Testimony before the House Foreign Affairs' Subcommittee on Asian, the Pacific, and the Global Environment
Hearing on "Our Forgotten Responsibility: What Can We Do To Help Victims of Agent Orange?"

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Chief International Officer
American Association for the Advancement of Science

Chairman Faleomavaega, Ranking Member Manzullo, and Members of this Subcommittee, thank you for giving me this opportunity to testify on the important topic of the Agent Orange legacy. I am Vaughan Turekian, Chief International Officer of the American Association for the Advancement of Science (AAAS) – the world's largest general scientific society whose mission is to advance science in service of society. For the purposes of today's hearing, I am testifying as a member of the US-Vietnam Dialogue Group on Agent Orange.

The persistent problems associated with Agent Orange contamination remain among the most contentious legacies of the Vietnam War, leading to some bilateral tension between the U.S. and Vietnamese governments. Addressing this legacy, both through government to government mechanisms as well as through civil society partnership presents an opportunity to lay the foundation for a stronger and sustainable relationship with this strategically important and economically vibrant Asian country.

This statement addresses the following issues:

- Scope of the spraying and some scientific background;
- Health impacts of Agent Orange and dioxin;
- Environmental impacts;
- Collaborative efforts to address Agent Orange and its legacy in Vietnam;

Scope

Agent Orange is a toxic herbicide that was used during the Vietnam War to remove trees and shrubbery that otherwise provided cover for enemy forces during the conflict. It was also used to reduce agricultural productivity. Agent Orange was made up of two less toxic compounds that when combined produced an extremely toxic byproduct 2,3,7,8 tetrachlorodibenzo-p-dioxin (most commonly referred to as TCDD) as a result of faulty production practices. Dioxins are some of the most toxic known human-synthesized chemicals, and TCDD is the most lethal dioxin compound.

Between 1962 and 1971, the U.S. military initiated Operation Ranch Hand, which was the systematic application of Agent Orange in southern and central Vietnam using airplanes, helicopters, boats, ground vehicles, and ground soldiers. South Vietnamese forces continued to use Agent Orange and other herbicides the United States gave them through 1975. According to U.S. military estimates, roughly 20 million gallons of Agent Orange was sprayed during that time, with an estimated 2-4 million citizens and soldiers that were directly sprayed. Current data show that roughly 10 percent of the total land area in southern Vietnam was impacted by the spraying. In some southern provinces, 50 percent of the land was completely stripped by Agent Orange.

TCDD does occur in nature, although in extremely low doses. For example, the typical concentration of TCDD in urban U.S. soil is about 10 parts per trillion (ppt). In Vietnam, varying amounts of dioxins are to this day found in areas affected by wartime spraying with the highest levels measured around former U.S. air bases, including Da Nang and Bien Hoa. In a 2001 study by Arnold Schecter et al., TCDD concentration in Bien Hoa was estimated at roughly 1.2 million ppt although this high concentration in Bien Hoa is attributed to accidental spills that occurred during the conflict, including the largest recorded spill of 7,500 gallons of Agent Orange. Dioxin concentration in Da Nang is estimated to be in the hundreds of thousands of ppt. Areas that were not sprayed during the war, generally in the northern region, have very low concentrations of TCDD. Today's dioxin contamination of the Vietnamese environment is a point source problem rather than a widespread/landscape contamination problem.

Health Impacts

U.S. veterans started reporting health problems shortly after returning from service in Vietnam. Of the roughly 3 million U.S. veterans that served in Vietnam during the war, nearly half were there during the period of heaviest spraying. It was not until Congress passed the Agent Orange Act of 1991 (P.L. 102-4) that the Secretary of Veteran Affairs (VA) called upon the National Academies Institute of Medicine (IOM) to conduct a scientific review of Agent Orange and adverse health effects. The IOM published its first report in 1994 and subsequent reviews were conducted every two years (until 2014 under the Veterans Education and Benefits Expansion Act, P.L. 107-103). The IOM studies found a strong scientific association ("sufficient evidence) between Agent Orange exposure and certain types of cancers, including soft-tissue sarcoma, non-Hodgkin lymphoma, Hodgkin disease, and chronic lymphocytic leukemia, and chloacne. The IOM also found looser associations, categorized as "limited/suggestive evidence", "inadequate/suggestive evidence", or "inadequate/insufficient evidence", with Agent Orange exposure and other cancer, congenital birth defects, diabetes type II, and other health disorders. The last update was completed in 2006 (see Appendix C for summary of findings), with the 2008 update currently in progress. In addition to the studies from IOM, the EPA also released a report in 2000, concluding that dioxins are carcinogenic in humans and may cause adverse health effects including: immune system alterations, reproductive, developmental or nervous system effects, endocrine disruption, altered lipid metabolism, liver damage, and skin lesions.

The National Academies and EPA studies focused on the adverse health effects of U.S veterans, who for the most part, suffered from short-term exposure to the TCDD. These effects pale in comparison to the Vietnamese people who remained in the affected areas and suffered much longer-term exposure. These people continued drinking water with dioxin-laced sediment and eating fatty tissues fish from contaminated water sources. Since the Vietnamese diet is based around vegetables and fish, TCDD entered the food chain through consumption. Given their fat contents food sources including fish, poultry, and dairy products account for the majority of dioxins exposure in humans. A 1996-1999 study by Dwernychuk et al. confirm that the levels of TCDD in blood, breast milk, and tissue samples are markedly higher in people who lived in or near contaminated areas and hot spots.

The Vietnamese government estimates that 3 million of its citizens still suffer health effects due to Agent Orange spraying. The Vietnamese government provides monetary compensation of approximately $3-$7 a month to these victims, hardly enough to cover medical expenses or care for disabled children (the GDP per capita in 2007 was $2,600, though anecdotally many of the affected families are outside of the more prosperous urban centers). The Vietnamese government has filed various appeals to the U.S. government for victim compensation, all of which have been rejected. As a result, many support groups and NGOs have organized to take legal action. For example, the Vietnamese Association for Victims of Agent Orange filed a lawsuit against producers of Agent Orange; that case was dismissed in 2005 and the verdict was upheld earlier this year.

Environmental Impacts

The original intention of spraying Agent Orange was to clear the dense forests of vegetation to help U.S. soldiers to uncover opposition forces. Consequentially, the spraying turned the once lush green forests into barren lands. Today these areas have been taken over by a very tough weed-like grass that the Vietnamese refer to as “American grass”. Without direct human intervention, such as planting trees or tearing up the hillsides, the invasive grass prevents trees or other vegetation from growing back. Furthermore the tree loss has reduced the spread of plant roots that help protect the soil, resulting in soil erosion, increased landslides, and flooding, all of which remain major problems today.

Dioxins are also part of a class of compounds known as “persistent organic pollutants” meaning that they can remain in the environment. It is estimated that the cost of containment and removal of the dioxins at Da Nang alone is at least $ 15 million.

Collaborations

In 2006, President Bush and Vietnamese President Nguyen Minh Triet for the first time issued a joint statement acknowledging dioxin contamination as a legacy of war. They

agreed to engage in collaborative efforts to clean up dioxin hot spots at former U.S. military air bases and increase humanitarian assistance to the disabled. Beyond the political issues, legal concerns over liability, and extent of impact, one of the major impediments to fully addressing Agent Orange issues is the cost associated with such efforts. For example, dioxin screenings of both environment and biological samples range from $600-$1,000 per sample. And clean up and remediation costs in the areas with the highest concentrations present are estimated to be at least $60 million. Long-term health care for disabled Vietnamese veterans and their children are even more costly.

The Vietnamese government recognizes that alone it cannot mitigate the impacts of Agent Orange exposure and contamination, and has welcomed opportunities for international collaborations – not only government to government interactions, but also bilateral civil society partnerships. A number of US private foundations are getting involved. For example, the Ford Foundation has invested nearly $4.5 million to address Agent Orange contamination and its impacts in the environment and human populations. As part of this effort it has funded efforts through the Aspen Institute and convened a binational committee with US and Vietnamese co-chairs, the U.S.-Vietnam Dialogue Group on Agent Orange. The Dialogue Group brings together policymakers and scientists from both nations to strengthen cooperation between the two countries and to identify resources to help mitigate the problem. The Dialogue Group has identified five main areas for the priority attention of stakeholders:

- To support clean up at former U.S. military air bases and health and livelihood programs for the surrounding communities;
- To expand support for treatment and education centers for victims of dioxin-related illnesses by improving available services;
- To assist in developing a dioxin testing laboratory in Vietnam, to both mitigate costs and develop local skills and independent expertise to sustain efforts over the long-term;
- To train local communities on environmental restoration of the affected land;
- To continue educating and advocating to build support for ongoing efforts in the United States.

The Dialogue Group has met three times so far. The most recent meeting was in February 2008 when the Group assembled in Vietnam to observe the progress being made in dioxin containment measures. The group also noted progress made in the expansion of services to people with disabilities and establishing a high-resolution dioxin testing laboratory.

Addressing Agent Orange issues through such collaborative efforts augments governmental endeavors and, in fact, increases the efficiency and effectiveness of responses. Further, meeting these challenges through such partnerships represents an opportunity for U.S. civil society to practice the act of soft diplomacy. My own experiences reflect the value and potential of scientist to scientist interactions as a critical tool for building bilateral goodwill, which may translate into improved bilateral

relationships – one need only look at polls from around the world to see the high regard which U.S science is held.

As with other international scientific engagements, our work with the Vietnamese scientific community allows us to move beyond the politically contentious issues. Instead, we are able to focus on finding solutions to challenges related to environment, health, and long-term measurement and monitoring.

I believe that the U.S. scientific community can continue to work in partnership with Vietnamese scientists to build capacity and integrate Vietnamese scientists into the rapidly developing global science enterprise. The proposed dioxin lab provides a great example of this approach. The collaboration between the Government of Vietnam, U.S.-based foundations and the scientific community to develop a high-resolution dioxin testing center in Vietnam will ultimately allow Vietnamese scientists to test their own environmental and (more critically) human samples, rather than outsourcing them to foreign labs in Europe and Canada. With continued international collaboration and training, this lab may become the first regional standards laboratory for monitoring organic pollutants, contributing to the peer reviewed literature on a range of potential environmental contaminants that have impact at both national and regional scales. More importantly, this lab will also provide a training facility for future generations of Vietnamese scientists. This technically trained next generation will not only contribute to the continued economic innovation and growth in Vietnam, but will also provide a window of opportunity for scientific collaboration with counterparts in the United States.

Summary

Rather than being an issue of the past, the legacy of Agent Orange still impacts human and environmental health and diplomatic relationships. After more than thirty years since the end of the Vietnam War, the U.S. must start fulfilling its obligation as a responsible global citizen by helping to contain dioxin hot spots and providing the necessary humanitarian assistance to affected people. This collaboration must be seen as a chance to improve the relationship between our two countries through engaging our scientific communities. The value of science diplomacy should not be underestimated; this is a perfect opportunity where science may prove to be a powerful tool for engagement, as many solutions to Agent Orange issues lie in science and technology. It is time to address this legacy of war and work towards putting it behind us so that our rapidly growing bilateral relationship can continue to flourish.

Attachments:
APPENDIX A: Background on the American Association for the Advancement of Science (AAAS);
APPENDIX B: Biographical information about Dr. Vaughan C. Turekian;
APPENDIX C: Institute of Medicine's 2006 Summary of Findings.

APPENDIX A

American Association for the Advancement of Science (AAAS)

The American Association for the Advancement of Science (AAAS) is the world's largest general scientific society, and publisher of the journal, *Science* (). AAAS was founded in 1848, and includes 262 affiliated societies and academies of science, serving 10 million individuals. *Science* has the largest paid circulation of any peer-reviewed general science journal in the world, with an estimated total readership of one million. The non-profit AAAS () is open to all and fulfills its mission to "advance science and serve society" through initiatives in science education, science policy; international programs; and an array of activities designed both to increase public understanding and engage the public more with science.

APPENDIX B

Biographical Sketch - Dr. Vaughan Turekian

Dr. Vaughan Turekian is the Chief International Officer for the American Association for the Advancement of Science (AAAS). In this role he leads, develops and coordinates the broad range of AAAS's international activities.

Prior to this position, Dr. Turekian served as Special Assistant to the Under Secretary of State for Democracy and Global Affairs, where and was her lead advisor on international science, technology, environment and health issues, including, clean energy, sustainable development, climate change, scientific outreach and avian influenza. He is the two time recipient of the Department's Superior Honor Award for his work on climate change and avian influenza.

Prior to his time at the State Department, Dr. Turekian worked at the National Academy of Sciences (NAS). In 2001, he was the Study Director for the White House requested NAS report on climate change science. He has published a numerous articles on the linkages between science and international policy.

Dr. Turekian received his masters and doctorate in atmospheric geochemistry from the University of Virginia, where he focused on applying stable isotopic tracers to characterize aerosol sources and chemistry in the marine boundary layer and was awarded the Maury Prize as the Outstanding Student in Environmental Sciences. He is a graduate of Yale University with degrees in Geology and Geophysics and International Studies.

Vaughan Charles Turekian

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Employment

Chief International Officer, The American Association for the Advancement of Science (AAAS),
March, 2006 - Present

- Develop and implement strategy for increasing AAAS' global profile and presence
- Accelerate internationalization of organization (internal):
- Build and maintain relationships with members of the international science community
- Work with foreign policy community to increase role of science as an instrument of "soft diplomacy"
- Represent AAAS at international meetings, conferences, congressional hearings, and community forums
- Initiate and advance dialogues and collaboration amongst governmental and science organizations.

Special Assistant to the Under Secretary for Global Affairs, U.S. Department of State,
June, 2003 – March 2006

- Advised Under Secretary on foreign policy issues related to climate change, environment, energy, science, technology and health, including the recently launched International Partnership on Pandemic and Avian Influenza
- Drafted articles, speeches and statements
- Contributed to the development of diplomatic and public diplomacy strategies
- Followed Congressional activities related to environment, science and technology and advise on possible actions
- Provided policy guidance to Under Secretary during international negotiations
- Represented Under Secretary at meetings with the Executive Office of the President, and other Executive branch agencies to discuss U.S. policy options for climate change, avian flu and other international science and environment issues
- Worked with environment, science and technology offices to develop new initiatives, such as science and technology outreach to the Islamic world

AAAS, Science Diplomacy Fellow: U.S. Department of State; Office of Global Change,
September, 2002 - June, 2003

- Worked on issues related to the U.N Framework Convention on Climate Change and the Intergovernmental Panel on Climate Change, Organization for Economic Co-operation and Development
- Promoted U.S. Government objectives on climate change in international negotiations
- Participated in interagency working groups to help formulate and shape U.S. policy on climate change
- Served as the State Department liaison to the U.S. Climate Research Initiative/U.S. Global Change Research Program and the Climate Change Technology Initiative

Program Director: Committee on Global Change Research; National Academy of Sciences, July, 2001 – August, 2002

- Developed and implemented a long-term strategic plan for the committee
- Worked with representatives from Federal Agencies and Congress to provide advice to government on issues in global change
- Worked with other Divisions within the National Academy of Sciences to promote a dialogue and increase collaboration on issues in global change

Program Officer: National Academy of Sciences, August, 2000 – July, 2001

- Directed studies, organized and administered committee meetings and workshops
- Study director White House requested report on climate change science
- Wrote technical reports with findings and recommendations
- Briefed findings and recommendations to representatives from Federal Agencies and Congress
- Developed project content and prepare proposals and budgets

Visiting Professor: The American University of Armenia June, 2000 – July, 2000

- Taught graduate courses in Environmental Sciences and Atmospheric Chemistry

Education

Ph.D. University of Virginia May, 2000
Charlottesville, Virginia
Environmental Sciences
Dissertation: *The Application of Chemical and Isotopic Tracers to Characterize Aerosol Sources and Processing In Polluted Marine Air*

M.S. University of Virginia May, 1996
Charlottesville, Virginia
Environmental Sciences
Thesis: *Carbon and Nitrogen Isotopes as Tracers of Biomass Burning Processes and Products*

B.S. Yale University May, 1993
New Haven, Connecticut
Primary Major: Geology and Geophysics (Atmosphere and Oceans)
Thesis: ^{222}*Rn and its Progeny as Tracers of Atmospheric Processes*
Second Major: International Studies
Thesis: *The Role of the International Atomic Energy Agency in the Non-Proliferation Treaty*

Awards

U.S. Department of State
Superior Honor Award 2006
Superior Honor Award 2005

The National Academy of Sciences
Division on Earth and Life Studies Staff Performance Award
2001

University of Virginia:

Maury Prize as Outstanding Student in Environmental Sciences	2000
Dean's Reserve Research Fellowship	1997-1999
Pegau Prize as Outstanding First Year Graduate Student in Geology	1995
DuPont Research Fellowship	1994-1996

Yale University:

Pat Wilde Prize for Excellence in Marine Geology and Oceanography	1993

Publications

Policy Articles and Editorials

Saunders, P.J. and V.C. Turekian, "Why Climate Change Can't be Stopped", *Foreign Policy online*, September 2007.
Leshner, A.I. and V.C. Turekian, "Chinese Science on the Move", *Science*, 318, 1523, 2007
Lord, K.M and V.C. Turekian, "Time for a New Era of Science Diplomacy**",** *Science*, 315, 769-770, 2007
Turekian, V.C. "Science, a tool for peace", *Research Africa, January, 23, 2007*
Saunders, P, J and V.C. Turekian, "Meeting the Energy Challenge", *The National Interest*, Summer, 2006.
Saunders, P.J. and V.C. Turekian, "America's energy policy". *The Washington Times, November 30, 2006*

Refereed Scientific Publications

Sander, R., W.C. Keene, A.A.P. Pszenny, R. Ariomoto, G.P. Ayers, J.M. Cainey, P.J. Crutzen, R.A. Duce, W. Maenhaunt, V.C. Turekian, and R. van Dingenen, Inorganic bromine in the marine boundary layer: a critical review, *Atmospheric Chemistry and Physics*, 3, 1301-1336, 2003.

Turekian, V.C., S.A. Macko and W.C. Keene, Concentrations, isotopic compositions, and sources of size-resolved, particulate organic carbon and oxalic acid in near-surface marine air at Bermuda during spring, *Journal of Geophysical Research, 108* (D5), 4157, doi:10.1029/2002JD2053,2003.

Turekian, V.C., S.A. Macko, and W.C. Keene, Application of stable sulfur isotopes to differentiate sources of size resolved sulfate in polluted marine air at Bermuda during spring, *Geophysical Research Letters, 28*, 1491-1494. 2001.

Turekian, V.C., W.C. Graustein, and K.K. Turekian, The ^{214}Bi to ^{214}Pb ratio in lower boundary layer aerosols and aerosol residence times at New Haven, CT, *Journal of Geophysical Research, 104*, 11,593-11,598, 1999.

Turekian, V.C., S.A. Macko, D.C. Ballentine, R.J. Swap, and M. Garstang, Causes of carbon and nitrogen isotope fractionation in the products of controlled vegetation burns, *Chemical Geology, 152*, 181-192, 1998.

Ballentine, D.C., S.A. Macko, and V.C. Turekian, Variability of stable carbon isotopic compositions in individual fatty acids from combustion of C3 and C4 plants: Implications for biomass burning, *Chemical Geology, 152*, 151-161, 1998.

Ballentine, D.C., S.A. Macko, V.C. Turekian, W.F. Gilhooly, and B. Martincigh, Compound specific isotope analysis for fatty acids and polycyclic aromatic hydrocarbons in aerosols: Implications for biomass burning, *Organic Geochemistry, 25*, 97-104, 1997.

Turekian, K.K., N. Tanaka, V.C. Turekian, T. Torgersen, and E.C. DeAngelo, Transfer rates of dissolved tracers through estuaries based on ^{228}Ra: A study of Long Island Sound, *Continental Shelf Research, 16*, 863-873, 1996.

Torgersen, T., K.K. Turekian, V.C. Turekian, N. Tanaka, E.C. DeAngelo, and J. O'Donnell, ^{224}Ra distribution in surface and deep water of Long Island Sound: Sources and horizontal transport rates, *Continental Shelf Research*, *16*, 1545-1559, 1996.

National Academy of Sciences Reports

Climate Change Science: An Analysis of Some Key Questions,
The Science of Regional and Global Change: Putting Knowledge to Work
Improving the Effectiveness of U.S. Climate Modeling
Predictability and Limits to Prediction in Hydrologic Sciences
Assessing Future Research in Weather Modification Research
Weather Radar Technology Beyond NEXRAD
The Role of Atmospheric Sciences in Homeland Security
Weather Forecasting Accuracy for Air Traffic Management

Book Chapters

Turekian, V.C., S.A. Macko, W.P. Gilhooly, D.C. Ballentine, R.J. Swap, and M. Garstang, Bulk and compound specific isotope characterization of the products of biomass burning: Laboratory studies, in *Biomass Burning and Global Change*, edited by J.S. Levine, pp. 422-427, MIT Press, Cambridge, MA, 1996.

Ballentine, D.C., S.A. Macko, V.C. Turekian, W.F. Gilhooly, and B. Martincigh, Chemical and isotopic characterization of aerosols collected during sugar cane burning in South Africa, in *Biomass Burning and Global Change*, edited by J.S. Levine, pp. 460-465, MIT Press, Cambridge, MA, 1996.

Gilhooly, W.P., S.A. Macko, V.C. Turekian, R.J. Swap, and W.F. Ruddiman, Stable carbon isotopic analysis of charcoal from single plant sources, in *Biomass Burning and Global Change*, edited by J.S. Levine, pp. 466-471, MIT Press, Cambridge, MA, 1996.

Boards and Committee Membership

National Academy of Sciences Sustainability Roundtable
US-Vietnam Dialogue Group on Agent Orange/Dioxin
Korean – US Science Cooperation Organization

APPENDIX C

Summary of Findings in Occupational, Environmental, and Veteran Studies Regarding the Association Between Specific Health Outcomes and Exposure to Herbicides

Sufficient Evidence of Association
Evidence is sufficient to conclude that there is a positive association. That is, a positive association has been observed between exposure to herbicides and the outcome in studies in which chance, bias, and confounding could be ruled out with reasonable confidence. For example, if several small studies that are free of bias and confounding show an association that is consistent in magnitude and direction, there could be sufficient evidence of an association. There is sufficient evidence of an association between exposure to the chemicals of interest and the following health outcomes:

- Soft-tissue sarcoma (including heart)
- Non-Hodgkin's lymphoma
- Chronic lymphocytic leukemia (CLL)
- Hodgkin's disease
- Chloracne

Limited or Suggestive Evidence of Association
Evidence suggests an association between exposure to herbicides and the outcome, but a firm conclusion is limited because chance, bias, and confounding could not be ruled out with confidence. For example, a well-conducted study with strong findings in accord with less compelling results from studies of populations with similar exposures could constitute such evidence. There is limited or suggestive evidence of an association between exposure to the chemicals of interest and the following health outcomes:

- Laryngeal cancer
- Cancer of the lung, bronchus, or trachea
- Prostate cancer
- Multiple myeloma
- AL amyloidosis (category change from *Update 2004*)
- Early-onset transient peripheral neuropathy
- Porphyria cutanea tarda
- Hypertension (category change from *Update 2004*)
- Type 2 diabetes (mellitus)
- Spina bifida in offspring of exposed people

Inadequate or Insufficient Evidence to Determine Association
The available studies are of insufficient quality, consistency, or statistical power to permit a conclusion regarding the presence or absence of an association. For example, studies fail to control for confounding, have inadequate exposure assessment, or fail to address latency. There is inadequate or insufficient evidence to determine whether an association exists between exposure to the chemicals of interest and the following health outcomes *that were explicitly reviewed*:

- Cancers of the oral cavity (including lips and tongue), pharynx (including tonsils), or nasal cavity (including ears and sinuses)
- Cancers of the pleura, mediastinum, and other unspecified sites within the respiratory system and intrathoracic organs
- Esophageal cancer (category change from *Update 2004*)
- Stomach cancer (category change from *Update 2004*)
- Colorectal cancer (including small intestine and anus) (category change from *Update 2004*)
- Hepatobiliary cancers (liver, gallbladder, and bile ducts)
- Pancreatic cancer (category change from *Update 2004*)
- Bone and joint cancer
- Melanoma
- Non-melanoma skin cancer (basal cell and squamous cell)
- Breast cancer
- Cancers of reproductive organs (cervix, uterus, ovary, testes, and penis; excluding
- prostate)
- Urinary bladder cancer
- Renal cancer
- Cancers of brain and nervous system (including eye) (category change from *Update 2004*)
- Endocrine cancers (thyroid, thymus, and other endocrine)
- Leukemia (other than CLL)
- Cancers at other and unspecified sites
- Infertility
- Spontaneous abortion (other than for paternal exposure to TCDD, which appears not to be associated)*b*
- Neonatal or infant death and stillbirth in offspring of exposed people
- Low birth weight in offspring of exposed people
- Birth defects (other than spina bifida) in offspring of exposed people
- Childhood cancer (including acute myelogenous leukemia) in offspring of exposed people
- Neurobehavioral disorders (cognitive and neuropsychiatric)
- Movement disorders, including Parkinson’s disease and amyotrophic lateral sclerosis (ALS)
- Chronic peripheral nervous system disorders
- Respiratory disorders
- Gastrointestinal, metabolic, and digestive disorders (changes in liver enzymes, lipid abnormalities, and ulcers)
- Immune system disorders (immune suppression, allergy, and autoimmunity)
- Ischemic heart disease
- Circulatory disorders (other than hypertension and perhaps ischemic heart disease)
- Endometriosis
- Effects on thyroid homeostasis

This committee used a classification that spans the full array of cancers. However, reviews for nonmalignant conditions were conducted only if they were found to have been the subjects of epidemiologic investigation or at the request of the Department of Veterans Affairs. *By default, any health outcome on which no epidemiologic information has been found falls into this category.*

Limited or Suggestive Evidence of *No* Association
Several adequate studies, which cover the full range of human exposure, are consistent in not showing a positive association between any magnitude of exposure to the herbicides of interest and the outcome. A conclusion of "no association" is inevitably limited to the conditions, exposures, and length of observation covered by the available studies. *In addition, the possibility of a very small increase in risk at the exposure studied can never be excluded.* There is limited or suggestive evidence of *no* association between exposure to the herbicides of interest and the following health outcomes:

- Spontaneous abortion and paternal exposure to TCDD*b*

a Herbicides indicates the following chemicals of interest: 2,4-dichlorophenoxyacetic acid (2,4-D), 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) and its contaminant 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD, or dioxin), cacodylic acid, and picloram. The evidence regarding association was drawn from occupational, environmental, and veteran studies in which people were exposed to the herbicides used in Vietnam, to their components, or to their contaminants.
b This conclusion appropriately constrained by specific chemical and exposed parent was drawn in *Update 2002* but was not carried into the summary table.
* The committee was unable to reach consensus as to whether these endpoints had **Limited or Suggestive Evidence of Association** or had **Inadequate or Insufficient Evidence to Determine Association**, and so these were left in the lower category.

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