

Superfund Health Risk Technical Support Center

FY17 Annual Report
October 2016 – September 2017



National Center for Environmental Assessment
Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, Ohio 45268

This page intentionally left blank.



DISCLAIMERS

This report is intended to inform the public, Remedial Project Managers, On-Scene Coordinators, and Superfund Technology Liaisons of progress at the Superfund Health Risk Technical Support Center (STSC) involved sites, cutting-edge approaches, and STSC operations.

This document has been reviewed by the U.S. Environmental Protection Agency, Office of Research and Development, and approved for publication.

The views expressed in this report are those of the author(s) and do not necessarily represent the views or policies of the U.S. Environmental Protection Agency.

Mention of company trade names or products does not constitute endorsement by the U.S. Environmental Protection Agency and are provided as general information only.



ACKNOWLEDGEMENTS

The Superfund Health Risk Technical Support Center (STSC) is part of a core group of technical support centers and regional forums established and maintained under the Technical Support Project.

The STSC acknowledges the following individuals for their support in the preparation of Provisional Peer-Reviewed Toxicity Values (PPRTVs) and STSC technical responses during the 2017 Fiscal Year:

**U.S. EPA, Office of Research and Development (ORD),
National Center for Environmental Assessment (NCEA):**

Chris Cubbison
Allen Davis
Jeffrey Dean
Jeffrey Gift
Belinda Hawkins
Phillip Kaiser
Jason Lambert
Lucina Lizarraga
Anuradha Mudipalli
Dan Petersen

Jon Reid
Glenn Rice
Paul Reinhart
Teresa Shannon
Jeff Swartout
Michael Troyer
Scott Wesselkamper
George Woodall
Jay Zhao
Bette Zwayer

We would also like to express our great appreciation for the funding provided by the Office of Superfund Remediation and Technology Innovation and the Human Health Risk Assessment National Research Program.



TABLE OF CONTENTS

DISCLAIMERS	iii
ACKNOWLEDGEMENTS	iv
LIST OF TABLES	vi
LIST OF FIGURES	vi
ABBREVIATIONS AND ACRONYMS	vii
INTRODUCTION	1
STSC ACCOMPLISHMENTS.....	3
Provisional Peer-Reviewed Toxicity Value (PPRTV) Assessments	3
PPRTV for p-Chlorobenzene sulfonic acid—EPA Region 9 and the State of California	6
PPRTVs for p,p'-Dichlorodiphenyldichloroethane (p,p'-DDD) and p,p'-Dichlorodiphenyldichloroethylene (p,p'-DDE)—EPA Region 2	6
Chemical Nomination and Selection for PPRTVs.....	7
STSC Hotline Requests	8
Evaluation of Uncertainty in the Cobalt PPRTV—EPA Region 4 and the State of Georgia ..	9
Hurricane Harvey Support—EPA Region 6	9
Mode of Action of Toxaphene—EPA Region 4.....	10
SUMMARY	12
CONTACT INFORMATION.....	13
REFERENCES	14



LIST OF TABLES

Table 1. PPRTVs Developed in FY2017	5
---	---

LIST OF FIGURES

Figure 1. Locations of ORD Technical Support Centers	1
Figure 2. Number and Description of Provisional Toxicity Values Derived in FY2017	4
Figure 3. p-CBSA is a By-Product of DDT Production at Facilities Such as the Montrose Chemical Corporation in California.....	6
Figure 4. The Diamond Alkali Superfund Site in Region 2	7
Figure 5. A Mechanical Dredge Removes Sediment from an Area on the Passaic River.....	7
Figure 6. FY2017 STSC Hotline Requestor Affiliation	8
Figure 7. Hurricane Harvey	9
Figure 8. Hercules Landfill Superfund Site	11



ABBREVIATIONS AND ACRONYMS

ATSDR	Agency for Toxic Substances and Disease Registry
CalEPA	California Environmental Protection Agency
CM	Chemical Manager
EPA	Environmental Protection Agency
FY	fiscal year
HEAST	Health Effects Assessment Summary Tables
IRIS	Integrated Risk Information System
NCEA	National Center for Environmental Assessment
ORD	Office of Research and Development
p-IUR	provisional inhalation unit risk
p-OSF	provisional oral slope factor
PPRTV	provisional peer-reviewed toxicity value
p-RfC	provisional reference concentration
p-RfD	provisional reference dose
QSAR	Quantitative Structure Activity Relationship
STSC	Superfund Technical Support Center



INTRODUCTION

The primary goal of the Superfund Human Health Risk Technical Support Center (STSC) is to provide scientific technical support in the area of human health risk assessments for the Office of Land and Emergency Management (OLEM), state, and regional partners. The STSC is operated by the U.S. Environmental Protection Agency (EPA or Agency) Office of Research and Development's (ORD's) National Center for Environmental Assessment (NCEA) in Cincinnati, Ohio.

The STSC is one of five active technical support centers (TSCs) established as part of the Technical Support Project (TSP) partnership (Figure 1). In 1987, OLEM (formerly the Office of Solid Waste and Emergency Response [OSWER]), Regional Superfund Office, and ORD established the Superfund TSP to provide technical assistance to regional remedial project managers (RPMs) and on-scene coordinators. The TSP consists of a network of regional forums, the Environmental Response Team, and specialized TSCs.

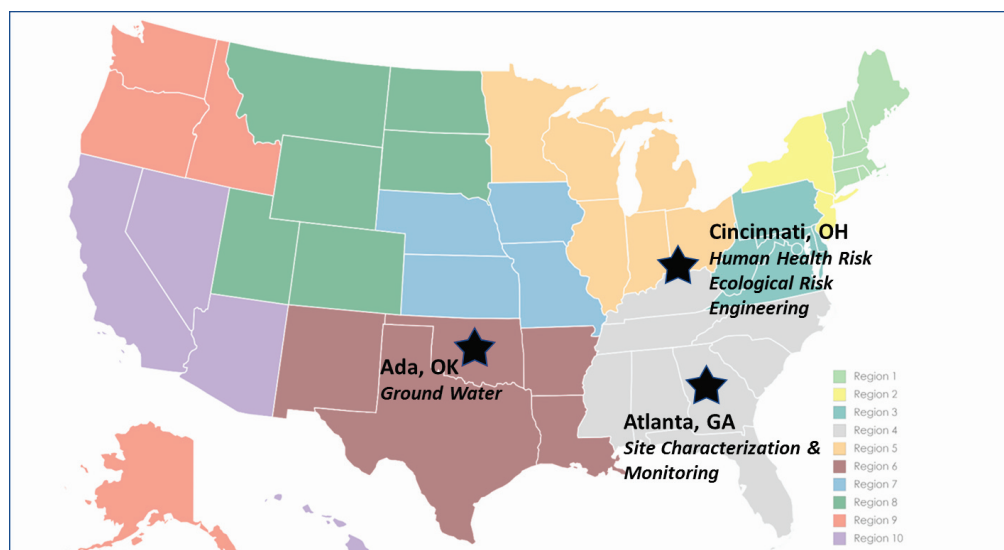


Figure 1. Locations of ORD Technical Support Centers

Each TSC has a specific focus of expertise and is dedicated to serving the EPA and its clients by supplying high-quality, quick-response, technical support services for contaminated sites. Clients of the STSC are scientific staff supporting the Superfund program. Specific clients include EPA regional scientists and risk managers, authorized contractors, state scientists, and others. The STSC performs two general functions to support the Superfund program: (1) preparation and distribution of Provisional Peer-Reviewed Toxicity Value (PPRTV) assessments and (2) scientific/technical consultations in support of states, EPA regional scientists, and associates regarding issues related to contaminated sites. This report provides an overview of these functions of the STSC and a selection of technical responses provided in FY2017.



STSC ACCOMPLISHMENTS

In FY2017, the STSC provided technical support through the development and release of 12 PPRTV assessments and by responding to 19 technical requests from various EPA regions, state agencies, and international requestors.

The STSC support staff tracks requests and activities, including requestor and site information, initiation and completion dates, summaries of the requests, and hours associated with that request. The information is compiled into an internal tracking database.

PROVISIONAL PEER-REVIEWED TOXICITY VALUE (PPRTV) ASSESSMENTS

The STSC's PPRTV Program supports the Agency's mission to protect human health and the environment by identifying and characterizing the health hazards of chemicals of interest to the Superfund Program. PPRTV assessments are an important source of toxicity information and toxicity values for use by OLEM. Derivation of PPRTVs for use by OLEM is necessary when such values are not publicly available elsewhere. PPRTV assessments provide subchronic and chronic provisional toxicity values (e.g., provisional oral reference doses [p-RfDs], inhalation reference concentrations [p-RfCs], and cancer risk values) for subchronic or chronic exposure to chemicals. Importantly, the information in PPRTV assessments can be used in combination with exposure metrics to characterize the public health risks of a given substance at a particular Superfund site. These risk characterizations can form the basis for risk-based decision making, regulatory activities, and other risk management decisions designed to characterize and protect human health.

PPRTVs are derived after a review of the relevant scientific literature and use Agency methodologies, practices, and guidance for the development of toxicity values. All PPRTV assessments receive internal review by EPA scientists and external peer review by independent scientific experts. For additional information on PPRTVs and the methodologies used, please refer to <https://www.epa.gov/pprtv>. PPRTV assessments are eligible to be updated as requested by the Agency to incorporate new data or methodologies that might impact the science and decisions used to derive provisional toxicity values, and are revised as appropriate.

In addition, screening PPRTVs can be derived in the appendix of a PPRTV assessment when the data do not meet all requirements for deriving a toxicity value in the main body. Screening values can be subchronic and chronic p-RfDs and p-RfCs, as well as provisional oral slope factors (p-OSFs) and provisional inhalation unit risks (p-IURs). Screening PPRTVs are derived using the same methodologies and undergo the same development and review processes (i.e., internal and external peer review, etc.) as provisional values presented in the main body of an assessment. Users of screening PPRTVs are made aware that there is more uncertainty associated with the derivation of these values than for values presented in the main body of a PPRTV assessment.

Screening provisional toxicity values are also developed for chemicals of interest that have no useful human or animal toxicity data by applying an expert-driven read-across approach. Human health assessments are often requested for compounds found at contaminated sites throughout the United States that have limited or no available toxicity information. Consequently, these data-poor chemicals that do not have associated toxicity values, are not considered in the calculation of a hazard index, and do not inform cleanup levels. To address this data gap, a framework was designed to apply an expert-driven read-across approach for quantitative human health risk assessment (Wang et al., 2012). The approach relies on the identification of three main types of potential analogues (structural, metabolic, and toxicity-like) for the selection of a final surrogate chemical. This framework was applied to support the analysis of seven PPRTV chemicals in FY2017.

The STSC, in consultation with OLEM's Office of Superfund Remediation and Technology Innovation (OSRTI), prioritizes candidate chemicals for PPRTV development. In FY2017, the STSC developed 12 chemical-specific PPRTV assessments, providing the Superfund Program with 25 provisional toxicity values (Figure 2). As mentioned above, seven (7) of these assessments applied an expert-driven read-across approach to deriving screening provisional toxicity values based on surrogate chemical points of departure (PODs), resulting in 15 individual screening provisional toxicity values for these data poor chemicals. Table 1 provides a list of each assessment as well as the type of value(s) derived in each assessment.

PPRTVs are publicly available for download from the "PPRTV Assessments Electronic Library" at <https://www.epa.gov/pprtv>.

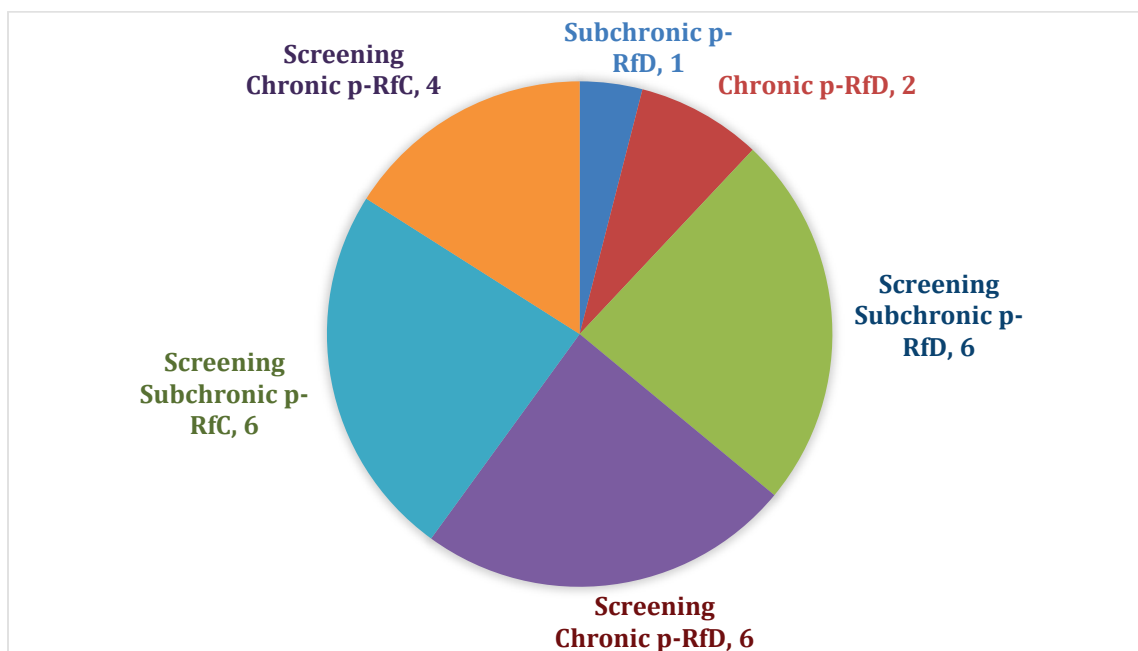


Figure 2. Number and Description of Provisional Toxicity Values Derived in FY2017

Table 1. PPRTVs Developed in FY2017

Assessment Information			Provisional Values Derived ^a						
Chemical	CASRN	New/ Update	Chronic p-RfD (mg/kg-d)	Subchronic p-RfD (mg/kg-d)	Chronic p-RfC (mg/m ³)	Subchronic p-RfC (mg/m ³)	p-IUR (mg/m ³) ⁻¹	p-OSF (mg/kg-d) ⁻¹	WOE Descriptor ^b
Bromo-3-fluorobenzene, 1-	1073-06-9	Update	3×10 ^{-4a}	3×10 ^{-3a}	NDr	3×10 ^{-2a}	NDr	NDr	<i>Inadequate</i>
Bromo-4-fluorobenzene, 1-	460-00-4	Update	3×10 ^{-4a}	3×10 ^{-3a}	NDr	3×10 ^{-2a}	NDr	NDr	<i>Inadequate</i>
Butyl formate, <i>tert</i> -	762-75-4	Update	NDr	8×10 ^{-3a}	NDr	NDr	NDr	NDr	<i>Inadequate</i>
Chlorobenzenesulfonic acid, <i>p</i> -	98-66-8	Update	1×10 ^{-1a}	1 ^a	NDr	NDr	NDr	NDr	<i>Inadequate</i>
Dichlorodipheylidichloroethane, <i>p,p'</i> - (<i>p,p'</i> -DDD)	72-54-8	Update	3×10 ^{-5a}	3×10 ^{-5a}	NDr	NDr	NDr	IRIS value cited	IRIS descriptor cited
Dichlorodiphenyldichloroethylene, <i>p,p'</i> - (<i>p,p'</i> -DDE)	72-55-9	Update	3×10 ^{-4a}	3×10 ⁻⁴	NDr	NDr	NDr	IRIS value cited	IRIS descriptor cited
Difluoropropane, 2,2-	420-45-1	Update	NDr	NDr	3×10 ^{1a}	3×10 ^{1a}	NDr	NDr	<i>Inadequate</i>
Diphenyl ether	101-84-8	New	NDr	NDr	4×10 ^{-4a}	4×10 ^{-3a}	NDr	NDr	<i>Inadequate</i>
Heptanal, <i>n</i> -	111-71-7	Update	NDr	NDr	3×10 ^{-3a}	3×10 ^{-2a}	NDr	NDr	<i>Inadequate</i>
Lactonitrile	78-97-7	New	2×10 ^{-4a}	2×10 ^{-3a}	NDr	NDr	NDr	NDr	<i>Inadequate</i>
Methyl-2-pentanol, 4- (MIBC)	108-11-2	Update	NDr	NDr	3 ^a	3 ^a	NDr	NDr	<i>Inadequate</i>
Toluic acid, <i>p</i> -	99-94-5	New	5×10 ⁻³	5×10 ⁻²	NDr	NDr	NDr	NDr	<i>Inadequate</i>

^aDenotes a(n) screening/appendix value.

^bCancer WOE descriptors according to U.S. EPA *Guidelines for Carcinogen Risk Assessment* ([U.S. EPA, 2005](#)) are defined as:

Carcinogenic = *Carcinogenic to Humans*; *Likely* = *Likely to be Carcinogenic to Humans*; *Suggestive* = *Suggestive Evidence of Carcinogenic Potential*; *Inadequate* = *Inadequate Information to Assess Carcinogenic Potential*; *Not Likely* = *Not Likely to be Carcinogenic to Humans*.

CASRN = Chemical Abstracts Service registry number; FY = fiscal year; IRIS = Integrated Risk Information System; NDr = not determined; p-IUR = provisional inhalation unit risk; p-OSF = provisional oral slope factor; PPRTV = provisional peer-reviewed toxicity value; p-RfC = provisional reference concentration; p-RfD = provisional reference dose; WOE = weight of evidence.

The following section highlights the impact and scientific challenges addressed by a selection of FY2017 PPRTV assessments.

PPRTV for *p*-Chlorobenzene sulfonic acid—EPA Region 9 and the State of California

From the 1950s until approximately 1982 facilities across California, such as Montrose Chemical Corporation, manufactured the pesticide dichlorodiphenyltrichloroethane (DDT). *p*-Chlorobenzene sulfonic acid (*p*-CBSA) is a by-product of the production of DDT and is often found in large quantities in soil at former DDT manufacturing sites (Figure 3). *p*-CBSA is highly water soluble making it extremely mobile in aqueous environments, and has been identified in potential drinking water sources beneath these sites in California. Unfortunately, *p*-CBSA has not been well-studied for its potential toxic effects on human health or the environment.

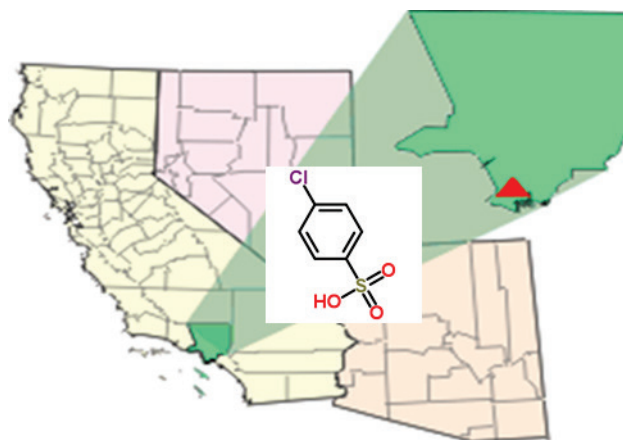


Figure 3. *p*-CBSA is a By-Product of DDT Production at Facilities Such as the Montrose Chemical Corporation in California

Because of high interest in evaluating the potential human health effects of *p*-CBSA, the State of California’s Environmental Protection Agency (CalEPA) and the STSC, in collaboration with Region 9, worked together in assembling extant study data leading to the development of a PPRTV. This PPRTV assessment identified information sufficient for derivation of a provisional reference value that informs risk associated with oral *p*-CBSA exposures. The impact of this work is realized in the facilitation of risk-based decision making and activities by CalEPA on sites contaminated with *p*-CBSA.

PPRTVs for *p,p'*-Dichlorodiphenyldichloroethane (*p,p'*-DDD) and *p,p'*-Dichlorodiphenyldichloroethylene (*p,p'*-DDE)—EPA Region 2

The Diamond Alkali Superfund site in Region 2 consists of several distinct sites including the former manufacturing facility in Newark, NJ and the Lower Passaic River Study Area (LPRSA). The LPRSA is densely populated and heavily industrialized and includes the 17-mile tidal stretch of the river from Dundee Dam to Newark Bay and tributaries. From the 1940s to 1971, agricultural and other chemicals were manufactured at this site, including *p,p'*-DDT and the herbicides used in the defoliant known as “Agent Orange.” In 1983, sampling by the state of New Jersey and the EPA at and near the site revealed high levels of 2,3,7,8-TCDD (dioxin), a highly toxic by-product of these manufacturing processes. The site was listed on the Superfund National Priorities List (NPL) in 1984 (Figures 4 and 5).

In FY2015, Region 2 requested assistance from the STSC in evaluating the suitability of surrogate chemicals for chemicals of interest without published toxicity values. Several organochlorine contaminants, including *p,p'*-DDD and *p,p'*-DDE, were detected as part of the sampling of various environmental media (e.g., sediment, fish, surface water, etc.) in the LPRSA. As part of this FY2015 request, the STSC applied an expert-driven read-across approach to identify suitable surrogates for these data-poor chemicals of interest. The STSC confirmed the suitability of *p,p'*-DDT as an appropriate surrogate for *p,p'*-DDD and *p,p'*-DDE based on similarities in structure, metabolism and toxicity profile. STSC also found that the proposed surrogate *p,p'*-DDT could not be recommended as a surrogate for *o,p'*-DDT, *o,p'*-DDD, or *o,p'*-DDE and could not suggest any other viable surrogates for these chemicals.



Figure 4. The Diamond Alkali Superfund Site in Region 2 Consists of Several Distinct Sites Including the Former Manufacturing Facility in Newark, NJ and the Lower Passaic River Study Area

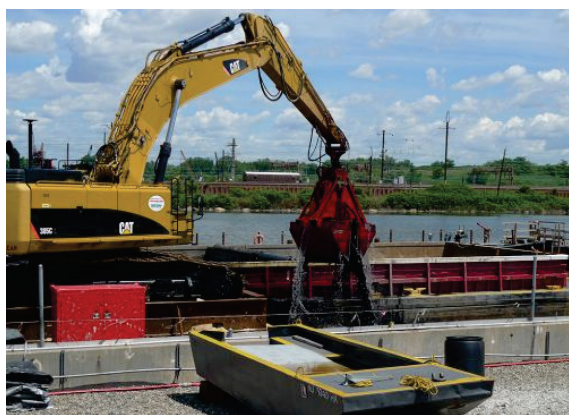


Figure 5. A Mechanical Dredge Removes Sediment from an Area on the Passaic River

(Photo credit: U.S. National Oceanic and Atmospheric Administration)

In FY2017, the STSC extended the technical response beyond hazard identification to dose-response analysis for the derivation of PPRTV screening-level risk estimates for *p,p'*-DDD and *p,p'*-DDE. These PPRTVs provide published toxicity values for use by EPA regions and states, informing regulatory decisions at this site and other sites where these chemicals may be of concern.

Chemical Nomination and Selection for PPRTVs

As a new development in FY2017, representatives from the STSC, OLEM, and the OLEM Human Health Regional Risk Assessors Forum (OHHRRAF) Toxicity Workgroup formed a PPRTV scoping team that collaborated to seek nominations, select a candidate chemical list, and prioritize the chemicals for PPRTV assessment development on an annual

basis. The goals of selecting and prioritizing the chemicals requested for PPRTV assessment development were twofold: (1) emphasize development of high-quality deliverables based on the most current OLEM and regional priorities/needs and (2) optimize the expenditure of fiscal resources and human capital for assessment activities related to priority chemicals. The standard operating procedure (SOP) and related documents are available for further reference upon request to the STSC.

STSC HOTLINE REQUESTS

A second major function of the STSC is to provide technical support with human health risk assessments for the Superfund Program through the operation of the STSC Hotline. In FY2017, the STSC responded to 19 requests from various regions, state agencies, and international requestors (see Figure 6). Of these 19 requests, 9 were site specific, 8 were answerable using information from readily available sources (i.e., an Integrated Risk Information System [IRIS] reference, an active PPRTV, or other existing publication), 10 requests involved additional research, and 1 request was for the review of other documents.

In FY2017, half of the requests were for chemical-specific toxicity values. When this type of a request is made, the STSC searches a list of databases (e.g., IRIS, PPRTV, and other generally accepted sources [HEAST, ATSDR, California EPA]) for available toxicity values and, if available, the STSC immediately provides the client(s) reference(s) to these sources. In other cases, the request to the STSC are to address specific technical needs related to risk assessments of contaminated sites. The following sections highlight a few requests that deal with chemical or site-specific needs and provide examples of the STSC's work.

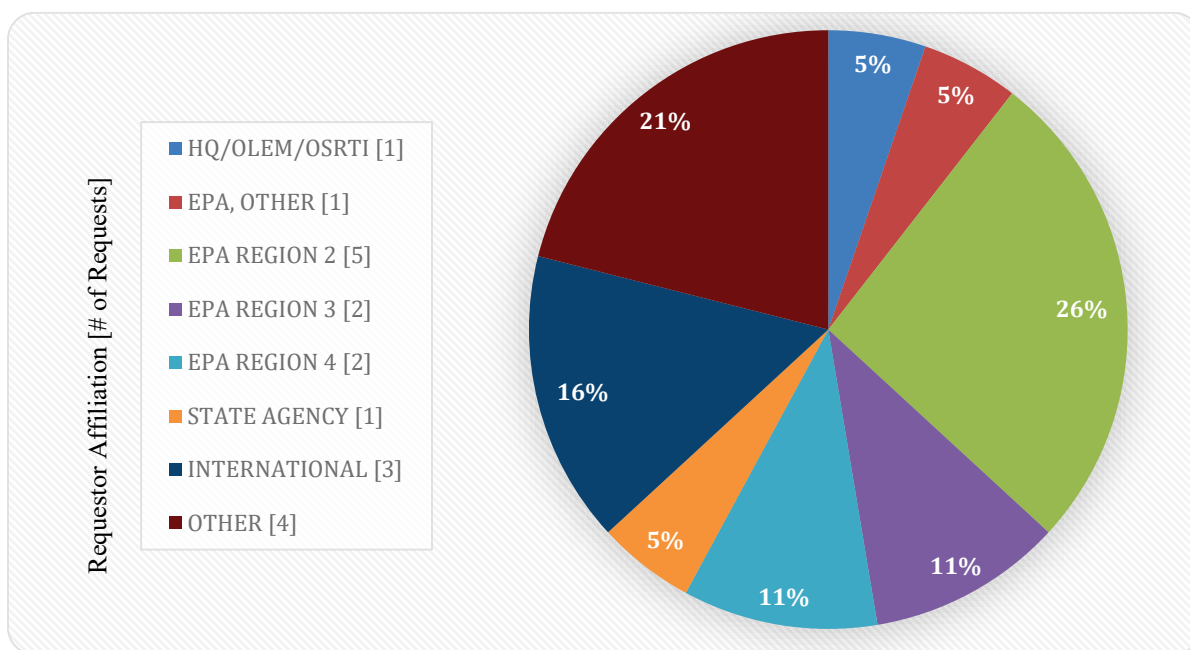


Figure 6. FY2017 STSC Hotline Requestor Affiliation

Evaluation of Uncertainty in the Cobalt PPRTV—EPA Region 4 and the State of Georgia

An important function of the STSC is to provide stakeholders clarification of the scientific conclusions and methodologies applied in the PPRTV assessments. In FY2017, the Georgia Environmental Protection Division requested clarification on the derivation of reference values for cobalt in the 2008 PPRTV and re-evaluation of the rationales considering more recently published information.

In 2008, the STSC published a PPRTV assessment for cobalt that derived a subchronic and chronic p-RfD based on decreased iodine uptake in humans ([U.S. EPA, 2008](#)). The POD for derivation of these toxicity values was from an oral exposure study to cobalt in humans (1 mg cobalt/kg-day) for 2 weeks showing markedly inhibited radioactive iodine uptake in the human thyroid ([Roche and Layrisse, 1956](#)). A composite uncertainty factor (UF_C) of 300 and 3,000 was applied to derive the subchronic and chronic p-RfDs, respectively. For the chronic p-RfD, this consisted of the following: interspecies uncertainty factor (UF_A) of 1, intraspecies uncertainty factor (UF_H) of 10, uncertainty in extrapolation of lowest-observed-adverse-effect level (LOAEL) (UF_L) of 10, subchronic-to-chronic uncertainty factor (UF_S) of 10, and database uncertainty factor (UF_D) of 3.

The Georgia Environmental Protection Division requested support from the STSC in FY2017 to better understand the implications of a subsequent peer-reviewed publication by [Finley et al. \(2012\)](#) that proposes a cobalt health value based upon alternative interpretations of essentially the same hazard database. The STSC reviewed the requested publication and scientific assertions, and re-evaluated the choice of POD and application of uncertainty factors used to derive the PPRTVs for Cobalt in 2008. The STSC determined that the alternative interpretation of the database for Cobalt was inconsistent with EPA guidance and practice and would not change the conclusions from the 2008 PPRTV assessment. This re-evaluation and explanation was provided to the Georgia Environmental Protection Division. Support such as this leads to increased confidence in the science supporting the PPRTVs and assurance that these toxicity values represent the current state of the science.

Hurricane Harvey Support—EPA Region 6

The STSC serves as a point of contact for the Superfund Program when there is an urgent need for available toxicity values. Hurricane Harvey was a Category 4 hurricane (Figure 7) that made landfall in Texas on August 26, 2017, resulting in unprecedented flooding and damage to the area. Forty-three (43) Superfund NPL sites were in the hurricane affected area and required assessment.

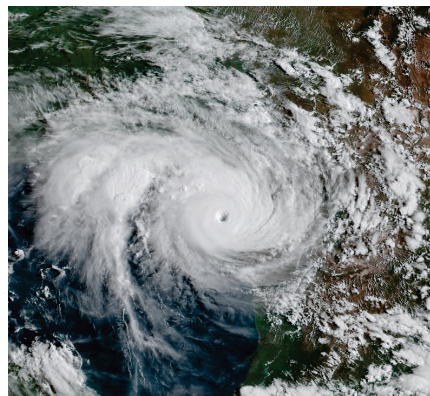


Figure 7. Hurricane Harvey
(Photo credit: U.S. National Oceanic and Atmospheric Administration)

The STSC aided in identifying available toxicity values for a list of 15 chemicals of interest to the Hurricane assessment effort. In addition, the STSC responded to follow-up clarification on the scope of the toxicity values provided for endosulfan. These requests supported the EPA responders in better understanding the human health impacts of Hurricane Harvey and its aftermath.

Mode of Action of Toxaphene—EPA Region 4

STSC provides stakeholders technical support through the review of critical science related to chemicals of interest to the Superfund Program. The STSC is in the process of reassessing the potential noncancer human health toxicity of the chemical mixture toxaphene (and its weathered by-products), a banned insecticide. Toxaphene sludge is a primary contaminant of concern at the Hercules 009 Landfill Superfund Site located in Brunswick, GA, which was placed on the NPL in 1984 (Figure 8).

In FY2017, Region 4 requested support from the STSC in reviewing the scientific conclusions and limitations of a newly published paper on the mode of action (MOA) of technical-grade toxaphene-induced mouse liver tumors ([Wang et al., 2017](#)). Currently, the cancer risk of exposure to toxaphene is addressed in the IRIS database, where a cancer oral slope factor (OSF) of $1.1 \text{ (mg/kg-day)}^{-1}$ for technical toxaphene is listed ([U.S. EPA, 1988](#)), along with a cancer weight-of-evidence (WOE) classification of Group B2 based on no evidence of carcinogenicity in humans but sufficient evidence in laboratory animals (hepatocellular tumors in mice and thyroid tumors in rats). After review of the [Wang et al. \(2017\)](#) publication and the preceding publication [Wang et al. \(2015\)](#), the STSC concluded that these studies do not confound or diminish a role for a genotoxic MOA, rather, they augment a WOE supporting a mixed MOA in technical-grade toxaphene-induced liver tumors. This conclusion and further observations were provided to Region 4 so that they may use the best available science in making decisions on this site.

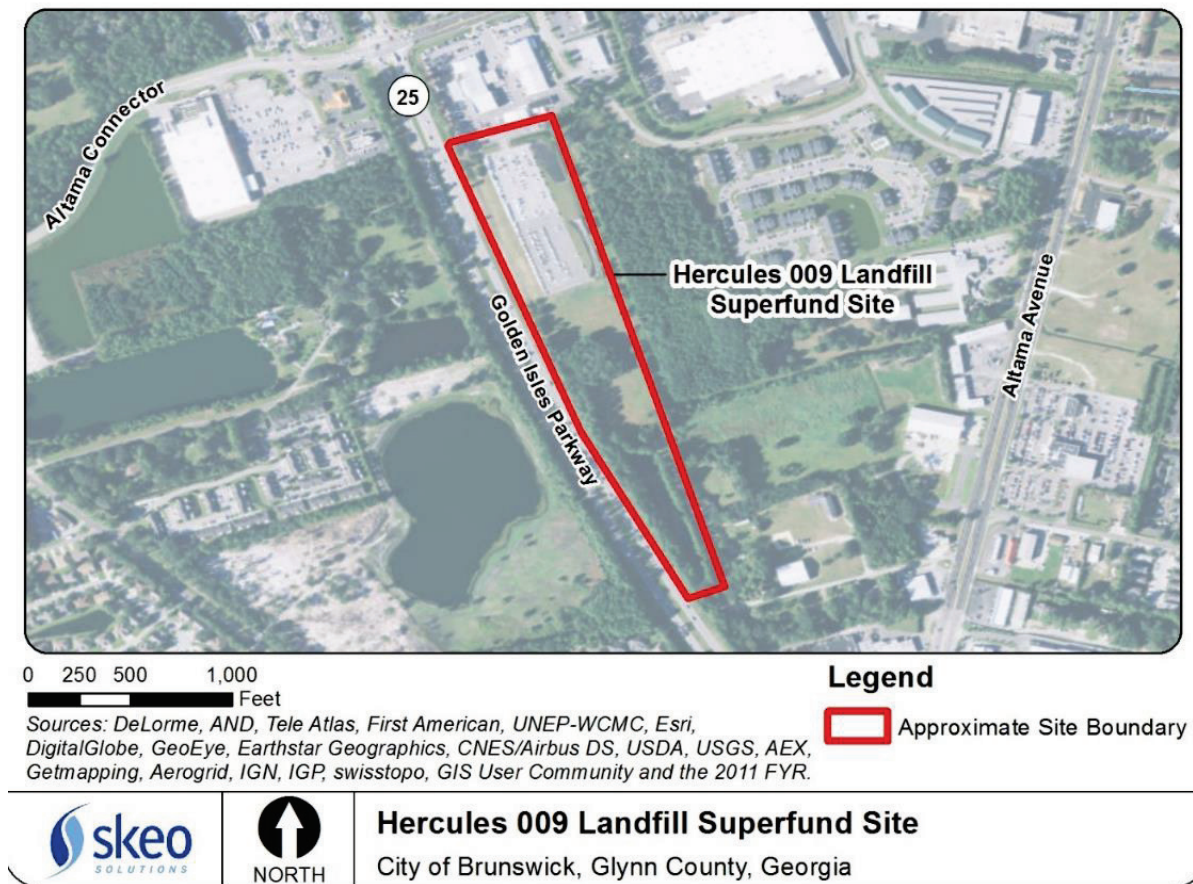


Figure 8. Hercules Landfill Superfund Site



SUMMARY

The technical support summarized in this report highlight the variety and impact of technical support provided by the STSC in FY2017. PPRTV assessments for 12 priority chemicals of interest to the Superfund Program and regional risk assessors were published, providing the Superfund Program with 25 unique toxicity values. Seven (7) of these assessments applied an expert-driven, read-across approach to deriving toxicity values for data-poor chemicals based on surrogate chemical PODs, resulting in 15 individual toxicity values. These newly derived toxicity values will be used to inform cleanup levels at Superfund sites across the United States.

In addition, the STSC responded to 19 requests to provide technical support to the Superfund Program in the area of human health risk assessments from various regions, state agencies, and international requestors through the operation of the STSC Hotline. The STSC serves a unique role to the Superfund Program community as a bridge between the site-specific regional risk assessors and the ORD risk assessors. Through the STSC Hotline, ORD scientists addressed the critical and time-sensitive needs of the regional scientists by activities such as providing toxicity values for chemicals of interest and reviewing newly published literature relevant to PPRTV chemicals. As such, the STSC acted as a key part of the larger TSC Program in ORD that is dedicated to serving the EPA and its clients ultimately resulting in lasting differences in communities across the country and ensuring public health protection.



CONTACT INFORMATION

Teresa Shannon

STSC Administrator, NCEA
(513) 569-7596; Shannon.Teresa@epa.gov

Beth Owens

STSC Director, NCEA
(513) 569-7241; Owens.Beth@epa.gov

U.S. Environmental Protection Agency
26 W. Martin Luther King Drive
Cincinnati, OH 45268

STSC Hotline

U.S. Environmental Protection Agency
26 W. Martin Luther King Drive
Cincinnati, OH 45268
(513) 569-7300; Superfund_STSC@epa.gov





REFERENCES

- Finley, BL; Monnot, AD; Paustenbach, DJ; Gaffney, SH. (2012). Derivation of a chronic oral reference dose for cobalt. *Regul Toxicol Pharmacol* 64: 491-503.
<http://dx.doi.org/10.1016/j.yrtph.2012.08.022>.
- Roche, M; Layrisse, M. (1956). Effect of cobalt on thyroidal uptake of I131 [Letter]. *J Clin Endocrinol Metab* 16: 831-833.
- U.S. EPA (U.S. Environmental Protection Agency). (1988). Integrated risk information system (IRIS) Chemical Assessment Summary for toxaphene. Washington, DC: Office of Research and Development, National Center for Environmental Assessment.
https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0346_summary.pdf.
- U.S. EPA (U.S. Environmental Protection Agency). (2005). Guidelines for carcinogen risk assessment [EPA Report] (pp. 1-166). (EPA/630/P-03/001F). Washington, DC: U.S. Environmental Protection Agency, Risk Assessment Forum.
<http://www2.epa.gov/osa/guidelines-carcinogen-risk-assessment>.
- U.S. EPA (U.S. Environmental Protection Agency). (2008). Provisional peer reviewed toxicity values for Cobalt (CASRN 7440-48-4) [EPA Report]. Cincinnati, OH.
- Wang, NC; Zhao, QJ; Wesselkamper, SC; Lambert, JC; Petersen, D; Hess-Wilson, JK. (2012). Application of computational toxicological approaches in human health risk assessment. I. A tiered surrogate approach. *Regul Toxicol Pharmacol* 63: 10-19.
<http://dx.doi.org/10.1016/j.yrtph.2012.02.006>.
- Wang, Z; Li, X; Wu, Q; Lamb, J; Klaunig, JE. (2017). Toxaphene-induced mouse liver tumorigenesis is mediated by the constitutive androstane receptor. *J Appl Toxicol* 37: 967-975. <http://dx.doi.org/10.1002/jat.3445>.
- Wang, Z; Neal, BH; Lamb, JC; Klaunig, JE. (2015). Mechanistic investigation of toxaphene induced mouse liver tumors. *Toxicol Sci* 147: 549-561.
<http://dx.doi.org/10.1093/toxsci/kfv151>.