]/Pond[b]/Wetland[c]) (No Effect Concentration)	NA	29[a]/40[b,c]	NA	NA	NA	NA	152[a]/337[b]	**0.4**[b]	**0.22**[b]
Piscivorous Fish (NOAEL/LOAEL)	NA	100/415	NA	NA	NA	NA	NA	NA	NA
Piscivorous Mammal (NOAEL/LOAEL)	0.0002/0.0008	0.02/0.32	NA	NA	NA	NA	NA	NA	NA
Piscivorous Birds (NOAEL/LOAEL)	0.0000003/**0.0002**	0.0000009/**0.02**	NA	NA	NA	NA	NA	NA	NA
Omnivorous Waterfowl (NOAEL/LOAEL)	0.3/5.9	70/169	NA	226/4180	NA	NA	NA	NA	NA
Herbivorous Waterfowl (NOAEL/LOAEL)	0.04/0.82	11/27	NA	36/**740**	NA	NA	NA	NA	NA
Omnivorous Mammal (NOAEL/LOAEL)	0.0003/0.0011	NA	7/70	NA	NA	NA	NA	NA	NA
Herbivorous Mammal (NOAEL/LOAEL)	0.1/0.2	21/443	0.4/9	234/4849	1.8/**3.5**	0.02/**0.5**	NA	NA	NA
Aquatic Reptiles (NOAEL/LOAEL)	NA	119/204	NA	NA	NA	NA	NA	NA	NA

Notes:
PRG = preliminary remediation goal
Bolded PRGs identify lowest corresponding PRG for all assessment endpoints.
NA = Not applicable to endpoint
NOAEL = No observable adverse effects level
LOAEL = Lowest observable adverse effects level
mg/Kg dry wt = milligram per kilogram dry weight

However, site-specific soil and sediment cleanup targets for mercury were defined as 'approaching background levels' of mercury in the environment *because*, as noted in the Remedial Action Plan below, piscivorous birds and mammals are so sensitive to mercury in the

environment that they are impacted by mercury levels *below* prevailing background levels of mercury:

> "… total mercury (THg) in sediment and methyl mercury (MeHg) in the upper trophic levels of the local food chain are the key environmental risk drivers and should be a primary focus of any sediment remediation strategy. In Section 4.1, a preliminary RO identified for sediment was to reduce risks to acceptable levels for each of the nine environmental endpoints identified in the ERC as having potential risk of biological significant harm. However, review of the sediment PRGs for each endpoint show that for two endpoints (piscivorous birds and piscivorous mammals), the corresponding THg PRGs (0.02 and 0.32 mg/Kg, respectively) are lower than the lowest measured sediment background concentration for THg (0.34 mg/Kg for the river) at the Site. The Phase II CSA concluded that a residual risk to both endpoints exists at the background THg concentration. It is impractical to remediate the THg concentration in the sediment to below background levels."

Conclusion

In my opinion, if Hindustan Unilever Limited wishes to be an environmentally responsible corporate citizen with respect to its releases of mercury in Kodaikanal, then it must withdraw its current proposal and extend its full cooperation to the regulators. TNPCB should expeditiously do or direct HUL to do the following

- Conduct a detailed survey of aquatic wildlife, including piscivorous birds and mammals, that inhabit the Pambar Shola forest and other areas potentially impacted by mercury releases from the HUL Factory site;
- Establish site-specific soil and sediment cleanup target values protective of aquatic wildlife based on an understanding of the biology of such aquatic wildlife, including their ingestion rates of dietary components that might be contaminated with mercury;
- Determine the prevailing background levels of mercury in soils and sediments by characterizing mercury levels in soils and sediments of similar, nearby aquatic and forested areas not impacted by mercury releases;
- Design and implement a set of soil and sediment remediation actions so that residual levels of mercury are no higher than site-specific soil and sediment cleanup target values protective of aquatic wildlife OR the prevailing background levels of mercury in soils and sediments;
- Subject all project documents and project planning processes to public scrutiny

August 25, 2015

Mark Chernaik | Date