Tonga:

National Implementation Plan (NIP)
for
Persistent Organic Pollutants

January 2020





Foreword

Tonga's ratification of the Stockholm Convention on Persistent Organic Pollutants (POPs) in May 2002 reflects the nation's global commitment to the protection of human health and the environment from the adverse effects of persistent organic pollutants. As a Party, Tonga is required to take appropriate measures to reduce and eliminate releases of POPs chemicals to the environment.

The updated National Implementation Plan (NIP) on management of POPs fulfils, in part, Tonga's commitment to the Stockholm Convention and provides a review and update to the first NIP developed in 2009, taking into consideration new POPs chemicals listed under the Stockholm Convention. The NIP was reviewed based on guidance documents provided by the Stockholm Convention Secretariat and is a document that provides a framework for the future management of POPs (and other) chemicals in Tonga.

The successful revision of the NIP could not have been realised without the cooperation and support of all stakeholders including government agencies and utilities. We express our gratitude to the Secretariat of the Pacific Regional Environment Programme (SPREP), the United Nations Environment Programme (UNEP) and the Global Environment Facility (GEF) for the support and assistance provided towards the review and development of this document. A special word of appreciation is due to Ms Mafile'o Masi and Ms Sulieti Hufanga (Tonga Environment Department) and International Consultants Dr David Haynes, Ms Sharyn Cant and Ms Sue Mulvany for undertaking and drafting the revised NIP on behalf of the Government of Tonga.

We consider the NIP a living document that will be updated on a regular basis based on changes to relevant national policies and strategies, taking into consideration any new POPs chemicals added to the Stockholm Convention in the future. The experience and lessons learnt in this process will be essential in future reviews of the NIP.

In conclusion, I wish to record my appreciation of the lead role played by the Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Communications and Climate Change and key stakeholders in revising the NIP. The Government of Tonga is committed to ensuring a safe and healthy environment for its citizens, and the endorsement of the NIP by my Ministry clearly paves a way forward for improved chemical and waste management in the country. Further funding and technical support to implement the NIP will be critical to ensure that Tonga meets its obligations under the Stockholm Convention.

Name & title
Date

Executive Summary

The Tonga National Implementation Plan (NIP) has been completed to facilitate fulfilment of Article 7 of the Stockholm Convention on Persistent Organic Pollutants (Stockholm Convention), which Tonga ratified on 23rd October 2009. It contains available data and information about Persistent Organic Pollutants (POPs), including other organochlorine substances of interest that are (or may be) present in Tonga. It draws on available data and field surveys, workshops and information that was gathered during the review and revision of the origin document under the direction of the Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Communications and Climate Change (MEIDECC). The Tonga NIP has been developed in accordance with the guidelines of the United Nations Environment Programme (UNEP)[1], with an emphasis on provision of background information regarding POPs in Tonga to set the context for management of these pollutants into the future.

The POPs pesticides aldrin, chlordane, dieldrin, endrin, endosulfan, heptachlor, hexachlorobenzene, lindane, mirex, toxaphene and DDT were previously approved for use in Tonga, but there is no information available on the quantities that were used in the past. The importation and use of POPs pesticides was banned in 1973, although the pesticides were only formally withdrawn from national use in 1995. Limited national participation in the Global Monitoring Plan (GMP) has detected low concentrations of a number of POPs residues (chlordane, dieldrin, HCB, BDE, and 3 isomers of HCH) in breast milk samples collected in 2008. Continued participation in the GMP will assist with future monitoring for the presence of POPs, and also the future potential impact of these (and other) chemicals in Tonga.

Similarly, the pesticide DDT has been used in the past for agricultural and dengue vector pest control in Tonga, but is not currently used, or known to be present in Tonga. It has been detected in GMP breast milk samples collected in Tonga in 2008, and its presence should continue to be routinely monitored for under the monitoring programme. Lindane was commonly used in Tonga prior to 2016 as the active ingredient in *Benhex* treatment for scabies which was dispensed through Ministry of Health pharmacies.

Small quantities of dieldrin, 2,4-Dichlorophenoxyacetic acid, endosulfan and 241 kg of other pesticides were identified and repackaged for disposal at the Vaini Research Farm in 2002 and exported under the POPs in PICs project. Tonga does not have a chemical production industry and as such, does not produce any of the 15 pesticide chemicals listed in Annex A, Part 1 of the Stockholm Convention. Tonga has no intention to deliberately import any of these POPs chemicals into the country for use, and there is enough generic legislation in place (Pesticide Act (2002); and the Environment Management Act (2010)) that would control or prohibit the deliberate importation of these chemicals into the country into the future. A variety of non-POPs insecticides are currently imported for use in national agricultural activities.

[1]UNEP (2017). *Guidance for Developing a National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants*. UNITAR. 71 pp

No PCB contaminated transformer oil is believed to be present in Tonga. However, limited soil sampling from the Tukutonga dumpsite in 2006 following its decommissioning, detected low concentrations of a range of POPs (including PCBs). The dumpsite operated from the mid-1920s to 2006. Ongoing national participation in the GMP will assist in future monitoring for the presence and potential impact of PCBs, PCNs, SCCPs and HCBD in Tonga.

No direct information is available on the presence or use of polybrominated diphenyl ethers (POPs-PBDEs) and hexabromocyclododecane (HBCD) in Tonga. However, it is highly likely that POP-PBDEs and HBCD have entered the country in manufactured articles. These POPs-PBDEs may be present in plastic components of common household and office goods, such as computers and electrical appliances, and in furniture fabrics and textiles, as well as in foamed plastics and rubbers used in furniture, mattresses, carpet underlays, car seats, and in foamed building insulation.

Census data indicates that ownership of electronic goods is high in Tonga and the estimated quantity of hexa/heptaBDE in electronic items (CRT TVs and monitors) in use in Tonga (in 2015) ranges from 0.071 to 0.207 tonnes and the quantity of decaBDE ranges from 0.483 to 0.664 tonnes, both contained in 151 tonnes of polymeric fraction. The quantity of hexa/heptaBDE and decaBDE estimated to be present in household flat screen TVs in 2015 either in use or stockpiled, is approximately 0.033 tonnes contained in 12 tonnes of polymeric fraction.

Based on national import data, the 2016-2018 estimated hexa/heptaBDE amount in imported CRT TVs and monitors ranges from 0.007 tonnes to 0.010 tonnes and the decaBDE amount ranges from 0.024 to 0.065 tonnes, both contained in 15 tonnes of polymeric fraction, while the estimated hexa/heptaBDE and decaBDE in imported flat screen TVs during 2016-2018 is 0.157 tonnes contained in 56 tonnes of polymeric fraction.

At the end of their service life, these electronic products containing POP-PBDEs are likely to be disposed of by export or in landfills. The 2016-2017 estimated hexa/heptaBDE amount in waste electrical and electronic equipment (WEEE) ranges from 0.001 tonnes to 0.003 tonnes and the decaBDE amount ranges from 0.007 to 0.009 tonnes, both contained in 2 tonnes of polymeric fraction. Introduction of improved national e-waste management practices would practically manage this issue in Tonga. The number of motor vehicles imported into Tonga is relatively low due to the low demand created by a small national population and small land area.

As at 2019 it is estimated that there is approximately 0.519 tonnes of POP-PBDEs contained in 75 tonnes of polyurethane foams from vehicles in current use; 0.177 tonnes of POP-PBDEs in vehicles that have been recycled; and 0.160 tonnes in end of life vehicles that have been collected and stored in Tonga. Past monitoring has detected the presence of POP-PBDEs in dumpsite sediments, and improved solid waste and e-waste management will minimise the risk to Tonga from these chemicals into the future.

Due to the similarity in use of hexabromo-biphenyl (HBB) and POPs-PBDEs, any minor amount of HBB that may be present in Tonga will concomitantly be addressed through national POPs-PBDEs management measures.

The presence of short-chain chlorinated paraffins (SCCPs) in Tonga is currently unknown. However, improved national management of e-waste and national participation in the GMP will assist in the management of these chemicals into the future.

In most applications, PCNs have not been produced or used for over 30 years and it can be assumed that most PCN-containing products with short lifetimes (e.g. textiles, papers, lubricants, cutting oils and grease) have already been disposed of and will not be present in Tonga. PCNs are also unintentionally formed and released together with dioxins and furans in thermal processes. Unintentionally produced PCNs are not separately addressed in this NIP as PCN emissions will be reduced by the same measures applied to reduce dioxins and furans.

AFFF fire-fighting foam containing PFOS/PFOA is not held or used by fire suppression services in Tonga.

Management of HCB, HCBD, PeCB, PCDDs, PCDFs, PCBs and PCNs will be managed through a national management and community education and awareness programme for unintentionally produced POPs (uPOPs). UPOPs emissions from Tonga are very low by world standards. The most significant national uPOPs management priorities include minimisation of low temperature waste and healthcare waste incineration and reductions in national tobacco smoking rates.

While there are currently no formal policies relating to national management of POPs pesticides in Tonga, there is sufficient generic legislation to control or prohibit the deliberate importation of these chemicals into the country. The updated NIP presents an opportunity for Tonga to address its entire chemical management framework to cater for current and future challenges, including management of POP chemicals.

The NIP presents a range of pragmatic actions that should be implemented to enhance national capacity to manage chemicals into the future. These include improved regulatory measures, infrastructure development, improved waste management practices, and technical and scientific improvements including ongoing monitoring of POPs and pesticides. Building on past projects, integrating a national chemical management framework into sustainable development planning would help improve the national management of organochlorine and other pesticides to prevent impacts on Tonga's peoples and local environments. Key national actions and priorities for future management of chemicals listed under the Stockholm Convention are summarised in Table 1.

Table 1: Tonga POPs management priority summary

Chemical	Use	Annex	National Presence	Action required	Action Plan number
Aldrin	Pesticide	A	Unlikely to be present	Monitor (GMP)	AP11
Chlordane	Pesticide	A	Past use in Tonga	Monitor (GMP)*	AP11
Dieldrin	Pesticide	A	Past use in Tonga	Monitor (GMP)*	AP9 AP11
Endrin	Pesticide	A	Unlikely to be present	Monitor (GMP)	AP11
Heptachlor	Pesticide	A	Unlikely to be present	Monitor (GMP)	AP11
Hexachlorobenzene (HCB)	Pesticide and Industrial chemical	A & C	Past use in Tonga	uPOPs management Monitor (GMP)*	AP4 AP8 AP11
Mirex	Pesticide	A	Unlikely to be present	Monitor (GMP)	AP11
Toxaphene	Pesticide	A	Unlikely to be present	Monitor (GMP)	AP11
Chlordecone	Pesticide	A	Not Present	Not required	

Chemical	Use	Annex	National Presence	Action required	Action Plan number
Alpha Hexachloro-cyclohexane (á-HCH)	Pesticide	A	Unlikely to be present	Monitor (GMP)	AP11
Beta Hexachloro-cyclohexane (β-HCH)	Pesticide	A	Unlikely to be present	Monitor (GMP)*	AP11
Lindane (Y-HCH)	Pesticide	A	Likely to be present	Monitor (GMP)*	AP11
Pentachlorophenol (PCP) and its salts and esters	Pesticide	A	Unlikely to be present	Not required	
Technical Endosulfan and its related isomers	Pesticide	A	Unlikely to be present	Monitor (GMP)	AP11
DDT	Pesticide	B	Past use in Tonga	Monitor (GMP)*	AP7 AP9 A11
Perfluorooctane sulfonic acid (PFOS), its salts and Perfluorooctane sulfonyl fluoride (PFOS-F)	Industrial chemical	B	Potentially present	Improved waste management	AP6 AP9
Polychlorinated biphenyls (PCBs)	Industrial chemical	A & C	Potentially present	PCB management uPOPs management Monitor (GMP)*	AP4 AP9 AP11
Decabromo-diphenyl ether (commercial mixture, c-decaBDE)	Industrial chemical	A	Likely to be present	Improved waste and e-waste management*	AP5 AP11
Hexabromobiphenyl (HBB)	Industrial chemical	A	Unlikely to be present	Not required	
Hexabromo-cyclododecane (HBCD)	Industrial chemical	A	Unknown	Improved waste and e-waste management Monitor (GMP)*	AP5 AP11
Hexabromo-diphenyl ether (hexaBDE) and Heptabromo-diphenyl ether (heptaBDE)	Industrial chemical	A	Likely to be present	Improved waste and e-waste management	AP5 AP11
Short Chain Chlorinated Paraffins (SCCPs)	Industrial chemical	A	Unlikely to be present	Not required	
Tetrabromo-diphenyl ether (tetraBDE) and Pentabromo-diphenyl ether (pentaBDE) (commercial pentabromo-diphenyl ether)	Industrial chemical	A	Likely to be present	Improved waste and e-waste management	AP5
Hexachlorobutadiene	Industrial chemical	A & C	Unintentionally produced	uPOPs management	AP8 AP11
Polychlorinated naphthalenes (PCN)	Industrial chemical	A & C	Unintentionally produced	uPOPs management and Improved waste management	AP8 AP11
Pentachlorobenzene (PeCB)	Pesticide and Industrial chemical	A & C	Unintentionally produced	uPOPs management	AP8 AP11

Chemical	Use	Annex	National Presence	Action required	Action Plan number
Polychlorinated dibenzo-p-dioxins (PCDDs)	By products	C	Unintentionally produced	uPOPs management Monitor (GMP)*	AP8 AP11
Polychlorinated dibenzofurans (PCDFs)	By products	C	Unintentionally produced	uPOPs management Monitor (GMP)*	AP8 AP11

*Detectable in human breast milk samples collected in Tonga under the GMP (2008).

Table of Contents

Abbreviations

AFFF	Aqueous Film-Forming Foam
BAT	Best Available Techniques
BEP	Best Environmental Practices
c-OctaBDE	Commercial octabromodiphenyl ether
c-PentaBDE	Commercial pentabromodiphenyl ether
COP	Conference of Parties
DDT	Dichlorodiphenyltrichloroethane
EDC	Endocrine Disrupting Chemical
EEE	Electrical and Electronic Equipment
EOL	End of Life
EPS	Expanded Polystyrene
e-waste	Electronic Waste
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
GEF	Global Environment Facility
GMP	Global Monitoring Plan
HBB	Hexabromobiphenyl
HBCD	Hexabromocyclododecane
HCB	Hexachlorobenzene
HCBD	Hexachlorobutadiene
HCH	Hexachlorocyclohexane
hexaBDE	Hexabromodiphenyl ether
heptaBDE	Heptabromodiphenyl ether
HIPS	High Impact Polystyrene
IMO	International Maritime Organization
MAFF	Ministry of Agriculture, Food and Forests
MARPOL	Convention for the Prevention of Pollution from Ships
MEIDECC	Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Communications and Climate Change
NGO	Non-Government Organisation
NIP	National Implementation Plan
PBDEs	Polybrominated diphenyl ethers
PCBs	Polychlorinated biphenyls
PCDDs	Polychlorinated dibenzo-p-dioxins
PCDFs	Polychlorinated dibenzofurans
PCNs	Polychlorinated naphthalenes
PCP	Pentachlorophenol
PeCB	Pentachlorobenzene
pentaBDE	Pentabromodiphenyl ether
PET	Polyethylene terephthalate
PFOS	Perflurooctane sulfonic acid
PFOSF	Perfluorooctane sulfonyl fluoride
PIC	Pacific Island Country
POPs	Persistent Organic Pollutants
POP-PBDEs	POPs- Polybrominated diphenyl ethers
SCCP	Short Chain Chlorinated Paraffins
SPREP	Secretariat of the Pacific Regional Environment Programme
SMC	Sound Management of Chemicals
tetraBDE	Tetrabromodiphenyl ether
TPL	Tonga Power Limited
UNEP	United Nations Environment Programme
uPOPs	Unintentionally produced Persistent Organic Pollutants
WAL	Waste Authority Limited
WEEE	Waste Electrical and Electronic Equipment
WHO	World Health Organisation
XPS	Extruded Polystyrene

1 Introduction

The Stockholm Convention on Persistent Organic Pollutants (the Stockholm Convention) is an international treaty that requires Parties to phase-out and eliminate the production and use of the most persistent and toxic chemicals that have adverse impacts on human health and the environment. The Stockholm Convention was adopted on 22nd May 2001 and entered into force on 17th May 2004. On entry into force, the Stockholm Convention listed 12 priority Persistent Organic Pollutants (POPs), which was subsequently expanded to include 28 chemicals through amendments adopted by the Conference of Parties (COP) in 2009, 2011, 2013, 2015 and 2017.

Tonga became a signatory to the Stockholm Convention on Persistent Organic Pollutants on 21st May 2002 and ratified the Convention on the 23rd October 2009. As such, under Article 7 of the Stockholm Convention, Tonga is required to develop, endeavour to implement, and update as appropriate a National Implementation Plan (NIP), outlining how its obligations under the Convention will be met. Tonga developed its first NIP in 2009 to address management of the 12 initial POPs.[2] This current NIP represents the first review and update to the initial NIP and it covers the 28 POPs chemicals listed under the Stockholm Convention to 2017. The NIP has been developed and structured in accordance with guidelines provided by the United National Environment Programme (UNEP).[3]

1.1 The 28 listed POPs

POPs chemicals are toxic, persist in the environment, bio-accumulate in the food chain, and have trans-boundary transportation capabilities, often ending up in locations and being bio-accumulated in human (and animal) populations that are removed from the source of generation. The 28 POPs managed under the Stockholm Convention (Table 2) include pesticides, industrial chemicals and unintentionally produced POPs (uPOPs), which are listed under three Annexes as follows:

Annex A: these chemicals are mostly, but not exclusively, pesticides scheduled for elimination; Parties may register specific exemptions to continue the use of Annex A chemicals to allow for the time that may be needed to adapt and take necessary management measures required by the Convention.

Annex B: Parties must take measures to restrict the production and use of these chemicals; Parties may register specific exemptions or restrict use of Annex B chemicals to an 'acceptable purpose' listed under the Convention.

Annex C: these chemicals are produced unintentionally due to incomplete combustion, and during the manufacture of pesticides and other chlorinated substances. They are emitted

[2]Government of Tonga (2009). *Tonga enabling activities for the development of a national implementation plan for the Stockholm Convention on persistent organic pollutants: Draft National Implementation Plan*. 156 pp.
[3]UNEP (2017). *Guidance for Developing a National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants*. UNITAR. 71 pp.

mostly as a by-product of the incineration of hospital waste, municipal waste, and hazardous waste, and from automobile emissions, and the combustion of biomass including coal, wood and household waste. Parties must take measures to reduce the unintentional release of chemicals listed in this Annex, with the goal of continuous minimisation and, where feasible, ultimate elimination.

Table 2: POPs chemicals listed in the Stockholm Convention up to 2017

Stockholm Convention Chemical (listed alphabetically)	Annex	Date listed	Pesticide	Industrial chemical	By product
Aldrin	A	May 2004	●		
Chlordane	A	May 2004	●		
Chlordecone	A	May 2009	●		
Decabromodiphenyl ether (commercial mixture, c-decaBDE	A	May 2017		●	
DDT	B	May 2004	●		
Dieldrin	A	May 2004	●		
Endrin	A	May 2004	●		
Heptachlor	A	May 2004	●		
Hexabromobiphenyl (HBB)	A	May 2009		●	
Hexabromocyclododecane (HBCD)	A	May 2013		●	
Hexabromodiphenyl ether and heptabromodiphenyl ether	A	May 2009		●	
Hexachlorobenzene (HCB)	A & C	May 2004	●	●	●
Hexachlorobutadiene (HCBD)	A & C	May 2015		●	
Alpha-hexachlorocyclohexane (α-HCH)	A	May 2009	●		
Beta-hexachlorocyclohexane (β-HCH)	A	May 2009	●		
Lindane (γ-HCH)	A	May 2009	●		
Mirex	A	May 2004	●		
Pentachlorobenzene (PeCB)	A & C	May 2009	●	●	●
Pentachlorophenol and its salts and esters (PCP)	A	May 2015	●		
Perfluorooctane sulfonic acids and salts and Perfluorooctane sulfonyl fluoride (PFOS)	B	May 2009	●	●	
Polychlorinated biphenyls (PCBs)	A & C	May 2004		●	●
Polychlorinated dibenzo-p-dioxins	C	May 2004			●
Polychlorinated di-benzofurans	C	May 2004			●
Polychlorinated naphthalenes	A & C	May 2015		●	●
Short-chain chlorinated paraffins	A	May 2017		●	
Technical endosulfan and its related isomers	A	May 2011	●		
Tetrabromodiphenyl ether and pentabroodiphenyl ether	A	May 2009		●	
Toxaphene	A	May 2004	●		

1.2 Stockholm Convention Obligations

In addition to the obligation to develop and implement a NIP, Tonga has several other obligations under the Stockholm Convention (Table 3). This NIP outlines the actions that Tonga will take to deliver on these obligations.

Table 3: Summary of Tonga's obligations as a Party to the Stockholm Convention

Stockholm Convention	Tonga's obligations
Article 3	Eliminate the importation, production, use, and export of chemicals listed in Annex A except where authorised under the Convention, and restrict the production and use of chemicals listed in Annex B
Article 5	Reduce or eliminate unintentional production and release of Annex C chemicals
Article 6	Reduce or eliminate releases from stockpiles and wastes containing chemicals listed in Annexes A, B and C, and identify products or articles in use and sites contaminated with these chemicals
Article 7	Develop, endeavour to implement, and update as appropriate, a National Implementation Plan (NIP) outlining how its obligations under the Convention will be met
Article 9	Establish mechanisms to exchange information on POPs between Parties and the Secretariat
Article 10	Promote awareness of POPs among policy and decision makers and educate the public on the dangers of POPs to their health and the environment
Article 11	Encourage and/or undertake appropriate research, development, monitoring and cooperation pertaining to persistent organic pollutants and, where relevant, to their alternatives and to candidate persistent organic pollutants
Article 15	Report periodically to the Conference of Parties Secretariat on the status and measures on POPs reduction undertaken nationally
Article 16	Participate in the Global Monitoring Plan on POPs for the national presence of chemicals listed in Annexes A, B and C, as well as their global and environmental transport

1.3 NIP development process

The Government of Tonga sought assistance for the development of the NIP update from the Secretariat of the Pacific Environment Programme (SPREP), who contracted an international consultant team to complete the NIP revision in late 2019. This NIP update was carried out in seven connected phases:

I. A desktop review of available information and data relevant to contemporary chemical management in Tonga;
II. A review of progress achieved by the Government of Tonga in completing actions identified in the original NIP for improved national management of chemicals listed under the Stockholm Convention;
III. In-country training of national stakeholders on the national requirements of the Stockholm Convention, on improved national management of chemicals and the minimisation of the release of uPOPs;
IV. In country investigation of the status of management of Stockholm (and other) chemicals;
V. In country inventory of Stockholm Convention listed chemicals;
VI. Identification and costing of appropriate actions at the national level to implement the requirements of the Stockholm Convention at the national level; and
VII. Drafting of the updated NIP document.

1.4 Structure of the NIP

This NIP contains five chapters including this introductory chapter.

Chapter 2 of the NIP sets the country context by providing an overview of the social, economic, and environmental conditions of Tonga. Where relevant, the potential contribution of national activities to POPs releases and the potential impacts of POPs on national activities have been highlighted. Chapter 2 also summarises the national policy, regulatory and institutional environment within which POPs are managed. Chapter 2 of the NIP presents the findings of the national inventory on POPs, which was conducted as part of the NIP update process. Where necessary, inventory findings have been supplemented with additional desktop research and analysis to fill national data gaps.

Chapter 3 describes the gender dimensions relevant to successful NIP Implementation.

Chapter 4 presents a socio-economic assessment of management of Stockholm listed chemicals and describes the relative cost (and benefit) of implementing management of the chemicals under the NIP.

Chapter 5 contains the Strategy and Action Plan elements of the NIP. Each Action Plan is costed and identifies a lead implementing agency, who will be responsible for driving the national implementation of the corresponding activities.

2 Country Baseline

2.1 Country Profile

2.1.1 Geography

Located in Oceania, the Kingdom of Tonga is a small archipelago in the South Pacific Ocean, situated directly south of Samoa and about two-thirds of the distance from Hawaii to New Zealand (Figure 1). The archipelago lies between latitudes 15 and 24 degrees South and longitudes 173 and 177 degrees West. The island kingdom has 170 islands with a total area of 747km^2 located in four main island groups: the Niuas (Niua-toputapu and Niua-fo'ou) Group in the far north; the Vava'u Group; the Ha'apai Group; and the main Tongatapu Group (including 'Eua). The Ha'apai group consists of about 60 islands, of which 16 are inhabited, and the Vava'u group consists of about 70 islands, of which 13 are inhabited. Tongatapu is low, flat, and intensively settled and cultivated.

The Tongan islands are built on two ridges, the Tonga Ridge and the Tofua Ridge, running in parallel to one another in a southwest-northeast direction. In parallel to these ridges is the axis of the Tonga Kermadec Trench, which is one of the deepest locations on earth. The islands on the Tonga Ridge are coral in origin and low and flat; these include the Tongatapu, Ha'apai and Vava'u Groups, which accommodate almost all the national population. The Tonga Ridge is not volcanic, but it is tectonically active. The islands on the Tofua Ridge are volcanic in origin, high and rugged, and include the islands of 'Ata (southernmost island), Kao and Tofua (Ha'apai Group), Late Island (Vava'u Group), and the Niuas. Active volcanoes are present on four of the islands.[4] The Tongan Volcanic Arc has been important in supplying the islands on the Tonga ridge with an andesite tephra soil (volcanic ash) that has resulted in an extremely rich soil capable of supporting a high-yield, short-fallow agricultural system.[5] Other island soils include coral sands and lagoonal sands and mud.

2.1.2 Climate[6]

Tonga has two distinct seasons - a warm wet season from November to April and a cooler dry season from May to October. Tonga's climate varies considerably from year to year due to El Niño-Southern Oscillations. On the island of Tongatapu, the average annual temperature is 23°C with a maximum of 32°C and a minimum of 11°C. Annual and wet season mean, and minimum and maximum temperatures have increased in Nuku'alofa since 1949. Almost two-thirds of the nation's annual rainfall falls during the wet season. The northern parts of Tonga receive on average of about 2,600mm of rainfall per annum while the south islands receive about 1,700mm per annum.

[4]Government of Tonga (2009). *National Implementation Plan*. 161 pp
[5]Burley, D. (1998). Tongan Archaeology and the Tongan Past, 2850-150 B.P. *Journal of World Prehistory*, 12, No. 3
[6]Pacific-Australia Climate Change Science and Adaptation Planning Program (2015). *Current and future climate of Tonga*. www.pacificclimatechangescience.org

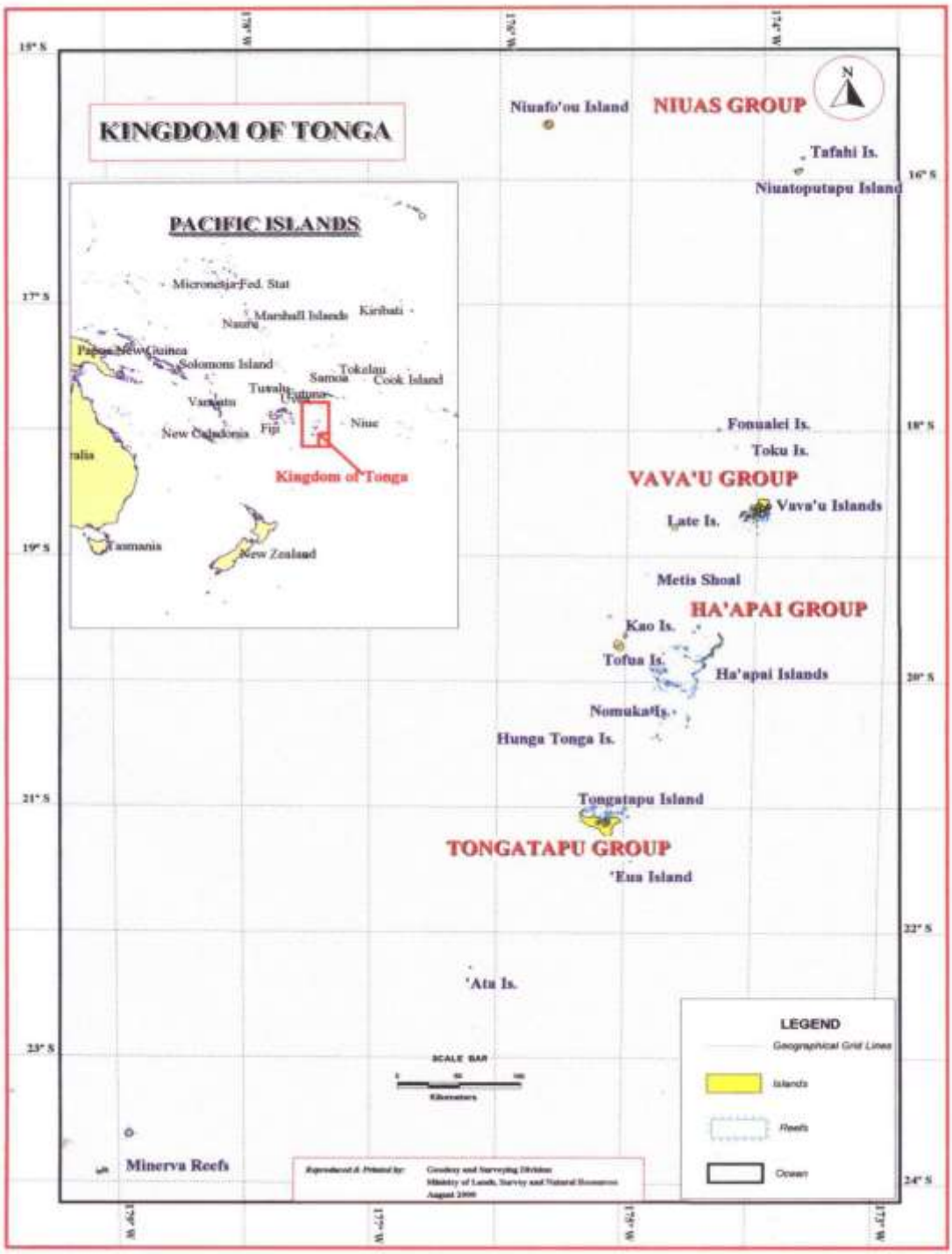


Figure 1. Map of the nation of Tonga[7]

Tropical cyclones are a common occurrence in Tonga between November and April. In the 42-year period between 1969 and 2010, 85 tropical cyclones developed or crossed into Tonga's Exclusive Economic Zone, an average of 20 cyclones per decade.

[7]Geodesy & Surveying Section – Ministry of Lands, Survey & Natural Resources, Tonga

Tonga is extremely vulnerable to the adverse impacts of climate change and disaster risks. The geographical, geological and socio-economic features of Tonga have resulted in a self-classification as one of the countries in the world most at risk to these impacts and risks.[8] This was supported in 2016, when Tonga was ranked second on the World Risk Index due to its exposure to natural hazards and its capacity to respond.[9] Since 1993, Tonga's sea level has been rising by approximately 6 mm per year.[10] Projections for all climate change emissions scenarios indicate that the annual average air temperature and sea surface temperature will increase in the future in Tonga. The future climate of Tonga is predicted to have:[11]

- higher air and sea temperatures
- more extreme-rainfall days
- more very hot days
- less frequent, but more intense tropical cyclones
- continued rise in sea levels
- continued ocean acidification.

These impacts will likely affect the infrastructure, economy, community and environment of Tonga. Climate change for Tonga will have cross-cutting effects on marine, coastal, fresh water and agricultural resources, as well as on biodiversity and the economy. The effects of climate change may include:

- greater risk of disaster from extreme weather events
- increasing coastal erosion and loss of marine habitats
- declining fresh water and natural food resources
- increasing incidence of crop pests and diseases
- increasing incidence of human diseases and poverty
- increasing demand for energy.

2.1.3 Population and Culture

The population of Tonga (in 2016) was 100,651.[12] Approximately 75% of Tongan residents live on Tongatapu, and approximately 15% of the population live on Vava'u. The capital and largest city of Tonga is Nuku'alofa on the island of Tongatapu which has a population of 24,500. There is an ongoing net movement of outer island populations towards Tongatapu and onwards to overseas destinations.[13]

The Tongan language is the official language, along with English. Archaeologists believe Tonga was first inhabited at least 3,000 years ago, but the arrival of the first Polynesian settlers is estimated at around 3,500-3,000 years ago.[14] Tongans, Polynesian by ethnicity, represent more than 98% of the inhabitants of Tonga. The first Christian missionaries arrived in Tonga in 1797.

[8]Government of Tonga (2016). *Tonga Climate Change Policy: A Resilient Tonga by 2035*. 30pp.
[9]World Risk Report (2016). The World Risk Index consists of indicators in four components: (a) exposure towards natural hazards such as earthquakes, cyclones, flooding, drought and sea level rise, (b) susceptibility depending on infrastructure, food, ho using and economic framework conditions, (c) coping capacities depending on governance, risk reduction, early warning, healthcare, social and material coverage and (d) adaptive capacities related to future natural hazards and the impacts of climate change.
[10]Government of Tonga (2015). *Second National Communication of Tonga to the United Nations Framework Convention on Climate Change.* 68pp.
[11]https://www.pacificclimatechangescience.org/wp-content/uploads/2013/06/4_PCCSP_Tonga_8pp.pdf
[12]Government of Tonga (2017). *Tonga 2016 Census of Population and Housing*
[13]Government of Tonga (2017). *Tonga 2016 Census of Population and Housing*
[14]Kirch, Patrick Vinton (1997). *The Lapita Peoples*. Wiley, ISBN 1-57718-036-4.

In 1845, the warrior, strategist and orator Taufa'ahau, united Tonga into a kingdom and declared Tonga a constitutional monarchy in 1875, formally adopted the western royal style, removed serfdom, enshrined a code of law, land tenure and freedom of the press, and limited the power of the chiefs.[15] Tonga became a protected State under a Treaty of Friendship with Britain in 1900 and remains the only Pacific nation to retain a monarchical government. The Treaty of Friendship and Tonga's protection status with Britain ended in 1970 under arrangements established by Queen Salote Tupou III prior to her death in 1965. Tonga joined the Commonwealth of Nations in 1970. Whilst exposed to colonial pressures, Tonga has always governed itself, which makes it unique in the Pacific.

All land in Tonga belongs to the Crown, and large estates have been allotted to nobles. By law, every male Tongan at age 16 is entitled to a small piece of agricultural land (from 2 to 4 ha) and a small-town plot.[16] However, in practice, there is not enough land and most men have not been allocated any land, and latterly there have been objections to the exclusion of women. Consequently, reform of the land tenure system has been under discussion. Tongan land cannot be sold to non-Tongans, although it can be leased.

2.1.4 Political System[17]

Under the 2010 constitution, Tonga is a constitutional monarchy and a parliamentary democracy with a unicameral legislative assembly consisting of 26 elected members, nine of whom are elected by and from among the country's 33 hereditary nobles, and 17 on the basis of universal adult suffrage in a general election which must take place at intervals of no longer than four years. Up to two cabinet ministers who are not already elected Assembly members become *ex officio* members. The monarchy is hereditary, and the monarch is Head of State. Until 2010, the constitution was essentially King George Tupou I's constitution granted in 1875, under which executive power resided with the monarch.

The Prime Minister is chosen by the Legislative Assembly and appointed by the monarch. The Prime Minister selects his cabinet who are then appointed by the monarch. The Prime Minister may nominate up to four ministers from outside the Assembly and on appointment they become members of the Assembly.

The Court of Appeal is presided over by the chief justice and its three other members are judges from other Commonwealth countries. It is the final court of appeal. The Supreme Court and the Land Court are also presided over by the chief justice, with one Tongan judge the other member in both cases. Litigants before the Supreme Court, in both civil and criminal cases, may opt for trial by jury. Appeals from the eight magistrates' courts are heard by the Supreme Court.

2.1.5 Economic Profile[18]

Tonga has a small, open island economy with a narrow export base in agricultural goods. It imports substantially more than it exports and has a relatively low level of private sector activity. The government faces high unemployment among the young, moderate inflation, pressures for democratic reform, and rising civil service expenditures. The GDP in 2017 was TOP$586 million and operating trade deficits over the past decades have accumulated foreign

[15]https://en.wikipedia.org/wiki/Tonga
[16]UNDP (2014). *Integrated Environmental Management of the Fanga'uta Lagoon Catchment*. 90 pp
[17]http://www.commonwealthofnations.org/sectors-tonga/government/
[18]https://www.indexmundi.com/tonga/economy_profile.html

debt to the point where it now represents 42% of GDP (TOP$250 million). The government is emphasizing the development of the private sector, encouraging investment, and is committing increased funding for health care and education. Tonga has a reasonably sound basic infrastructure and well-developed social services.

Tonga's economy is characterized by a large non-monetary sector dominated, if not owned, by the royal family and nobles. This is particularly true of the telecommunications and satellite services. The country remains dependent on external aid and remittances to offset its trade deficit. Remittances from Tongans living abroad, chiefly in Australia, New Zealand, and the United States, represented an estimated 26% of Gross Domestic Product in 2015.[19] Small industries producing manufactured items such as paints, leather garments, knitwear, wooden artefacts and woollen products are located in Nuku'alofa.[20] The nation imports a high proportion of its food, mainly from New Zealand.

Agriculture continues to be the predominant economic activity in Tonga, although its relative importance has dwindled in recent years. The sector's contribution to GDP declined from 26% in 2004/5 to about 19% in 2009/10; it then declined further to 18% in 2013/14.[21] Public administration, construction and manufacturing are other key sectors contributing to Tonga's total GDP. Agricultural exports, including fish, make up two-thirds of total national exports, and Tonga is yet to fully exploit her vast area of marine resources. Tonga's fisheries production, value of production and contribution to GDP fluctuates considerably due to boom and bust cycles driven by resource depletion, changes in the distribution of tuna, market access and prices, and environmental factors. While the fisheries sector is one of the most promising avenues for economic growth, implementation of sustainable management frameworks in Tonga remains compromised by a lack of measurable targets, financing plans and monitoring, and poor fisheries data.[22]

Tourism is the second-largest source of hard currency earnings after remittances and efforts are being made to increase this source of revenue. In 1995, approximately 29,000 tourists visited Tonga and tourism revenues amounted to USD10 million, or about 4.9% of the gross national product. Within 22 years, the country's dependence on tourism has increased dramatically. In 2017, 62,500 tourists visited Tonga and generated revenue worth USD48.5 million, accounting for 11.3% of the gross national product.[23] Vava'u is a well-established whale-watching destination and between July and October, the waters around the archipelago represent one of the most important breeding grounds for Oceania humpback whales (*Megaptera novaeangliae*).[24] The Tongan government allows, and tour operators strongly promote, tourist swimming activities with whales, focusing primarily on mother-calf pairs. However, there is increasing evidence that this kind of interaction affects cetacean behaviour and can lead to negative effects on the cetaceans involved and effective strategies that maintain the Industry's' sustainability are needed. Effective strategies to reduce the risk of detrimental effects on the whales targeted by swimming activities are also needed.

[19]Government of Tonga Budget Statement 2014-15, p13
[20]Government of Tonga (2009). *National Implementation Plan*. 161 pp
[21]Government of Tonga (2016). *2015 Tonga national agricultural census main report*. 278p.
[22]Government of Tonga (2016). *Tonga Fisheries Sector Plan 2016–2024*. 83pp.
[23]https://www.worlddata.info/oceania/tonga/tourism.php
[24]Fiori *et al*. (2019). Effects of whale-based tourism in Vava'u, Kingdom of Tonga: Behavioural responses of humpback whales to vessel and swimming tourism activities. *PLoS One*. 14(7):e0219364

2.1.6 Domestic Agriculture[25]

Approximately 26,709 ha (66,000 acres) of land are under agriculture and coconut production.[26] Overall, about 5% of the agriculturally active households engage in commercial agriculture activities, while the vast majority (95%) are still engaged in subsistence and semi-subsistence agriculture (Table 4).[27]

Table 4: Summary of Tongan domestic agricultural engagement (2015)

Island	Total number of households	Bush allotments for agriculture (acres)	Number of households engaged in agriculture	% of households engaged in agriculture
Tonga	16,122*	66,202	13,944	86%
Tongatapu	11,914	42,497	9,958	71%
Vava'u	2,360	11,549	2,190	16%
Ha'apai	934	4,501	915	7%
Eua	644	4,981	615	4%
Niuas	270	2,674	254	2%

*Householders abroad/non-respondents to agricultural census not included

Subsistence production focuses on a range of customary root crops such as yams, taro, sweet potato and more recently, cassava. Subsistence and semi-commercial agriculture are based around small bush allotments of 8 acres (3.6 ha)[28]. Allotments are generally initially cultivated by tractor pulled ploughs after either application of a knockdown herbicide, fire or both. Some farmers plough all vegetation into the soil directly. The tractor and implements are generally owned by contractors who charge for ploughing. Farmers who cannot afford contract ploughing use fire and hand cultivation, which generally occurs over smaller areas. Post ploughing cultivation is generally undertaken by hand with areas of dead grass accumulation removed by fire.

Commercial cropping is very much dependent on the production of few varieties of a single species crop for export. Commercial production has focused on squash pumpkin; however, considerable effort has been made to diversify into higher-value export crops notably vanilla and watermelon, but these have proven to be high-risk ventures because of the problems of quality control, diseases and major fluctuations in supply and demand. The increasing economic value of indigenous plants, such as paper mulberry (*Broussonetia papyrifera*), vanilla (*Vanilla fragrans*), kava (*Piper methysticum*) and pandanus (*Pandanus* spp.) and pineapple, has led to indigenous plants taking the place of yam as the main crop in the traditional cropping system. Currently, in many outer islands, forests are being cut down and cropped with these cash crops in traditional farming systems.

Pigs and poultry are the major types of livestock. The main purpose for livestock production is to meet social obligations such as funerals, weddings, birthdays, church conferences and other community or extended family events.

[25]http://mafff.gov.to/
[26]Government of Tonga (2016). *2015 Tonga national agricultural census main report*. 278p.
[27]Government of Tonga (2016). *2015 Tonga national agricultural census main report*. 278p.
[28]SPREP (2017). *Pesticide Container Management in the Pacific Tonga Feasibility Study and Integrated Waste Management Strategy for Pesticide Containers*. GHD. 104 pp.

2.1.7 Fisheries[29]

Tonga is heavily dependent on its fisheries and ocean resources for food, transport, economic development, and for culture.[30] Commercial fisheries jobs in Tonga account for approximately two percent of national employment, and subsistence fishing is a vital part of Tongan life, with an estimated 13% of Tongan families involved in reef fishing. Fisheries, marine biodiversity and coral reefs are also a critical part of Tonga's growing tourism industry.

The commercial fishery targets tuna, deep-water snapper, commercial sport, seaweed and the aquarium trade. Fishery exports are dominated by tuna and deep-water snappers (red snapper (*Etelis coruscans*) and pink snapper (*Pristopomoides filamentosus*)) which are air-freighted fresh mainly to Hawaii. In the past, mullet, *beche-de-mer* (sea cucumber), lobster and giant clam have had commercial value, but severe population declines have resulted in these species now being mostly absent from both commercial and subsistence fishing operations. Some commercial fisheries have virtually collapsed, while some species are close to extinction.

Subsistence fisheries throughout Tonga target mostly reef fish by a variety of methods such as night spearfishing, gillnetting, hand-line fishing and the use of fish fences. Small boats of various types are used including canoes, and both outboard and inboard engine-powered small vessels. Destructive fishing methods such as dynamite fishing, fish poisoning and using hookah and SCUBA diving are still ongoing activities, even though these fishing methods has been declared illegal practices under Fisheries Management Act (2002).

Tonga also has aquaculture programs focusing on pearl-wing oyster (*Pteria penguin*) farming, giant clam (*Tridacna derasa*) cultivation, live rock and coral cultivation and the cultivation of other edible species such as urchins (*Tripneustes sp*.) and seaweed (*Limufuofua*). Mabé pearl farming is currently the most promising aquaculture activity in Tonga.

The Tonga Fisheries Sector Plan for Tonga identifies priority areas for investment to maximise contribution of the fisheries sector to food security and economic growth. Fisheries Management Plans have been developed for the most important fisheries and indicator targets and sustainable use limits have been identified for the fisheries. However, many of the plans require additional work to be finalised. To support implementation of the plans, the *TongaFish Pathway Program* is a six-year programme expected to provide the sustained investment in Tonga's fisheries sector needed to comprehensively support fisheries management policy and legislation, capacity building, strategic resource management and development efforts as well as inclusive stakeholder collaboration across the selected fisheries. If successful, a second six-year project may follow.

2.1.8 Environmental Conditions

Knowledge of Tonga's flora and fauna is limited, but diversity is believed to be low, although most past research has been conducted on agricultural-related fauna. Only 45 of Tonga's 170 islands are currently inhabited, but Tonga's human population of over 100,000 is growing steadily. The population increase has resulted in increased forest clearing on settled islands,

[29]World Bank (2019). *Tonga: Pathway to Sustainable Oceans (TongaFishPathway) Project –Environmental and Social Management Framework.* 126pp

[30]https://www.worldbank.org/en/news/press-release/2019/04/17/thousands-to-benefit-from-stronger-sustainable-fisheries-in-tonga

as well as in the establishment of crop plantations on many uninhabited islands.[31] The volcanic islands of Late (17km^2) and Tofua (55.4km^2) have some of the nation's remaining high diversity native forest and still support large populations of birds and reptiles.[32] A major (rapid assessment) biodiversity survey was undertaken in the Vava'u Islands in 2014.[33]

2.1.9 Biodiversity[34]

2.1.9.1 Flora

Of Tonga's total land area of 691km^2, it is estimated that less than 40 km^2 (4,000 hectares) of natural habitat remains.[35] Much of this habitat is located in inaccessible areas including steep cliffs, mangroves and swamps and on the less populated island of 'Eua.[36] This total includes 1,000 hectares of forest on Ha'apai Island and 450 hectares in the 'Eua National Park on 'Eua Island. Only 21 hectares of degraded forest remain on Tongatapu in the Toloa Rainforest Reserve. In the Vava'u group, forest cover has declined over the last few centuries from nearly 100% to about 10%.[37] Remnants of mature forest are still present in some areas that are too steep or rocky for cultivation, including steep coastal slopes, inland scarps and knolls, and on some of the smaller cliff bound islands (e.g. Kitu, Kulo and Luamoko). Areas of mature native forest have also persisted on some of the small, low, southern islands (e.g. Maninita and Taula), and in some more gently sloping parts of 'Uta Vava'u, including coastal terraces and beach flats in the vicinity of Utula'aina Point and Vai-utu-kakau.[38]

Tonga's ecological zones are classed into drylands and wetlands. Dryland ecosystems include tropical moist forests, tropical grasslands and tropical volcanic crater zones. Moist forests are found along the coastal fringes of all the Tonga islands with species of *Hibiscus, Calophyllum*, *Pometia, Casurina, Barringtonia* and *Scaevola* the most common. Secondary forest, the result of previous land clearing or cyclone disturbance, is the dominant forest type in Tonga and comprises a mix of native and introduced plant species. In the interior, many of the cleared areas previously under agricultural cultivation are dominated by *Lantana, Psidium* scrub and *Sorghum*. Tropical grasslands are dominated by *Panicum maximum,* a result of clearing and destruction of the natural vegetation for agricultural purposes.

Tonga's flora includes 419 fern and angiosperm species, with approximately 3% of species being endemic. Plant diversity on individual islands ranges from 340 species on Tongatapu, 300 species on 'Eua, 145 species on Late, and 107 species on Vava'u.[39] Around 770 species of vascular plants have been recorded from Tonga's crater zone including 70 ferns (three endemic species), three gymnosperms (one endemic) and 698 angiosperms (including nine endemic species).[40]

Wetlands ecosystems occupy an estimated 2,963 hectares nationally. These consist of mangroves (1,000 ha), volcanic crater lakes on Niuafo'ou, Tofua, Kao and Late, brackish

[31]Rinke, D. (1986). The status of wildlife in Tonga. *Oryx* 20:146-151.
[32]Steadman (1998). Status of land birds on selected islands in the Ha'apai Group, Kingdom of Tonga. *Pacific Science* 52:14-3.
[33]Atherton et al. (2014). *Rapid biodiversity assessment of the Vava'u archipelago, Kingdom of Tonga*. 312pp.
[34]Government of Tonga (2006). *National Biodiversity Strategy & Action Plan*. 98pp
[35]Tu'i'afitu, *et al.* (2005). Initial National Communication. Nuku'alofa: Climate Change Enabling Activity Project, Department of Environment.
[36]FAO. (2016). Forests and Forestry Sector, Tonga. Available http://www.fao.org/forestry/country/57478/en/ton/
[37]Atherton, J.N., McKenna, S.A, and Wheatley, A. (2014). *Rapid biodiversity assessment of the Vava'u Archipelago, Kingdom of Tonga.* SPREP, Apia, Samoa
[38]Atherton, J.N., McKenna, S.A, and Wheatley, A. (2014). *Rapid biodiversity assessment of the Vava'u Archipelago, Kingdom of Tonga.* SPREP, Apia, Samoa
[39]Sykes, W.R. (1981). The vegetation of Late Island, Tonga. *Allertonia* 2:323-353
[40]Dahl, A. (1986). *Problems in the Pacific Islands Environment*.

lagoons on Nomuka and 'Uta Vava'u, and a fresh-water marsh near Tu'anuku on 'Uta Vava'u. Mangroves are dominated by Rhizophora, (3 species), *Xylocarpus* (2 species), *Bruguiera gymnorrhiza* and *Lumnitzera littorea*. Overharvesting for firewood and building materials and the unsustainable stripping of the mangroves for tannins (a pigment that is used to make dyes) for tapa making and medicinal use pose major threats to the remaining mangrove forests in Tonga.[41]

Approximately 200 plant species have been introduced accidentally to Tonga as weeds, with the early Polynesian settlers thought to have introduced 70 weeds prior to European arrival. Several invasive species have been identified as threats to terrestrial biodiversity, with *Merremia peltata* (Fuemea) covering lower and higher canopy plants in 'Eua. Continuing expansion of large-scale commercial agriculture constitutes the most significant cause of forest ecosystem degradation and habitat loss in Tonga and the biggest threat to the conservation of its biodiversity.

2.1.9.2 Fauna[42]

Invertebrates present in Tonga are mostly agricultural pest species found throughout the Pacific and tropical environments, and include beetles, moths, flies and worms. Of vertebrates, other than the domesticated ones of low conservation significance, birds have the highest diversity. Seventy-four species have been reported, 51 of which are resident breeding species, 22 are native land birds, 23 are sea bird species, and six are introduced species. The remaining 23 species are migrant or vagrants, of which six are shore birds, 13 seabirds and three land and wetland species[43]. Endemism is low with only one species present (the Tonga whistler; *Pachycephala jacquinoti*). Other faunal species include hepterofauna, of which some 20 species are reported (one iguanid, nine geckos, nine skinks, and the Pacific boa (*Candoia bibroni*)), two species of fruit bats (*Pteropus tonganus* and *P. samoensus*), rodents and cats. A recent desktop review identified 141 plants and eight animal species reported as introduced and invasive in Tonga.[44]

Tonga has widely distributed fringing, barrier and submerged reefs and its marine biodiversity includes several species that are considered globally significant, including whales, hawksbill turtles, megapodes and several others that are endemic. Several of these are either endangered or critically endangered. These include the hawksbill turtle (*Eretmochelys imbricata*), *langakali vao* (*Aglaia heterotricha*), megapode (*Megapodius pritchardii*), the green turtle (*Chelonia mydas*), the giant wrasse (*Cheilinus undulates*) and the Phoenix petrel (*Pterodroma alba*). These species are declining in numbers. Endangered pelagic species found in Tongan waters include humpback and blue whales, and hawksbill turtles. Hawksbill turtles are protected under Tongan legislation. Other turtle species are fished seasonally (November to February) with a minimum size specified.

The main fisheries species in Tonga are offshore tuna (the Albacore tuna species dominates landing catch and export importance, followed by Skipjack, Yellowfin and Bigeye tuna), snapper, grouper and local inshore fisheries. The demand for marine resources has increased due to Tonga's growing population, a change in diet towards more marine protein-based products, and an increase in export demand, particularly from Asian countries, for marine products (e.g. sea cucumbers fisheries resources, seaweeds).[45] Anecdotal evidence suggests

[41]Vainikolo (2016). *The State of Tonga's biodiversity for food and agriculture*. FAO. 27pp.
[42]Department of Environment. (2004). *Tonga Biodiversity Stocktaking*. Technical Report 1. Government of Tonga.
[43]Watling, D. (2001). *Birds of Fiji and Western Polynesia.* Environmental Consultants, Suva Fiji.
[44]Government of Tonga (2019). *Tonga State of the Environment Report 2018*. 160p.
[45]https://www.cbd.int/countries/profile/default.shtml?country=to

that over-fishing of populations of tuna, billfish and sharks is occurring. Over exploitation and destructive fishing practices are the major threats to the marine ecosystem although natural disasters including cyclones, tsunamis, water temperatures variations, and natural predators may also contribute. A recent analysis suggested that over one-third of Tonga's coral reefs are threatened by overfishing and pollution, with the reefs around the most populated islands of Tongatapu and Vava'u being most at risk. [46]

2.1.10 Water and Sanitation Management

2.1.10.1 Water Management[47,48]

The source of freshwater for Tonga is either through rainwater harvesting or extracted from a thin freshwater lens within the highly porous limestone substrate. The water resources of Tonga are primarily in the form of groundwater. Surface water resources are not present on most islands; exceptions are 'Eua where supply originates from springs in caves high above sea level, and on a number of the volcanic islands including Niuafo'oua and Niuatoputapu and Tofua, where there are several salty lakes.

Almost 90% of households use rainwater for drinking supplies. All Tongan households have access to groundwater, either through the local water supply, the village water supply or their own wells. Groundwater is piped by the Tonga Water Board to all households in the urban centres of Nukualofa on Tongatapu, Neiafu on Va'vau and Pangai-Hihifo on Ha'apai, and to villages on 'Eua, where it is used domestically for cooking, bathing, washing food, watering plants and animals, flushing toilets, and cleaning the house and vehicles. It is also boiled and used for drinking if rainwater is not available.

Outside the urban centres, many villages have their own reticulated water system administered by their respective *Komiti Vai* (Water Committee), which falls under the responsibility of the Ministry of Health (MoH).

There are no definitive studies on Tongan groundwater resources, and lack of monitoring, and recharge calculations make the water resource essentially unmanaged.[49] Groundwater is also generally contaminated with faecal coliform and *E. coli* bacteria from human and animal waste. A Water Resources Bill to manage and monitor Tonga's underground water source was introduced into the Legislative Assembly in 2016.

In February 2018, Tropical Cyclone Gita significantly damaged water supplies across Tongatapu, creating potential for contamination of water supplies and increasing the risk of mosquito borne illnesses such as dengue. Emergency water filtration units were deployed to evacuation centres, disability centres and schools around Tonga to clean communal water tanks and minimise this risk.[50]

[46]Vainikolo (2016). *The State of Tonga's biodiversity for food and agriculture*. FAO. 27pp.
[47]https://sustainabledevelopment.un.org/content/documents/1164220TONGA%20FINAL%20draft.pdf
[48]SOPAC (2007). *National Integrated Water Resource Management Diagnostic Report Tonga*. 73pp
[49]White, I., Falkland, T., & Fatai, T. (2009). Vulnerability of Groundwater in Tongatapu, Kingdom of Tonga. Canberra, Australia: Australian National University.
[50]https://www.skyjuice.org.au/safe-water-for-20000-people-affected-by-tropical-cyclone-gita-in-tonga/

2.1.10.2 Wastewater and Sanitation[51,52]

There is no centralised reticulated sewerage system in Tonga. All wastewater is managed by on-site systems, with supervision by the MoH when resources permit. In this respect, wastewater management is in the hands of the community. Essentially all of Tonga's population has access to improved sanitation facilities.[53] Over 80% of Tongan households use septic tanks for human waste disposal. The remainder of the population has access to flush pit or traditional pit toilets. Poor maintenance and poor design of septic tanks is common, resulting in the potential for pathogens and nutrients being introduced into the surrounding environment, including its ingress into groundwaters. Desludging of septic tanks was uncommon in the past,[54] although sewage waste pumped from septic tanks can now be easily disposed of in sludge drying beds located at the Tapuhia sanitary landfill. An average of 4.8M litres of septic effluent is disposed of per annum at the Tapuhia sanitary landfill,[55] although this figure can range between 2.4M and 7.3M litres of treated septic effluent per year.[56]

Sewage and agriculture fertiliser runoff from plantations are major contributors to local eutrophication. Excess nutrient loads appear to be impacting the environmental health of the near shore reef in the Nuku'alofa area, and the Fanga'uta lagoon.[57,58] Domestic animal waste is also a significant source of (nutrient) pollution in Tonga. With an average of seven pigs per household, it is estimated that over 110,000 pigs are kept in Tonga.[59] Deaths from *Leptospirosis* in the Pacific have also increased awareness of the connections between sound waste management and rodent and disease vector control including pigs, and Tonga has legislation in place requiring the containment of pigs, although this is rarely enforced.[60]

2.1.11 Waste Management[61]

2.1.11.1 Solid Waste Management

Tonga Waste Authority Ltd (WAL) is a government public enterprise established in 2006 to manage solid waste in Tongatapu. WAL provides commercial, industrial and residential waste collection services and waste management facilities and promotes national recycling and waste minimization. WAL is funded through consumer tariffs included in Tonga Power Limited (TPL) bills which are paid directly to WAL. Adding the monthly waste collection charge to the household power bill commenced in April 2016 and significantly increased payment compliance.

WAL collects household waste on a weekly basis, and business wastes either weekly or daily, depending on need, using a fleet of six flat-bed trucks and a single compactor truck. Two privately-owned companies (*Waste Management* and *Bingo*) also collect rubbish from commercial premises and transport it to the landfill on a fee-for-service basis. Commercial waste comprises approximately 70% of the volume of waste disposed of in the landfill. WAL also undertakes community social-media campaigns to raise awareness and inspire

[51]Lal, P. and Takau, L. (2006). *Economic costs of waste in Tonga*. IWP-Pacific Technical Report no. 33. SPREP. 65pp
[52]SOPAC (2007). *National Integrated Water Resource Management Diagnostic Report Tonga*. 73pp
[53]Government of Tonga. *2016 Census*. 259 p
[54]Newton, A. (2008). *Sanitation and Wastewater Management in Tonga*. 25pp
[55]WAL data, June 2018-Oct 2019
[56]Neil Jenkin, Landfill Operations Manager, Pers Comms.
[57]Anon (2010). *Forth report: Review of Tonga National Biodiversity Strategy and Action Plan, Nuku'alofa*: Ministry of Environment and Climate Change. Kingdom of Tonga, 157 p.
[58]Newton, A. (2008). *Sanitation and Wastewater Management in Tonga*. 25pp
[59]Government of Tonga (2016). *Agricultural Census 2015.* 278p.
[60]Minshew, H. and M. Robotham (2007). Piggery Waste Management in American Samoa. United States Department of Agriculture. 10pp.
[61]https://www.adb.org/sites/default/files/publication/42660/solid-waste-management-tonga.pdf

participation in improved waste management. The Ministry of Tourism funds daily manual collection of street litter and a mechanised street sweeper is used to clean urban streets and gutters daily.

2.1.11.2 Household wastes

Tongatapu Island, including Nuku'alofa, is served by a single integrated solid waste management system. A majority of household waste is contained in plastic garbage bags prior to collection. On average, around 470,000m^3 of rubbish is landfilled every month from Tongatapu, with significant inputs from business customers.[62] Waste generation rates in Tonga are unknown and have been estimated to be between 5,000 and 18,000 tonnes per year. This equates to around 0.6kg per person per day, which is greater than that typically generated by Pacific Island households (0.45 kg per person per day).[63]

Detailed waste generation data is urgently required for Tonga for planning and management purposes. The landfill has a weighbridge at its entrance that is not yet in operation. A solid waste composition assessment on Tongatapu completed ten years ago showed that green waste (primarily vegetation waste) accounted for roughly 33% of the municipal waste stream.[64] Organic materials (primarily food waste) made up another 15%, followed by nappies; and smaller amounts of paper, plastic, glass, textiles, ferrous and nonferrous metals, and other materials.

2.1.11.3 Waste disposal

Collected waste is disposed of at the Tapuhia sanitary landfill approximately located in the centre of Tongatapu. The site covers an area of approximately six hectares which is elevated between 15 and 20 meters above sea level. The landfill site is a former quarry, extending to a depth of about nine meters beneath the existing ground surface. The landfill floor has been raised above the existing groundwater table with clay and coral rock layering and also has a basal liner system and leachate collection, treatment and transfer system. The landfill site infrastructure was extensively damaged by a cyclone in early 2018 and is expected to be fully operational again in 2020. Post cyclone reconstruction is being financed by the Australian Department of Foreign Affairs and Trade, the Asian Development Bank, and the Tongan Government. The infrastructure damaged or destroyed at the site included fencing and gates, a custom-built covered area used to store designated wastes, a recycled material storage area, the leachate treatment system, sludge drying beds, and a vehicle and equipment storage facility.

Waste entering the facility is disposed of in a disposal cell, compacted and covered with soil. Landfill gas collection and treatment systems are not installed at the facility. Two septic sludge tankers are operated by WAL, delivering collected sludge to the drying beds at the Tapuhia sanitary landfill. An average of 4.8M litres of septic effluent is disposed of per annum at the Tapuhia sanitary landfill,[65] although this figure can range between 2.4M and 7.3M litres of collected septic effluent per year.[66] Dried and aged sewage sludge is mixed with sand and sold as fertiliser to the farming community. Twenty-four groundwater monitoring wells are placed around the facility and monitored quarterly by the Tongan Government Geological Division. All site effluent including leachate and septic supernatant is passed through a water treatment

[62]WAL: 2019 Waste collection data
[63]http://www.wasteauthority.to/sites/wasteauthority.to/files/documents/Final%20Annual%20Report%202017%20sm-compressed.pdf
[64]https://www.adb.org/sites/default/files/publication/42660/solid-waste-management-tonga.pdf
[65]WAL data, June 2018-Oct 2019
[66]Neil Jenkin, Landfill Operations Manager, Pers Comms.

plant and a polishing lagoon before being irrigated around the facility. Monitoring results for groundwater testing at the site consistently meet required standards.

A dedicated waste cell located at the southern end of the Tapuhia sanitary landfill was used to dispose of a range of hazardous waste in the past, including asbestos, electronic waste (e-waste), lead acid batteries, paint and used oil. This practice is no longer carried out, but no records of past disposal have been maintained and the site is probably contaminated with a range of potentially hazardous materials. Quarantine waste that has been sterilized by blast-freezing is currently buried at the landfill site. Between six and ten 20-foot container loads of quarantined food and cigarettes are buried at the landfill annually. A significant landfill fire occurred at the Tapuhia landfill in 2016-2017. This is the first landfill fire to occur in Tonga and it took 10 days to extinguish. The landfill liner was not damaged by the fire.

2.1.11.4 Recycling

Although no longer occurring, waste segregation at the household level in Nuku'alofa was common-place 10 years ago, and many households segregated aluminium, steel and plastic bottles and cans by placing them in 170 community recycling cages located in most villages and throughout urban Nuku'alofa. Urban recycling is expected to recommence when the Tapuhia landfill becomes fully operational again in 2020 after damage caused by the last cyclone is rectified. The landfill will have a glass crusher and a plastic shredder as part of this programme. Collected plastic will be shredded and melted into road fill for use around Tongatapu.

GIO Recycling is a well-established private recycling company located in Nuku'alofa and in Vava'u. When economically feasible, the company recycles ferrous and non-ferrous metal, e-waste and used lead acid batteries. The company has also exported used oil, paper and plastic in the past. GIO recycling currently exports one 20-foot container of non-ferrous metal (including aluminium) for recycling per month to Australia. The company also exports two containers of lead acid batteries per year to Korea and India and has containers of separated e-waste and crushed car bodies stored for export when the recycling commodities market increases in value.

2.1.11.5 Outer Island Waste Management[67]

Island waste collection services in Vava'u commenced in January 2018 following construction of a local semi-aerobic landfill. Approximately 200 tonnes of waste are landfilled monthly in Vava'u, with 45% of the waste being green and food wastes, and the remainder consisting of paper, plastic and glass. Ha'apai has a sanitary landfill managed by the MoH, and no island collection service, while 'Eua has a designated dumpsite managed by the MoH and no waste collection services.

2.1.11.6 Used Oil

Two major companies (TOTAL and Pacific Energy) supply lubricating and hydraulic oil to Tonga. The quantity of lubricating oil imported into Tonga each year is unknown, but was reported as 450,000 litres in 2014.[68] Pacific Energy offers a used oil take-back service for its retail customers and exports around 10,000 litres of used oil per month to Fiji for use in a local steel mill, dependent on local shipping schedules. The used oil is transferred in intermediate bulk containers (IBCs) and shipped on the companies local trading vessel. Tonga has, in the past,

[67]http://www.wasteauthority.to/sites/wasteauthority.to/files/documents/Final%20Annual%20Report%202017%20sm-compressed.pdf
[68]Golder Associates (2014). *Contemporary used oil audit, Tonga*. SPREP. 18pp.

also exported containers of waste oil to India and to Japan with the export cost being covered by the used oil importer.

2.1.11.7 Disaster and Bulky Wastes and Hazardous Wastes

Tonga does not have a disaster waste management strategy. Huge quantities of green waste were removed and landfilled after the Category 5 cyclone in 2018. A dedicated waste cell located at the southern end of the landfill was used to dispose of a range of hazardous waste in the past, including asbestos, e-waste, lead acid batteries and used oil. This practice is no longer carried out, but no records of past disposal have been maintained and the site is contaminated with a range of potentially hazardous materials. WAL recently removed 2,520 derelict vehicles from around Tongatapu to the landfill site for crushing and export. There are believed to be another 5,000 derelict vehicles still to be collected around the island.

2.1.11.8 Marine Litter

Marine litter is removed from the waterfront on a weekly basis by the Ministry of Tourism, and other areas of coastline are cleaned up on a monthly basis. Improved marine plastic management is a major component of a project by the UK-based Centre for Environment, Fisheries and Aquaculture Science, which will commence in 2020 and will also help review Tonga's outdated Waste Management Strategy.

2.1.11.9 Asbestos[69]

Asbestos containing material was identified to be present at 21 sites in Tonga in 2014. The sites were considered moderate to high risk with regards to the occupant's and/or public's potential exposure to asbestos. These included Tonga Post Ltd, Prince Ngu Hospital (Vava'u), St Andrews School, Pacific International, Viola Hospital, Tongatapu and Tonga Water. Approximately 300 residential dwellings in Tongatapu and Vava'u were also identified with asbestos containing materials. The cost to remediate higher risk sites in Tonga and dispose of collected asbestos to local landfill was estimated to be around US$1.2M (in 2014).

2.1.11.10 Healthcare wastes[70]

The MoH is responsible for the collection, storage, transfer, treatment, and disposal of healthcare waste in Tonga. There are four major hospitals in Tonga (Table 5). A 2014 review of healthcare waste handling in all four major hospitals determined that waste management practices did not meet minimum standards in all assessed hospital at that time. The European Union-funded Pacific Hazardous Waste Programme (PacWaste) installed high temperature incinerators in the four main Tongan hospitals in 2016. However only one of these installed incinerators was still operational in December 2019. Lack of on-going maintenance services, high operating costs and need for on-going incinerator operator training were identified by MoH staff as key operational issues. Data provided by Viola Hospital suggested that 1,550 kg of healthcare waste was generated monthly in 2018, or approximately half of the quantity generated in 2014. This is likely to be, in part, a consequence of the reluctance to incinerate large quantities of healthcare waste due to the high (diesel) costs of operating the incinerator.

[69]SPREP (2015). *Survey of the Regional Distribution and Status of Asbestos-Contaminated Construction Material and Best Practice Options for its Management in Pacific Island Countries. Report for the Kingdom of Tonga*. 83 pp

[70]SPREP (2014). *The collection, collation and review of data on the management of healthcare waste and best-practice options for its disposal in participating Pacific Island Countries Tonga*. 78 pp

Table 5: Summary of Tonga's hospital waste disposal facilities 2014 and 2019

Hospital	Location	No. of Beds	Healthcare waste generation (kg/week)	Waste disposal mechanism	Waste assessment (2014)	Status as at 2019
Vaiola Hospital	Tongatapu	274	1026	Steam sterilization (not working)	Does not meet minimum standards	High temperature incinerator installed (2015), operating twice per week (average 1550 kg[71] waste incinerated per month)
Prince Ngu Hospital	Vava'u	62	190	Incinerator (not working)	Does not meet minimum standards	Small high temperature incinerator installed (2015), inoperable, waste to landfill
Niu'eiki Hospital	'Eua	20	13	Landfill	Does not meet minimum standards	Small high temperature incinerator installed (2015), inoperable, waste to landfill
Niu'ui Hospital	Ha'apai	18	105	Incinerator (not working)	Does not meet minimum standards	Small high temperature incinerator installed (2015), inoperable, waste to landfill

2.1.12 Waste Incineration

Under the Environmental Management (Litter and Waste Control) Regulations 2016, it is an offence to burn noxious waste which contains plastic, rubber, polystyrene foam, waste oil or wastes that creates uPOPs. It is also an offence to cause a fire to be lit at an authorised dumpsite. Litter or other wastes are permitted to be burnt provided they do not cause any nuisance to any person.[72]

2.1.12.1 Healthcare waste

Healthcare wastes from Vaiola Hospital are disposed of using an on-site high temperature incinerator. All other healthcare waste (sourced from other hospitals and local clinicals in Tonga) is disposed to landfill.

2.1.12.2 Household waste incineration

In 2015, twenty five percent (or 4,556) of Tonga's 18,005 households reported using open burning to dispose of household rubbish (Table 6).[73] Since then, regular rubbish collection services have commenced throughout Tongatapu and in Vava'u and is likely to have decreased the total amount of rubbish being burnt across Tonga by around 60%.

[71]Lesieli Tisiola Mahe (Public Health Inspector), Pers com 2019
[72]Government of Tonga (2016). Environmental Management (Litter and Waste Control) Regulations (2016)
[73]Government of Tonga (2016). *2016 Census*

Table 6: Summary of Tonga's past waste disposal methods, kg of waste per annum (2015)[74]

Disposal Method	Tongatapu (kg/year)	Vava'u (kg/year)	Ha'apai (kg/year)	'Eua (kg/year)	Total (kg/year)
Dumpsite (collected)	11,722	596	19	20	12,358
Dumpsite (not collected)	240	354	52	95	749
Open Burning	**786**	**1,695**	**1,056**	**759**	**4,556**
Compost	75	36	25	8	148
Bury	123	31	26	2	182
Other	7	3	1	1	12
Total	12,953	2,715	1,179	885	18,005

2.1.13 Energy Supply[75]

Established in July 2008 to act as the concessionaire in Tonga's concession-based electricity regulation regime, TPL is a 100% state owned enterprise providing electricity as its core service. TPL generates, distributes, and sells electricity to 23,561 commercial and domestic customers in Tongatapu, Vavaú, Haápai and 'Eua.

Tonga is highly dependent on imported fuels to meet its overall energy requirements. The last energy balance for Tonga, compiled in 2000, showed that 75% of Tonga's energy supply was derived from imported petroleum products, and 25% from biomass (i.e. fuel wood and wood waste, coconut and palm oil residues) and off-grid solar photo voltaic systems. Information received from TPL suggests that as at 2018, ninety one percent of Tonga's electricity supply (70M kWh) is generated using diesel fuel (Table 7).

Table 7: Summary of Tonga's energy sources (2018)[76]

Location	Annual Diesel Consumption (litres)	Diesel Energy Production (kWh)	Renewable Energy Production (kWh)	Number of Customers
Tongatapu	13,430,664	60,600,878	5,620,960	
Vava'u	1,636,795	6,505,466	351,181	
Ha'apai	396,397	1,862,645	450,511	
Eua	390,530	1,584,137	156,289	
Total	**15,850,000**	**70,553,126**	**6,165,000**	**23,561**

The Maama Mai solar facility was commissioned in July 2012 at TPL's Power Station at Popua, Tongatapu. The project was funded by the New Zealand Aid Programme (NZ$7.9 million). Since its commissioning in 2012, the farm has produced an average of 1,880 megawatt hours of energy per annum, reducing the country's diesel consumption by 460,000 litres per annum. The Vaini Solar Facility is a 1-megawatt micro grid control system completed in 2015 which saves around 327,000 litres of diesel per annum. This project was Tonga's first step towards the Tonga *Energy Road Map*[77] goal to reduce Tonga's reliance on fossil fuel for electricity generation by 50 percent by 2020. Five wind turbines producing a total of 1.3 megawatts have also been installed as part of Tonga's renewable energy programme at the western end of

[74] Government of Tonga (2016). *2016 Census*
[75]Government of Tonga (2010). *Tonga energy road map 2010-2020*. 97 pp.
[76]Steven Esau, TPL personal communication
[77]Government of Tonga (2010). *Tonga energy road map 2010-2020*. 97 pp.

Tongatapu. Tonga *Energy Road Map* goals have now been revised to a 2020 renewable target of 50% production from renewable sources and a 2030 target for renewable energy production of 75% of total electricity production.

2.2 Institutional, Policy, and Regulatory Framework

2.2.1 Strategic framework[78]

Tonga's environmental management framework is derived from relevant acts, regulations and strategies which are summarised in Table 8. These include legislation relevant to the Stockholm Convention, and the effectiveness of regulatory and enforcement infrastructure and national capacity for managing POPs.

Table 8. Summary of Tonga's regulatory framework for national chemical, waste and pollution management

Framework	Description of Framework	Responsible Department
Seabed Minerals Act 2014	Provides for the management of the Kingdom's seabed minerals, and prevent of pollution	Lands, Survey and Natural Resources
Waste Management Act (2005)	Provides for the collection and disposal of solid waste and management of all wastes	MEIDECC
Marine Pollution Prevention Act 2005	An act to provide for the prevention of, and response to, marine pollution and the dumping of waste and other matters and to give effect to international marine pollution conventions	Ministry of Infrastructure
Pesticides Act (2002)	An act to regulate the registration, manufacture, import, sale, storage, distribution, use and disposal of pesticides in Tonga	MAFF
Public Health Act (2008)	Proscribes water supply control measures to prevent contamination, sets air emission standards for vehicles and factories, and actions under health emergencies	Ministry of Health
Environment Management Act (2010)	Controls the movement and disposal of hazardous waste	MEIDECC
Hazardous Wastes and Chemicals Act (2010)	Allow national implementation of the Stockholm, Rotterdam, Basel and Waigani Conventions	MEIDECC
Customs Act (2008)	Controls duty payment on imported and exported goods	Ministry of Revenue and Customs
Environment Management (Litter and Waste Control) Regulations (2016)	Bans open burning and dumping of waste, and controls littering	MEIDECC
Cruise Ship Levy (2015)	Provides an additional funding mechanism for WAL operations	MEIDECC
Plastics Levy Regulation (2013)	Import tax on disposable plastic items	MEIDECC
Water Resources Bill (2012 & 2016: Withdrawn)	Provides for the management and conservation of water resources	Ministry of Health
National Infrastructure Investment Plan (NIIP)	The Plan covers major infrastructure initiatives including water and waste management	Government of Tonga
Tonga Agricultural Sector Plan (2016-2020)	Identifies the Kingdom's vision and priorities for maximizing contributions from the agricultural sector to the kingdom's economic growth, and sustained food security	Agriculture

[78] Katoa, A.E. (2019). *Tonga enabling activities for the development of a national implementation plan for the Stockholm Convention on persistent organic pollutants update of the National Implementation Plan 2009. 17pp.*

2.2.2 Existing legislation and regulations addressing POPs

2.2.2.1 Seabed Minerals Act (2014)

This is an Act to provide for the management of the Kingdom's seabed minerals, and the regulation of exploration and mining activities within the Kingdom's jurisdiction or under the Kingdom's control outside of national jurisdiction, in line with the Kingdom's responsibilities under international law. The Act has a protective objective to protect and preserve the Marine Environment and to protect the well-being of individuals and communities insofar as may be impacted by, or employed in Seabed Mineral Activities. This Act provides powers and duties to prevent, reduce and control pollution from seabed activities or caused by ships or by dumping of waste and other matters at sea. In addition, title holders have a duty to take the necessary steps to prevent, reduce and control pollution and other hazards to the Marine Environment, including waste material, arising from Seabed Mineral Activities. Title holders are not to dump mineral materials or waste from any vessel except in accordance with international law and the directions of the Authority. This Act allows the Minister responsible with the consent of Cabinet to make Regulations for the operation of this Act. However, to date, no regulations have been made.

2.2.2.2 Waste Management Act (2005)

The Waste Management Act (2005) provides a comprehensive legislative base for the effective development and management of the sector. It establishes WAL, mandating its functions, powers, and responsibilities. These are wide ranging, including the provision of municipal solid waste collection, transfer, and disposal services; promotion of waste reduction and recycling programs; development of rules and codes of practice; monitoring of public health and environmental impacts; public awareness raising; solid waste management community responsibilities; imposition and collection of solid waste management fees; and prosecutions for violations. The Act is specific on operational responsibilities, including the contracting of services to the private sector.

2.2.2.3 Marine Pollution Prevention Act (2002)

The Marine Pollution Prevention Act (2002) provides for the response to marine pollution from ships and land-based sources; places restrictions on the dumping and incineration of waste at sea; and gives effect to international marine pollution conventions.

2.2.2.4 Pesticides Act (2002)

This is an Act to regulate the registration, manufacture, import, sale, storage, distribution, use and disposal of pesticides in Tonga. The Pesticides Act (2002) identifies a Registrar of Pesticides who shall:

- Register pesticides and keep a Register of Pesticides in which shall be entered the trade name of all registered pesticides, their chemical names and concentration of active ingredients, the name and place of business of the manufacturer, and in the case of an imported pesticide, the name and place of the business of the importer
- Determine the conditions of use of any pesticide and issue guidelines for the storage, distribution, use and disposal of pesticides in the Kingdom
- May list any pesticide as a banned pesticide.

2.2.2.5 The Public Health Act (2008)

The Public Health Act (2015) provides regulations pertaining to the supply of water of a suitable quality, installation and standards related to sanitary facilities, sources and standards

of air pollutants and the management of public health emergencies (such as a dengue outbreak).

Part VI of the Public Health Act empowers the Minister of Health to make arrangements for the collection, transport and disposal of domestic, commercial and trade waste (section 91). The Minister of Health is also empowered under section 94 to make regulations specifying the types of solid or liquid waste which shall be considered to be toxic or hazardous to health; those sites approved by the Minister as suitable for the storage or controlled disposal of toxic or hazardous waste; the types and specifications of containers to be used for the storage or disposal of toxic or hazardous waste; and any other matters relating to the transportation, storage, or controlled disposal of toxic or hazardous waste as the Minister may require.

Moreover, the Act provides that the Minister is to establish the standards for the levels of emission of harmful materials into the air. The Minister of Health is also given the power to specify the standards of emission from any motor vehicle. For example, the Minister has the power to examine motor vehicles which emit excessive or harmful exhaust smoke or fumes to be examined and if necessary, can direct the owner of the vehicle to carry out such repairs to reduce the amount of exhaust smoke or fumes.

2.2.2.6 Environment Management Act (2010)

The Environment Management Act (2010) establishes Tonga's Ministry of Environmental and Climate Change (the Ministry), its functions, and its powers. These include the (i) monitoring of environmental impacts; (ii) regulation or prohibition of pollution to air, water, or land, as well as dumping of litter and rubbish, and movement or disposal of hazardous waste and chemicals; and (iii) protection of coastal areas.

An objective of the Act is to ensure Tonga observes its international obligations relating to the protection of the environment. To this end, the Ministry is charged with conducting all matters necessary for the observance of the international and regional conventions to which the Kingdom is a party.

Specifically, under the Act:

- No person may export any persistent organic pollutant except for the purpose of disposal in an environmentally sound manner in the country of import, and that any permissible export of a persistent organic pollutant shall be undertaken in accordance with the provisions of the National Implementation Plan and all applicable international rules, standards and guidelines;
- No person may manufacture, produce, store, import or use any regulated persistent organic pollutant in the Kingdom, unless the manufacture, production, storage or use is in accordance with the National Implementation Plan and the requirements of the Stockholm Convention;
- The Minister may approve a National Implementation Plan, and any amendment to it, for the control and proper management of persistent organic pollutants in the Kingdom, and the implementation of the Stockholm Convention; and
- Regulations made under this Act may make provision for the implementation and enforcement of the National Implementation Plan or any particular provision of the Plan.

2.2.2.7 Hazardous Wastes and Chemicals Act (2010)

The Hazardous Wastes and Chemicals Act (2010) deals specifically with national management of the Stockholm Convention; Rotterdam Convention; Basel Convention; and Waigani Conventions. Specifically, under the act:

- No person may manufacture, produce, import or use any prohibited persistent organic pollutant in the Kingdom
- No person may store any prohibited persistent organic pollutant in the Kingdom unless the persistent organic pollutants are being stored prior to their lawful disposal in accordance with this Act
- No person may export any persistent organic pollutant except for the purpose of disposal in an environmentally sound manner in the country of import
- The Minister may approve a National Implementation Plan, and any amendment to it, for the control and proper management of persistent organic pollutants in the Kingdom, and the implementation of the Stockholm Convention
- The Minister may approve regulations made under this Act to make provision for the implementation and enforcement of the National Implementation Plan (NIP) or any particular provision of the Plan.

2.2.2.8 Customs Act (2008)

The Customs Act provides for prohibiting or restricting the importation or exportation of goods into and out of the Kingdom. Part I Schedule II of the Customs and Excise Act, under paragraph 8, prohibits the importation into Tonga of "all toxic or hazardous wastes".

2.2.2.9 Environment Management (Litter and Waste Control) Regulations (2016)

Environment Management (Litter and Waste Control) Regulations (2016) define the activities and offences that relate to waste pollution. These include the dumping of waste and hazardous waste, waste that causes pollution, and the burning of litter and waste.

2.2.2.10 Waste Management (Plastic Levy) Regulations (2013)

The Plastic Levy Regulations (2013) was developed under Section 27 of the Waste Management Act, to create a levy for various plastic packaging items such as plastic takeaway containers and plastic bags. The 10% levy, payable on import of the plastic goods, helps fund the large costs associated with these types of waste. Plastics in the environment create marine pollution, exacerbate poor drainage, and impact on the beauty of Tonga, and hence its potential as a tourist destination. The levy aims to change peoples' buying behaviours through the rise in prices. It also assists WAL to deliver long term sustainable waste management services.

2.2.2.11 Cruise Ship Levy (2015)

A charge of US$5 per person for tourists visiting Tonga by cruise ship was approved by Cabinet in May 2015 and implemented in April 2016. This funding mechanism will provide an ongoing source of revenue to WAL, allowing them to improve environmental services such as emptying of public bins, cleaning and maintenance of public toilets and supporting community clean up initiatives.[79] All of this in turn helps the tourism industry continue to grow and develop in Tonga.

[79]http://www.wasteauthority.to/sites/wasteauthority.to/files/documents/Final%20Annual%20Report%202017%20sm-compressed.pdf

2.2.2.12 Water Resources Bill (2012; 2016, Withdrawn)

This is a Bill to provide for the management and conservation of the water resources in the Kingdom of Tonga.[80] This Bill ensures that environmental standards are applied to the taking of water and any activity that might affect the water management operations and supply. It also establishes a national water resources committee to ensure the effective monitoring of the water resources by the responsible agencies and that records of such monitoring are maintained and made accessible. Submitted and then withdrawn in 2016.

2.2.2.13 National Infrastructure Investment Plan (NIIP)[81]

The National Infrastructure Investment Plan (NIIP) outlines the Government of Tonga's priorities and plans for major infrastructure initiatives over the next five to 10 years. This is the second NIIP (NIIP2). It updates and builds on the successes of the first NIIP that was prepared in 2010. Of the 12 priority investment projects proposed in the first NIIP, most are now underway and many of the supporting reforms and capacity building initiatives are also moving forward. The Plan covers major infrastructure initiatives with national, regional, or local significance over the 2013-2023 time period. The Plan focuses on economic infrastructure facilities that support everyday life and business activity, such as energy supply systems, telecommunications, water and waste management, and transportation. In particular, the NIIP includes priorities and plans for major initiatives in the following sectors:

- Energy (electricity, fuel)
- Telecommunications (telephone, internet, broadcasting)
- Water and waste related services (water supply, wastewater, drainage, solid waste)
- Transport (airports, roads, seaports)

Other categories of built infrastructure supporting social services and governance, such as education, healthcare, and correctional services, are not included in this Plan and generally have their own sector plans.

2.2.2.14 Tonga Agriculture Sector Plan (2016-2020)

The Tonga Agriculture Sector Plan was identified as part of Tonga's national planning process. The plan identifies the Kingdom's vision and priorities for maximizing contributions from the agriculture sector to the Kingdom's economic growth and sustained food security in the face of a changing world economy, looming climate change, and on-going natural disasters in the Pacific. The plan also (i) articulates specific programmes and activities which are required to achieve sector priorities; (ii) clarifies the roles and responsibilities of the different sector stakeholders; (iii) estimates investment needs; and (iv) provides a framework for measuring progress over the short- and medium-terms.

2.2.3 Multilateral Environmental Agreements

Tonga's status in relation to key multilateral environmental agreements pertaining to the management of wastes, chemicals and hazardous substances is presented in Table 9. In becoming a Party to these agreements, the government has been able to demonstrate its commitment to addressing several environmental concerns.

[80]Government of Tonga (2012). *Water Resources Bill* (2012). 19pp
[81]Government of Tonga (2013). *Tonga National Infrastructure Investment Plan 2013 -2023*. PRIF, 65pp

Table 9: Tonga's status in relevant conventions on waste, chemicals, and hazardous substances

Convention	Description of Convention	Status
Basel Convention on Control of Transboundary Movements of Hazardous Wastes and Their Disposal	Aims to reduce the movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed countries	Party
Waigani Convention to Ban the Importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement of Hazardous Wastes within the South Pacific Region	The Waigani Convention Constitutes the regional implementation of the Basel Convention in the Pacific. However, unlike the Basel Convention, coverage extends to radioactive waste, and to the exclusive economic zone (200 nautical miles) of Parties	Party
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International trade	Provides an early warning system on hazardous chemicals, and enables monitoring and controlling trade of chemicals, giving Parties power to decide which they wish to import and exclude those they cannot manage safely. There are 47 chemicals, out of which 33 are pesticides, and four are severely restricted hazardous substances.	Party
Minamata Convention on Mercury	A global treaty to protect human health and the environment from the adverse effects of mercury. The convention includes a ban on new mercury mines, the phase-out of existing ones, control measures on air emissions, and the international regulation of the informal sector for artisanal and small-scale gold mining	Party
Stockholm Convention on POPs	Aims to protect human health and environment from the adverse effects of POPs that, when released, persist in the environment and can lead to adverse human health and ecological impacts	Party
Montreal Protocol on Substances that Deplete the Ozone Layer	Protects the ozone layer by phasing out the production and consumption of a number of man-made substances responsible for ozone depletion	Party
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (London Convention)	It covers the deliberate disposal at sea of wastes or other matter from vessels, aircraft, and platforms	Party
MARPOL 73/78: International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (Annexes I, II, III, IV, V, and VI)	Prevention of marine pollution by shipping	Party

2.2.3.1 Stockholm Convention on Persistent Organic Pollutants

Tonga became a Party to this Convention in 2009 and is working on its implementation through the actions undertaken under the National Implementation Plan (NIP) and through its review. The Environment Department has day-to-day responsibility for matters relating to the Stockholm Convention, although other national Agencies are also involved.

2.2.3.2 Basel Convention

Tonga is a Party to the Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal which aims to achieve the environmentally sound management of hazardous wastes through the reduction in transboundary movements to the minimum consistent with:

- Environmentally sound and efficient management.
- Treatment and disposal as close as possible to the source of generation.
- Minimisation of generation.

The Basel Convention is of importance when considering disposal of POPs and other hazardous wastes by export to treatment facilities in other countries. All exports of hazardous wastes are required to comply with stringent control procedures, including being approved by both the exporting and importing countries.

2.2.3.3 Waigani Convention

Tonga is a Party to the Convention to Ban the Importation into Forum Island Countries of Hazardous and Radioactive Wastes and to Control the Transboundary Movement and Management of Hazardous Wastes within the South Pacific Region (Waigani Convention). The Waigani Convention objective is to prevent the importation of hazardous and radioactive waste into the South Pacific region, to minimize production within the region and to ensure the environmentally sound management and disposal of existing wastes.

2.2.3.4 Rotterdam Convention

Tonga is a Party to the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade. The Rotterdam Convention is a multilateral treaty to promote shared responsibilities in relation to importation of hazardous chemicals. The convention promotes open exchange of information and calls on exporters of hazardous chemicals to use proper labelling, include directions on safe handling, and inform purchasers of any known restrictions or bans. Signatory nations can decide whether to allow or ban the importation of chemicals listed in the treaty, and exporting countries are obliged to make sure that producers within their jurisdiction comply.

2.2.3.5 Minamata Convention

Tonga acceded to the Minamata Convention on the 7th June, 2019. The Minamata Convention on Mercury is an international treaty designed to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds.

2.2.3.6 London Convention

Tonga is a Party to the London Convention. The "*Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972*", (the London Convention), is one of the first global conventions to protect the marine environment from human activities and has been in force since 1975. Its objective is to promote the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea by dumping of wastes and other matter.

2.2.3.7 MARPOL

Tonga is a Party to the International Convention for the Prevention of Pollution from Ships (MARPOL) which is the main international convention aimed at the prevention of pollution from ships caused by operational or accidental causes. It was adopted at the International Maritime Organization (IMO) in 1973 and amendments are made periodically through the Marine Environment Protection Committee (MEPC) of IMO. The Protocol of 1978 was adopted in response to a number of tanker accidents in 1976–1977. The 1978 Protocol was absorbed into the parent Convention and the combined instrument entered into force in 1983. In 1997, a Protocol was adopted to amend the Convention and a new Annex VI was added, which came into force in May 2005. The technical requirements of MARPOL are included in six separate Annexes:

- Annex I—Regulations for the Prevention of Pollution by Oil
- Annex II—Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk
- Annex III—Prevention of Pollution by Harmful Substances Carried in Sea in Packaged Form
- Annex IV—Prevention of Pollution by Sewage from Ships
- Annex V—Prevention of Pollution by Garbage from Ships
- Annex VI—Prevention of Air Pollution from Ships

2.2.4 Stakeholder Roles

The roles and responsibilities of relevant government agencies relevant to POPs management are identified in Table 10.

Table 10. Roles and responsibilities of Tongan Government Departments

Government Agency	Responsibility
Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Communications and Climate Change (MEIDECC)	Responsibility for protection of the environment from hazardous chemicals
Ministry of Agriculture, Fisheries and Forestry (MAFF)	Responsible for the implementation of the Pesticides Act (2002) and Quarantine services for Tonga
Ministry of Health	Responsible for the implementation of the Public Health Act (2002)
Revenue and Customs Department	Responsible for border imports and exports
Ministry of Land and Transport	Vehicular emissions
Ministry of Police, Prison and Fire	Responsible for fire suppression activities
Ministry of Infrastructure (Marine and Ports)	Responsible for marine pollution response
Tonga Power Ltd (TPL)	Responsible for electrical transformer management
Waste Authority Ltd (WAL)	Responsible for national waste management services

2.2.4.1 Ministry of Meteorology, Energy, Information, Disaster Management, Environment, Communications and Climate Change (MEIDECC)

The Ministry's core functions are centred on sustaining the integrity of the ecosystems of Tonga to support life and livelihoods and the achievement of a high standard of living and quality of life for the people of Tonga at present and into the next generation. The mandate of the Departments of Environment and Climate Change are to ensure the protection and proper management of the environment and the promotion of sustainable development in order to achieve sustainable development for Tonga's present and future generations through coordinated environmental management and protection, and climate change mitigation and adaptation. Waste management and pollution control responsibilities are vested in MEIDECC.

The goal of the Waste Management & Pollution Control Division is to regulate the management of wastes and chemicals in accordance with accepted international practices and the International Conventions applying to the use, transboundary movement and disposal of wastes and substances. The Waste Management & Pollution Control Division is responsible for national management of solid & liquid waste, hazardous waste & chemicals and other waste. The Division is also responsible for ensuring that the Waste Management Act (2005), the Hazardous Waste and Chemical Act (2010) and the signed international agreements are implemented.

2.2.4.2 Ministry of Agriculture, Food and Forests (MAFF)

MAFF is the primary government ministry with responsibility for monitoring, regulation and strategic development of the agricultural sector. MAFF provides policy advice to the government, administers government programs in the sector, regulates the import and export of food and other plant or livestock related products, and builds capacity in the sector. MAFF is responsible for the implementation of the Pesticides Act (2002) which establishes the Pesticides Registration Committee. The focus of MAFF's work is on the implementation of the Tonga Agriculture Sector Plan 2016-2020.

MAFF is the largest government department in Tonga, which reflects its multiple roles. These include provision of policy advice to the Tongan government to achieve a sustainable and competitive agricultural sector; and also social, economic and environmental benefits from limited natural resources. MAFF also administers government programs and legislation to support these objectives; regulates the import of food and other goods to ensure that Tonga is safeguarded against exotic animal and plant pests and diseases; and regulates the export of agriculture and forestry products to meet importing country requirements. The MAFF Quarantine Division has a crucial role in facilitating biosecurity systems for both import and export pathways.

2.2.4.3 Ministry of Health

The Ministry is responsible for provision of primary health care to the Tongan population through four major base hospitals located on each of the main islands. The Ministry is also responsible for the supply of water of a suitable quality, installation and standards related to sanitary facilities, sources and standards of air pollutants and the management of public health emergencies under the Public Health Act (2015). The Minister of Health also overseas waste management on Ha'apai and 'Eua under the Waste Management Act (2005).

2.2.4.4 Revenue and Customs Department

The primary function of the Ministry of Revenue and Customs is to collect revenue (and its associated data) through taxes and duties for the Government of Tonga to fund services to the people of Tonga. In addition, the Ministry is also responsible for border security and facilitating trade. Customs has a Border management services through its Offices at the Queen Salote Wharf and at Fua'amotu International Airport (Tongatapu). This Office is responsible for primary line control and clearance of aircrafts, travellers and air cargo entering Tonga.

2.2.4.5 Ministry of Land and Transport

The Ministry is responsible for the annual mechanical examination of vehicles road worthiness prior to issuance of an annual licence by the Traffic Department of the Ministry of Police.

2.2.4.6 Ministry of Police, Prison and Fire

The Fire Department is responsible for the prevention and suppression of accidental fires including bush fires, vehicle fires, house/building fires in Tonga. It maintains fire stations on all the main islands. Including three stations on Tongatapu. The airport corporation operates a fire rescue service focussed on fire suppression related to airfield operations.

2.2.4.7 Marine and Ports

The Ministry of Infrastructure (Marine and Ports Division) is responsible for the control of maritime operations in Tonga, including marine pollution and oil spill response.

2.2.4.8 Tonga Power Ltd (TPL)

TPL was established in July 2008 to act as the concessionaire in Tonga's concession-based electricity regulation regime. TPL generates, distributes, and sells electricity to 23,561 commercial and domestic customers in Tongatapu, Vavaú, Haápai and 'Eua. Ninety one percent of electricity used in Tonga is currently (2018) generated using diesel fuel. The company is responsible for the management of transformers used as part of the electricity supply network in Tonga.

2.2.4.9 Waste Authority Ltd (WAL)

WAL is a Government Public Enterprise established in 2006 and mandated to manage waste in Tongatapu and Vava'u. The organisation provides commercial, industrial and residential waste collection services and waste management facilities. It also raises awareness of waste management issues through community campaigns and promotes recycling and waste minimisation measures to keep Tonga clean, green and healthy.

2.3 Assessment of POPs in Tonga

2.3.1 Assessment of POPs pesticides (Annex A, Part I)

2.3.1.1 POPs Pesticides[82]

A national assessment, including review of relevant documents, was conducted to determine if the pesticides listed in Annex A of the Stockholm Convention were in use, or if they are likely to be an issue for Tonga because of past importation. Current knowledge of the use of Stockholm Convention listed chemicals in Tonga is summarised in Table 11.

Table 11. Status of Stockholm Convention pesticides in Tonga

Annex A Chemicals (elimination)	Tonga Status	International Chemical Use	Action Plan
Aldrin	Used until 1973	Applied to soils to kill termites and other insect pests. Rapidly converts to dieldrin	AP11
Chlordane	Used until 1973*	Used to control plant pests and ants	AP11
Chlordecone	Unlikely to be present	No evidence of present-day manufacture or use anywhere in the world	
Dieldrin	Used until 1984*	Used to control plant pests	AP11
Endrin	Used until 1973	Sprayed on the leaves of crops such as cotton and grains and used for rodent control	AP11
Heptachlor	Used until 1973	Primarily used to kill soil insects and malaria-carrying mosquitoes	AP11
Hexachlorobenzene (HCB)	Used until 1973*	Use as a fungicide in the 1940s	AP8 AP11
Alpha-hexachlorocyclohexane (α-HCH)	Unlikely to be present	Technical HCH was used as a pesticide in the 1940s	AP11
Beta-hexachlorocyclohexane (β-HCH)	Unlikely to be present*	Technical HCH was used as a pesticide in the 1940s	AP11
Lindane (Ɣ-HCH)	Used until 2016*	Used for head lice control	AP11
Mirex	Used until 1973	Used to control fire ants. It has also been used as a fire retardant in plastics, rubber, and electrical goods	AP11
Pentachlorobenzene (PeCB)	Unlikely to be present	Previously used as an intermediate in pesticide manufacture and as a fire retardant	AP11
Pentachlorophenol and its salts and esters (PCP)	Unlikely to be present	Used as a wood preservative but phased out in the 1980s and 1990s	AP11
Technical endosulfan and its related isomers	Previous use	Broad-spectrum insecticide currently used world-wide	AP11
Toxaphene	Used until 1973	Insecticide	AP11

*Detectable in breast milk samples collected from Tonga in the 2008 GMP

[82]Government of Tonga (2009). *National Implementation Plan*. 161 pp

The POPs pesticides aldrin, endrin, heptachlor, toxaphene, HCB (hexachlorobenzene), chlordane, dieldrin, mirex, lindane and DDT were previously approved for use in Tonga but there is no information available on the quantities that were used in the past.[83]

Chlordane, dieldrin, and hexachlorobenzene were used in Tongatapu, Vava'u, Ha'apai and 'Eua. The use of Mirex was restricted to the MAFF Research Station as a trial soil sterilizer. Aldrin, endrin, heptachlor and toxaphene were trialled for the control of stick insects in coconut plots in Kauvai, Pelehake, Niumate and at the MAFF Research station. Chlordane was used until 1973 in Tongatapu, Vava'a and Ha'apai for the control of rose beetle in watermelon and vegetable crops.

Hexachlorobenzene was used as an agriculture pesticide in Tongatapu until 1973. Dieldrin (and DDT) was used up until 1973 to control *Lemprosema octosema* moths in banana plants in Tongatapu, Vava'u, Ha'apai and 'Eua. Low concentrations of dieldrin were still detectable in soil samples collected from the old MAFF research station in Tokomololo in 2011 (Table 12).

Table 12: DDT (and dieldrin) concentrations detected in soil samples collected at the old MAFF research station in Tokomololo, Tongatapu (mg/kg dw), 2011.

Analyte	Surface sample	Composite 0.5m depth	0.5m depth	0.5m depth	0.5m depth
4,4'-DDD	0.015	ND	ND	ND	ND
2,4-DDE	0.018	ND	ND	0.25	0.39
4,4'-DDE	0.66	0.186	0.119	ND	ND
2,4'-DDT	0.039	0.012	ND	0.025	0.013
4,4'-DDT	0.38	0.065	0.018	0.097	0.041
Dieldrin	0.013	ND	ND	0.047	ND

ND: Not detected

The importation and use of POPs pesticides in agriculture was banned in 1973. The pesticides were formally withdrawn from use in 1995 upon a recommendation from the Secretariat of the Pacific Community that biological agents be used instead to target the specific pest to be eliminated. A number of pesticides including dieldrin (20kg), 2,4-Dichlorophenoxyacetic acid (2,4-D; 5kg), Endosulfan (1kg) and 241kg of other pesticides were repackaged for disposal at the Vaini Research Farm in 2002[84] and exported under the POPs in PICs project.

Lindane was commonly used in Tonga prior to 2016 as the active ingredient in *Benhex* treatment for scabies which was dispensed through MOH pharmacies. More recently, only formulations with permethrin as the active ingredient are being supplied.[85] *Benhex* was withdrawn from sale in New Zealand in August 2015 due to health concerns linked with lindane exposure.[86]

The presence in Tonga of the additional seven pesticide chemicals listed after 2004 under the Stockholm Convention is unknown, but they are unlikely to be present in Tonga. Tonga does not have a chemical production industry and as such does not produce any of the fifteen pesticide chemicals listed in Annex A, Part 1. Tonga has no intention to deliberately import

[83]Government of Tonga (2008). *National Implementation Plan. 161 pp*
[84]SPREP (2003). *Tonga POPs Project Country Plan*. 18pp
[85]Jasmin Dodge, Pharmacist, Village Mission Clinic and Pharmacy, pers comm
[86]Wolf R, Davidovici B. (2010). Treatment of scabies and pediculosis: Facts and controversies. *Clin Dermatol* 28:511-18.

any of the listed POPs chemicals into the country for use and there is enough generic legislation in place that would control or prohibit the deliberate importation of these chemicals into the country.

Participation in the GMP has detected low concentrations of several POPs residues (chlordane, dieldrin, HCB, BDE, and 3 isomers of HCH) in breast milk samples (Appendix 5). Continued participation in the GMP will assist in the future monitoring of the presence and potential impact of these chemicals in Tonga.

2.3.1.2 Other pesticides imported into and used in Tonga

Data on the total quantities of non-POPs pesticides held in Tonga is not available. Data on insecticides, fungicides, herbicides and other agricultural chemicals imported into Tonga is collected and aggregated by the Customs Department and is reported as pcs (pieces).

2.3.1.2.1 Public Health

Three different insecticides are used to control vectors for Dengue, Chikungunya and Zika (Table 13). The insecticides are supplied by the World Health Organisation (WHO), Suva. Fogging and knapsack spraying complement an active public education programme to minimise free standing water around communities, which is carried out in Tongatapu as well as on the outer islands. Public Health Officers are stationed on all islands and sampling for the presence of mosquito larvae is regularly undertaken.

2.3.1.2.2 Quarantine

Queen Salote wharf has a container-based Methyl bromide fumigation facility. There is a second facility at Vava'u which is not operational.[87] Methyl bromide is used to disinfect around 200 shipping containers per year. Each export container is treated with 2kg of methyl bromide for 4hr contact period. Treated containers export watermelons, coconuts and taro to New Zealand, Samoa and American Samoa. Tonga has 6 fruit fly species that are of concern to importing countries, including New Zealand.[88] This is the highest number of any Pacific Island country. Active national quarantine programmes are in place to prevent entry of red fire ants, African snail, toads, taro leaf blight and red back spiders into Tonga.

2.3.1.2.3 Household Use

General household pesticide use is low in Tonga and limited to a small number of products offered for sale at retail outlets and local supermarkets (Table 13).

Table 13: Non-Stockholm pesticides in current use in Tonga

Product	Pesticide Type	Active Ingredient	Unit Size
Public Health			
Aqua K	Insecticide (fogging)	Deltamethrin	1 litre
BestSeller 100EC	Insecticide	Alpha-cypermethrin 10%	1 & 5 litre
Aqua Resigen	Insecticide (fogging)	S-bioallethrin 0.14% w/w; Permethrin 10.27% w/w; Piperonyl butoxide 9.84% w/w	1 litre
Quarantine			
Shipping container disinfection	Insecticide	Methyl bromide	200kg pa

[87]Arts *et al.* (2018). *Tongan Agricultural Sector Diagnostic Study, Final Report. 161 p*
[88]Arts *et al.* (2018). *Tongan Agricultural Sector Diagnostic Study, Final Report. 161 p*

Product	Pesticide Type	Active Ingredient	Unit Size
Chemist and Supermarket Retailers			
Dimethicone Lotion	Insecticide (Head lice)	Dimethicone 4%	500ml
A-scabies Anti-Scabies	Insecticide (Scabies)	Permethrin 5%	30ml
Mortein	Insecticide spray	Imiprothrin, cypermethrin	350g
Mortein	Insecticide coil	d-Allethrin	120g
Victoria	Insecticide coil	No product label. Made in Peoples Rep China	130g
Agricultural Store Retailers			
Agazone paraquat	Herbicide	Paraquat (1,1'dimethyl 4,4'bipyridinium)	1 and 5 litres
Agchem Benomyl	Fungicide	Benomyl	500g
AgChem BT	Insecticide	Bacillus thuringiensis	500g
Agral LN	Wetting agent	Nonylphenyl Ethoxylates	1 & 5 litres
Agriquat	Herbicide	Paraquat dichloride salt	5 litres
Blitzem pellets	Slug & snail bait	Metaldehyde 15g/kg	1 Kg
Confidor	Insecticide	Imidacloprid	750ml & 25g
D-C Tron PLUS organic	Mineral oil	Insulfone 96%	1 Litre
Diazinon 20	Insecticide	Diazinon solvent, Hydrocarbon solvent	1 litre
DiPel DF	Insecticide	Bacillus thuringiensis	500g
Dithane M45 DG	Fungicide	Mancozeb (750g/kg)	3kKg
DuPont Kocide Opti	Fungicide/bactericide	Copper Hydroxide	1.5kKg
DuPont Steward eVo	Insecticide	Indoxacarb	1 litre
DuPont Talendo	Fungicide	Proquinazid	1 litre
Floraset (Suva)	Growth hormone	1-Naphthalene Acetic Acid	200ml
Fruit Fly Lure	Insect lure	Yeast autolysate	5 litre
Glyphosate 360	Herbicide	Glyphosate	1 litre
Growth formula	Growth formula	Vit B, naphthalene, Acetic acid, Indol Acetic acid	1 litre
Jazz	Herbicide	Metribuzin	1 litre
Linuron 50DF	Herbicide	Linuron	2.5kKg
Manzate Evolution	Fungicide	Mancozeb	1k Kg
Methomyl	Carbamate	Methomyl carbamate	5 & 20 Litres
Nikasol	Fungicide	Propiconazole EC	500mls
Niuvea	Fungicide/bactericide	Copper Hydroxide	500g
Nizac	Fungicide	Mancozeb	500g
Pineapple spray	Growth regulator	2-Chloroethylphosphonic acid	1 litre
Prevathon	Insecticide	Chlorantraniliprole	100ml
Protek	Fungicide	Carbendazim	5 litres
Robust	Herbicide	Glyphosate	5 litres
Rodenticide	Brodicafoum	Anti-coagulant poison	0.15 and 1 Kg
Salute	Fungicide	Azoxystrobin	1 litre
Suncis	Insecticide	Deltamethrin	1 litre
Sundomil	Fungicide	Mancozeb, metalaxy	500g
Supermanz	Fungicide	Mancozeb	10 litres
Talon WB	Rodenticide	Brodifacoum	10 Kg
Taratek 5F	Fungicide	Chlorothalonil Thiophanate-methyl	10 litres
Other			
CCA	Timber treatment	Copper-chrome- arsenate (CCA)	200 litres

2.3.1.2.4 Agriculture[89]

A range of agricultural pesticides are available for sale through two retail outlets (*Nishi Trading* and *Bills Farming and Fishing)* in Tonga. These are also listed in Table 13. An annual import register of pesticides is administered by MAFF. All pesticides are imported into Tongatapu, where they are then purchased by farmers for use throughout the archipelago. Herbicides dominate imports with Paraquat by far the most common herbicide used. Paraquat imports have remained relatively stable since 2013.

Chemical use among allotment farmers is widespread on the main island of Tongatapu, and almost all imported agricultural chemicals (94%) are applied in Tongatapu.[90] Post emergent herbicides are extensively used for weeding within crops, as these are believed to be more cost effective than hiring labourers to reduce weeds. Due to relative costs, around 30% of the pesticides are imported in 1L sized containers, 65% in 5L containers and the remaining 5% (rodenticides) in 20L sized containers. It was estimated that over the last five years 75,000 plastic pesticide containers have been imported to Tonga and require disposal.[91] Farmers are reported to rinse pesticide containers and use the rinsate as make-up water, as is recommended.

Interviews with farmers have established that 20L containers and some smaller (5L) containers are re-used for transporting fuel and irrigation water for agricultural use. None of the 1L containers are reused, and this suggests that at least 14,500 containers are generated for disposal annually.[92] The majority of these are left in the bush adjacent to the blocks being farmed, and these are unintentionally burnt over time.[93]

Nearly 10,000L of copper chrome arsenate is imported annually in 200L drums for wood preservation. These drums are retained at the processing site and used to store sludges generated through cleaning of the chemical recycle baths.[94]

Most imported plastic pesticide containers are composed of high-density polyethylene (HDPE) and other polyethylene compounds. Field burning of plastic pesticide containers at low temperatures results in the formation of complex volatile organic chemical species such as aldehydes and ketones and can generate furans and dioxins.[95] No specialised facilities exist in Tonga for the handling, storage and transportation of hazardous materials, and none for the treatment and disposal of hazardous wastes. No specific mechanism or site for pesticide container disposal currently exists in Tonga. Disposal of empty pesticide containers to the Tapuhia landfill would consume approximately 20m^3 of landfill space per year and could be an interim management option for collected pesticide containers. A deposit system on containers which are returned to point of sale is also a potential option.

[89]SPREP (2017). *Pesticide Container Management in the Pacific Tonga Feasibility Study and Integrated Waste Management Strategy for Pesticide Containers*. GHD. 104 pp.
[90] MAFF (2015). *Tonga National Agricultural Census: Main Report*. 251 pp.
[91]SPREP (2017). *Pesticide Container Management in the Pacific Tonga Feasibility Study and Integrated Waste Management Strategy for Pesticide Containers*. GHD. 104 pp.
[92]SPREP (2017). *Pesticide Container Management in the Pacific Tonga Feasibility Study and Integrated Waste Management Strategy for Pesticide Containers*. GHD. 104 pp.
[93]SPREP (2017). *Pesticide Container Management in the Pacific Tonga Feasibility Study and Integrated Waste Management Strategy for Pesticide Containers*. GHD. 104 pp.
[94]SPREP (2017). *Pesticide Container Management in the Pacific Tonga Feasibility Study and Integrated Waste Management Strategy for Pesticide Containers*. GHD. 104 pp.
[95]Maya and Levin. (1987). A Literature Review of the Chemical Nature and Toxicity of the Decomposition Products of Polyethylenes. *Fire and Materials*, 11, 55-70

2.3.1.3 Other hazardous materials

2.3.1.3.1 Laboratory Chemicals

The chemical laboratories located at the University of the South Pacific (USP) campus on Tongatapu are used by up to 250 undergraduate students each week as well as senior students (forms 5 and 6) from two secondary schools enrolled in bridging courses. Laboratory chemicals are pre-ordered through USP Fiji's online ordering system and stored in a small unlocked building adjacent to the main laboratories, which requires urgent refurbishment. The most dangerous chemicals held in the laboratory are carcinogenic organic chemicals and strong acids. Waste organic solvents are accumulated at around 200ml per month and are stored in 2.5 litre Winchester bottles and a stockpile of approximately 60 litres of waste chemicals exists. All laboratory wastewaters are diluted, premixed to neutralise where possible, and then discharged directly to the ground outside the chemistry laboratory.

2.3.1.3.2 Asbestos Containing Materials

Surveys of asbestos containing material in 2014 identified asbestos at 21 sites in Tonga, which were considered moderate to high risk with regards to the occupant's and/or public's potential exposure to asbestos. These included Tonga Post Ltd, Prince Ngu Hospital (Vava'u), St Andrews School, Pacific International, Viola Hospital and Tonga Water.

Approximately 300 residential dwellings in Tongatapu and Vava'u were also identified with asbestos containing materials. The cost to remediate higher risk sites in Tonga and dispose of collected asbestos to local landfill was estimated to be around US$1.2M (in 2014).[96] Many of these sites were subsequently cleared of asbestos in 2016 (Table 14). Priorities for future asbestos removal works are identified in Table 15. The cost to complete residential remediation work is estimated at around US$3.4M. The cost to remediate commercial premises was not quantified.

Table 14: PacWaste *asbestos* removal summary (2016)

Location	Type of material	Area	Status
MOI WOF Centre	Cladding	900m^2	Removal completed
St Andrews School	Fibreboard	160m^2	Removal completed
Tonga Post ltd	Fibre cement roof, Soffits	1400m^2	Removal completed
Viola Hospital, Tongatapu	Walkway fibre cement roof	20m^2	Removal completed
Fua'amotu Domestic Airport - Residential	Fibre cement roof	450m^2	Removal completed
Tonga Water	Fibre cement roof	120m^2	Removal completed
Neiafu former market - Tonga Football Association, Vava'u	Fibre cement roof	300m^2	Removal completed
Prince Ngu Hospital, Neiafu, Vava'u	Fibre cement roof	3650m^2	Removal completed

[96]SPREP (2015). *Survey of the Regional Distribution and Status of Asbestos-Contaminated Construction Material and Best Practice Options for its Management in Pacific Island Countries. Report for the Kingdom of Tonga*. 83 pp

Table 15: PacWaste Plus (2020-onwards) asbestos removal priorities[97]

Location	Type of material
Plumbing Shop	Roof and Facades
Pacific International (Tonga) Ltd)	Roof
Industrial 01, Nuku'alofa	Roof
Vava'u Former bulk fuel terminal	Roof, Cladding (removal only)
Industrial 02, Nuku'alofa	Roof
CAT Depot Nuku'alofa	Soffit
Small Business Centre Management Office	Cladding
Residential Houses	150 residences with asbestos roofs
Residential Houses	50 residences with asbestos cladding

2.3.1.3.3 Used oil

Two major companies (TOTAL and Pacific Energy) supply lubricating and hydraulic oil to Tonga. The quantity of lubricating oil is imported into Tonga each year is unknown, but was reported as 450,000 litres per year in 2014.[98] Pacific Energy offers a used oil take-back service for its retail customers and exports around 10,000 litres of used oil per month to Fiji, depending on local shipping schedules. The used oil is transferred in IBCs and shipped on Pacific Energy's local trading vessel. GIO Recycling has, in the past, also sent containers of waste oil to India and to Japan with the export cost being covered by the used oil importer. TOTAL does not accept used oil as it is not currently found to be economically feasible.

2.3.2 Assessment of polychlorinated biphenyls (PCBs; Annex A, Part II)

PCBs are industrial chemicals previously used as coolants and lubricants in electrical equipment (such as transformers and capacitors), hydraulic fluids, and additives in paint, carbonless copy paper, plasticisers and dye carriers. PCBs were used in these applications as they do not burn easily and are good insulators. PCBs were produced in several countries and most production was phased out by the 1990s. PCBs have previously been used in Tonga as transformer fluids. However, extensive testing of in-line and decommissioned transformers and adjacent soils in 1999, 2003 and 2006 only detected one transformer containing potentially PCB contaminated oil,[99] which was removed to Australia for destruction in 2006.[100]

2.3.2.1 1999 Testing

Seventy-six (76) transformers were dumped in the coastal area of Fangakakau Lagoon outside the Anana Power station in 1999. The oil remaining in 49 of the dumped transformers was tested for PCBs, and the adjacent soil tested for PCBs in 2006 (PCB concentrations were found to be less than 20ppm). Additional soil samples were analysed from the old Siaine Power station which also contained less than 0.01 mg/kg dry wt PCBs.[101]

[97]O'Grady (2018). *Regional Distribution and Status of Asbestos-Contaminated Construction Materials and Best Practice Options for its Management in Pacific Island Countries. SPREP. 163p.*
[98]Golder Associates (2014) Contemporary used oil audit, Tonga. SPREP. 18pp.
[99]Government of Tonga (2009). *National Implementation Plan.* 161 pp
[100]Government of Tonga (2009). *National Implementation Plan.* 161 pp
[101]Government of Tonga (2009). *National Implementation Plan*. 161 pp

2.3.2.2 2003 and 2006 Testing

The POPs in PICs project (2003) tested 104 transformers stockpiled at the Popua Power Station yard, Tongatapu, for the presence of PCBs and only detected one PCB contaminated transformer, which had a PCB concentration of 98 mg/kg. This transformer was subsequently removed to Australia for destruction in 2006.[102] Sixty-three transformers throughout Tonga were tested for PCBs in 2006. Only 67% of transformers online were tested at this time, and it was intended to test the remaining transformers as they were decommissioned for disposal. No PCBs were detected in tested transformers.[103] Transformers were also tested at the power stations on Vavau and Ha'apai and were found to be uncontaminated with PCBs.[104]

All transformers used in Tonga since 1980 have been certified as being PCB-free, and all transformer (and other infrastructure) management in Tonga has been contracted out by Tonga Power Ltd (TPL) to Transnet, a New Zealand Company for the last 10 years. This includes replacement of all transformers and transformer oil. Whilst PCBs are unlikely to present any threat to power sector workers, local staff have not been trained to be aware of potential PCB issues in the workplace. Additionally, the GMP has detected PCBs in breast milk samples collected in Tonga in 2008 (Appendix 5). Continued participation in the GMP will assist in the future monitoring of the presence and potential impact of these chemicals in Tonga.

Limited sampling of soil collected from the Tukutonga dumpsite in 2006 following its decommissioning indicated that low levels of a range of POPs (including PCDD/PCDFs, PCBs and PBDEs) were detectable (Table 16).[105] The dumpsite operated since the mid-1920s and was subject to frequent unintentional fires caused by methane build up.

Table 16: Sediment sample pollutant concentrations, closed Tukutonga dumpsite (2006)

Congener	Concentration (pg/g dry weight)
ΣPCDD/PCDF	7,720
OCDF	180
OCDD	2,710
PCB 105	13,400
PCB 118	28,300
ΣPBDE	270
PBDE 47	13
PBDE 209	160

2.3.3 Assessment of Polybromodiphenyl ethers (POP-PBDEs), HBB (Annex A Part I) and HBCD (Annex A Part I and Part VII)

2.3.3.1 POP-PBDEs

The POP-PBDEs are a group of industrial chemicals that have been used since the 1970s as additive flame retardants in a wide range of (mainly) consumer products including electrical and electronic equipment, furniture and mattresses, textiles, and carpets, and vehicles. They include hexabromodiphenyl ether (hexaBDE), heptabromodiphenyl ether (heptaBDE),

[102]Government of Tonga (2009). *National Implementation Plan*. 161 pp
[103]Vaka'uta, S., Vi, S., McDowell, R. and Slee, D (2006). *PCBs in transformers on-line and wastes Tonga.* Tonga POPs Inventory 2006/2007 pp 19-31
[104]SPREP (2003). *Tonga POPs Project Country Plan*. 18pp
[105]Vi *et al.* (2009). *Assessing the levels of dioxins and furans, dioxin like PCBs and PBDE in Tukutonga Garbage Dump*. 8pp.

tetrabromodiphenyl ether (tetraBDE), and pentabromodiphenyl ether (pentaBDE). PBDEs were produced with three different degrees of bromination and marketed as:

- commercial pentaBDE (c-PentaBDE), in which tetraBDE and pentaBDE were the most abundant congeners;
- commercial octaBDE (c-OctaBDE) in which hexaBDE and heptaBDE were the most abundant congeners; and
- commercial decaBDE (c-DecaBDE).

It is believed that the production of c-PentaBDE and c-OctaBDE ended in 2004, whilst production of c-DecaBDE continues.[106] Although c-DecaBDE has not been found to contain POP-PBDEs, it can form POP-PBDEs by debromination during its life cycle, thus representing an important reservoir of POP-PBDEs.[107] The presence of any of these POP-PBDEs in Tonga will be the result of importation of articles containing the chemicals, a large proportion of which end up in waste dumps and landfills.

Only limited information is available on the presence of POP-PBDEs in Tonga, and it is highly likely that POP-PBDEs precursors have entered the country in manufactured articles. These potential POP-PBDEs precursors may be present in plastic components of common household and office goods, such as computers and electrical appliances, and in furniture fabrics and textiles, and in foamed plastics and rubbers such as that used in furniture, mattresses, carpet underlays, car seats, and in foamed building insulation. Past monitoring has detected their presence in dumpsite sediments (Table 16).

2.3.3.1.1 Electrical and Electronic Equipment Sector[108]

Census data indicates that ownership of electronic goods is high in Tonga. POP-PBDEs are only expected to be contained in second-hand imports of electronic equipment as international production ceased in 2004.[109] Given the high cost of importing items into Tonga, it is likely that only limited quantities of second-hand goods are imported. However, many new electronic items that potentially contain POP-PDE precursors are imported annually or bought in by Tongan residents following trips overseas.

POP-PBDE imports 2016-2018

Based on Tonga Customs data, the 2016-2018 estimated hexa/heptaBDE amount in imported CRT TVs and monitors ranges from 0.007 to 0.010 tonnes and the decaBDE amount ranges from 0.024 to 0.065 tonnes, both contained in 15 tonnes of polymeric fraction (Table 17). The estimated hexa/heptaBDE and decaBDE in imported flat screen TVs during 2016-2018 is 0.157 tonnes contained in 56 tonnes of polymeric fraction (Table 17). These recent estimates (2016-2018) likely overestimate the quantities of POP-PBDE in TVs imported into Tonga as importation of CRT based units is likely to have declined from the 15% estimate obtained in 2015.[110]

[106]UNEP (2017). *Guidance for the inventory of polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on Persistent Organic Pollutants.* 105pp
[107]UNEP (2017). *Guidance for the inventory of polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on Persistent Organic Pollutants.* 105pp
[108]Leney, A. (2018). Review of e-waste Related Activities in the Pacific Islands. 70 pp.
[109]UNEP (2017). *Guidance for the inventory of polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on Persistent Organic Pollutants.* 105pp
[110] IIEC (2015). *Promoting Energy Efficiency in the Pacific (Phase 2): Analysis of the tonga national survey of household lighting and electrical appliances*. ADB. 40pp

Table 17. Estimated quantity of c-OctaBDE and decaBDE in electrical and electronic equipment (EEE) imported into Tonga 2016 - 2018

	CRT TV Screen**	CRT Computer Monitors	Flat Screen TV**
Number of screens (2016-2018)*	935	1,021	11,803
Screen weight (kg)	25	25	13***
Polymer weight fraction (%)	30	30	37
Total polymer weight (kg)	7,015	7,656	56,771
Typical hexa/heptaBDE content (kg/tonne)[111]	0.47	1.37	0.009
Typical decaBDE content (kg/tonne)[112]	4.4	3.2	2.75
Total estimated quantity hexa/heptaBDE (kg) in tonnes of polymeric fraction	(935+1021) x 25 kg x 0.3 x [0.00047 to 0.00137] = 7 – 10 kg in 15 tonnes polymer		11,803 x 13 kg x 0.37 x [0.000009 + 0.00275] 157 kg in 56 tonnes polymer
Total estimated quantity decaBDE (kg) in tonnes of polymeric fraction	(935 + 1021) x 25 kg x 0.3 x [0.0032 to 0.0044] = 24 – 65 kg in 15 tonnes polymer		

*Tonga Customs data, accessed 2019
**Based on 2015 survey data[113] that determined approximately 15% of TV screens imported in Tonga were CRT screens
*** Assumed the majority of the flat screen TVs imported in Tonga are the 32 Inch ones weighting 13 kg/flat screen TV

POP-PBDEs in use/stockpiled EEE in households

The quantity of hexa/heptaBDE estimated to be present in household TV and computer CRT screens in 2015[114] that were either in use or stockpiled ranges from 0.071 to 0.207 tonnes and the quantity of decaBDE ranges from 0.483 to 0.664 tonnes, both contained in 151 tonnes of polymeric fraction (Table 18). The quantity of hexa/heptaBDE and decaBDE estimated to be present in household flat screen TVs in 2015 either in use or stockpiled, is approximately 0.033 tonnes contained in 12 tonnes of polymeric fraction (Table 18). Most likely the imported flat screen TVs have already entered in use, but there is no official Census data to document this and to allow a POP-PBDEs estimation using more recent data. Therefore, a POP-PBDEs estimation update is included in the respective Action Plan (see Chapter 5.3.5).

Table 18: Estimated quantity of c-OctaBDE and decaBDE in electrical and electronic equipment (EEE) in use/stockpiled in households in Tonga in 2015

	CRT TV Screen	CRT Computer Monitors	Flat Screen TV
Number of screens (2015)	13,923	6,188	2,457
Screen weight (kg)	25	25	13*
Polymer weight fraction (%)	30	30	37
Total polymer weight (kg)	104,423	46,410	11,818

[111]UNEP (2019). Preliminary draft guidance on preparing inventories of decabromodiphenyl ether. Table 10. Total polymer fractions and c-octaBDE and decaBDE concentrations in relevant EEE categories (data from Europe; Waeger et al., 2010; Hennebert & Filella 2018)
[112]UNEP (2019). Preliminary draft guidance on preparing inventories of decabromodiphenyl ether. Table 10. Total polymer fractions and c-octaBDE and decaBDE concentrations in relevant EEE categories (data from Europe; Waeger et al., 2010; Hennebert & Filella 2018)
[113] IIEC (2015). *Promoting Energy Efficiency in the Pacific (Phase 2): Analysis of the tonga national survey of household lighting and electrical appliances*. ADB. 40pp
[114]Government of Tonga (2016). *2015 Census*

	CRT TV Screen	CRT Computer Monitors	Flat Screen TV
Typical hexa/heptaBDE content (kg/tonne)[115]	0.47	1.37	0.009
Typical decaBDE content (kg/tonne)[115]	4.4	3.2	2.75
Total estimated quantity hexa/heptaBDE (kg) in tonnes of polymeric fraction	(13923 + 6188) x 25 kg x 0.3 x [0.00047 to 0.00137] = 71 – 207 kg in 151 tonnes polymer		2457 x 13 kg x 0.37 x [0.000009 + 0.00275] 33 kg in 12 tonnes polymer
Total estimated quantity decaBDE (kg) in tonnes of polymeric fraction	(13923 + 6188) x 25 kg x 0.3 x [0.0032 to 0.0044] = 483 – 664 kg in 151 tonnes polymer		

*Assumes most of the flat screen TVs in Tonga are 32 Inch ones weighting 13 kg

POP-PBDEs in E-waste

At the end of their service life, electronic products containing POP-PBDEs are likely to be exported for recycling or disposed of in landfills, so introduction of improved national e-waste management practices will practically manage this issue in Tonga. Tonga has taken an active role in managing the e-waste problem since 2009, when a local non-governmental organisation (NGO), E-waste Tonga, was formed to address the issue. The local recycler (GIO Recycling) collected 8,800kg of e-waste during the period September 2016 to March 2017 from both Tongatapu and Vava'u and continues to stockpile dismantled e-waste at the rate of one 20-foot container per year. All e-waste collected since 2017 is currently stockpiled. The 2016-2017 estimated hexa/heptaBDE amount in E-waste (WEEE) ranges from 0.001 tonnes to 0.003 tonnes and the decaBDE amount ranges from 0.007 to 0.009 tonnes, both contained in 2 tonnes of polymeric fraction (Table 19).

Table 19: Estimated quantity of c-OctaBDE and decaBDE contained in stockpiled E-waste in Tonga (2016 – 2017)

	CRT TVs Waste	CRT Computer Monitors Waste
2016-2017 generated WEEE weight (kg)	7,040*	
Polymer weight fraction (%)	30	30
Total polymer weight (kg)	2112	
Typical hexa/heptaBDE content (kg/tonne)[116]	0.47	1.37
Typical decaBDE content (kg/tonne)[115]	4.4	3.2
Total estimated quantity hexa/heptaBDE (kg) in tonnes of polymeric fraction	7040 x 0.3 x [0.00047 to 0.00137] = 1 – 3 kg in 2 tonnes polymer	
Total estimated quantity decaBDE (kg) in tonnes of polymeric fraction	7040 x 0.3 x [0.0032 to 0.0044] = 7– 9 kg in 2 tonnes polymer	

*Assumes 80% of the 8,800 kg of e-wastes are CRT TVs and monitors

2.3.3.1.2 Transport sector

Commercial pentaBDE (c-pentaBDE) in which tetraBDE and pentaBDE are the most abundant congeners, was widely used in cars, buses and trucks to treat flexible polyurethane (PUR)

[115]UNEP (2019). Preliminary draft guidance on preparing inventories of decabromodiphenyl ether. Table 10. Total polymer fractions and c-octaBDE and decaBDE concentrations in relevant EEE categories (data from Europe; Waeger et al., 2010; Hennebert & Filella 2018)

[116]UNEP (2019). Preliminary draft guidance on preparing inventories of decabromodiphenyl ether. Table 10. Total polymer fractions and c-octaBDE and decaBDE concentrations in relevant EEE categories (data from Europe; Waeger et al., 2010; Hennebert & Filella 2018)

foams for seats, head rests, car ceilings, and acoustic systems. C-OctaBDE has also been used to some extent in plastic vehicle parts including steering wheels, dashboards, and door panels.[117] At the end of their service life, vehicles containing HBCD are either stripped and the metal body exported offshore (with other components landfilled) or the entire vehicle collected and disposed of in the landfill. Introduction of improved national waste management practices will therefore practically manage this issue in Tonga.

Ideally, end of life (EOL) vehicles would be collected and wrecked for spares, before being stripped out, the interior plastic elements shipped offshore for disposal, and the metal parts recycled. The highest value in an EOL vehicle is the recoverable spare parts, but these must be removed reasonably soon after the vehicle becomes disused, or else local corrosion will render any potential spares useless. EOL vehicles will also deposit quantities of waste oils and paints into the local groundwater as they degrade. Aggregating EOL vehicles can be facilitated using a deposit refund system, with a deposit paid at import that is refunded several years later when the EOL vehicle is handed in for recovery of spare parts and export of scrap.

The number of motor vehicles imported into Tonga is relatively low due to the low demand created by a small national population and the small size of the land area. At the level of 2019 it is estimated that there is approximately 0.519 tonnes of POP-PBDEs contained in 75 tonnes of PUR foams from vehicles in current use (Table 20), 0.177 tonnes of POP-PBDEs in vehicles that have been recycled (Table 21) and 0.160 tonnes in end of life vehicles (Table 22) that have been collected and stored in Tonga.

Table 20: Estimated POP-PBDE amount within vehicles in use into Tonga in 2019

Vehicle Category	Estimated total number of vehicles present in Tonga 2019*	Estimated total number of vehicles manufactured before 2005 in use in Tonga 2019	Estimated total number of vehicles manufactured 2005-2017 in use in Tonga 2019	Average POP-PBDE content in vehicles manufactured prior to 2004 (g)	Average POP-PBDE content in vehicles manufactured 2005-2017 (g)	Total Estimated POP-PBDE amount (kg) in all in use vehicles in Tonga in 2019
Hire Car	1,500	0	750	80	20	Total B x 0.08 kg + Total C x 0.02 kg = 519 kg = 0.519 tonnes contained in 75 tonnes of PUR foam
Car	7,618	1,523	6,094	80	20	
Truck	1,022	204	817	80	20	
Van	6,995	1,399	5,596	80	20	
Bus	119	24	95	80	20	
TOTAL	**17,254 (A)**	**3,150 (B)**	**13,352 (C)**			

*Based on national car licence plate registration numbers

[117]Stockholm Convention Secretariat (2017). *Guidance for the inventory of polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on Persistent Organic Pollutants*

Table 21: Estimated POP-PBDE amount within recycled vehicles into Tonga prior to 2019

Vehicle Category	Estimated total number of vehicles manufactured before 2005 recycled in 2019 into Tonga	Estimated total number of vehicles manufactured 2005-2017 recycled in 2019 into Tonga	Average POP-PBDE content in vehicles manufactured prior to 2004 (g)	Average POP-PBDE content in vehicles manufactured 2005-2017 (g)	Total Estimated POP-PBDE amount (kg) in vehicles recycled in Tonga in 2019
GIO recycled cars*	600	2,400	80	20	Total A x 0.08 kg + Total B x 0.02 kg = 177 kg = 0.177 tonnes
WAL recycled cars	504	2,016	80	20	
TOTAL	**1,104 (A)**	**4,416 (B)**			

*Includes POP-PBDEs in materials stripped from car bodies and landfilled prior to metal body being crushed and exported by GIO Recycling prior to 2018. The company exported 3000 crushed car bodies in 100 containers (~27 car bodies per container) to Malaysia and Indonesia between 2015-2018.

Table 22: Estimated POP-PBDE amount within end of life vehicles into Tonga in 2019

Vehicle Category	Estimated total number of end of life vehicles manufactured before 2005 in 2019 into Tonga	Estimated total number of end of life vehicles manufactured 2005-2017 recycled in 2019 into Tonga	Average POP-PBDE content in vehicles manufactured prior to 2004 (g)	Average POP-PBDE content in vehicles manufactured 2005-2017 (g)	Total Estimated POP-PBDE amount (kg) in vehicles recycled in Tonga in 2019
Remainder Wrecks	1,000	4,000	80	20	Total A x 0.08 kg + Total B x 0.02 kg = 160 kg = 0.160 tonnes
TOTAL	**1,000 (A)**	**4,000 (B)**			

2.3.3.2 Assessment of Hexabromobiphenyl (HBB; Annex A, Part I)

Hexabromobiphenyl (HBB) was used as a flame retardant in three main commercial products: ABS thermoplastics (used in business machine housings, and the industrial and electrical sectors); PUR foam for automotive upholstery; and cable coatings and lacquers. The available data indicates that the USA was the sole producer of HBB, producing approximately 5,400 tonnes of the chemical between 1970 and 1976. It is further believed that most HBB-containing materials were disposed of decades ago and are therefore of little relevance to Tonga. Due to the similarity in use between HBB and POP-PBDE, any minor amount of HBB that may be present will be addressed through national POP-PBDE management measures.[118]

2.3.3.3 Assessment of Hexabromocyclododecane (HBCD; Annex A; Part I and Part VII)

HBCD has been on the world market since the late 1960s and has been produced mainly in China, the European Union, and USA. It is used as a flame-retardant additive to reduce ignition of flammable polymers and textiles in buildings, vehicles or electrical and electronic equipment (EEE). HBCD is currently used in four principal insulation product types:

[118]Stockholm Convention Secretariat (2017). *Guidance for the inventory of polybrominated diphenyl ethers (PBDEs) listed under the Stockholm Convention on Persistent Organic Pollutants*

expandable polystyrene (EPS), extruded polystyrene (XPS), high impact polystyrene (HIPS) and in polymer dispersions for coating textiles.

The main application (90%) of HBCD is in EPS and XPS foams (both often referred to by the trademark Styrofoam), which are used widely as insulation boards in building and construction. EPS is also used for insulation in buildings and refrigerated trucks and containers, as a fill and shape material in concrete construction, in packaging, and as the filling material for bean bags. A smaller proportion of EPS and XPS is used in textile applications, including residential and commercial furniture and vehicle upholsteries, draperies and wall coverings. HBCD may also be added to HIPS (used in EEE such as audio-visual equipment cabinets and refrigerator lining), latex binders, adhesives, and paints.

Tonga does not manufacture HBCD, but it may be present in products and articles imported prior to 2014. The quantities of HBCD imported into Tonga are unknown. At the end of their service life, products containing HBCD are likely to be disposed of in landfills, so in the absence of information, improved national waste management practices, in particular to construction and demolition waste, will practically manage this issue in Tonga.

2.3.4 Assessment of Hexachlorobutadiene (HCBD; Annex A, Part I)

HCBD was produced as unintentional by-products during the manufacture of chlorinated solvents and also deliberately, to meet demands for HCBD. It was used for several technical and agricultural applications including as heat transfer fluid in transformers, and as a fumigant, pesticide, seed dressing, fungicide, and biocide.[119] Tonga does not manufacture chlorinated solvents, thus the potential presence of HCBD in Tonga would be due to imported products containing the chemical, including in transformer, heat exchange and hydraulic fluids. Continued participation in the Global Monitoring Plan will assist in the future monitoring of the presence and potential impact of these chemicals in Tonga.

2.3.5 Assessment of Polychlorinated naphthalenes (PCNs; Annex A, part I)

Polychlorinated naphthalenes (PCNs), which are structurally like PCBs, consist of 75 possible compounds in eight homologue groups, seven of which are listed in the Stockholm Convention. Due to structural similarities to PCBs, PCNs were often intentionally produced for use in similar industrial and consumer applications as PCBs, including in transformer fluids, cable insulation, fluids in capacitors and condensers, wood preservation, and as an additive in paints and dye carriers.[120] PCNs were mainly used between 1920 and 1960 but have been used in certain applications until early 2000. In most applications, PCNs have not been produced or used for over 30 years and it can be assumed that most PCN-containing products with short lifetimes (e.g. textiles, papers, lubricants, cutting oils and grease) have already been disposed of. Some PCN-containing products (e.g. PCN-treated wood, paint) produced before 2000 may still be in use today, for example in building construction, and painted ships and bridges[121]. PCNs are also unintentionally formed and released together with dioxins and furans in thermal processes. There is no known information available about the presence of PCNs in Tonga. Unintentionally produced PCNs are not separately addressed in this NIP as PCN emissions will be reduced by the same measures applied to reduce dioxins and furans.

[119]Stockholm Convention Secretariat (2017). *Draft guidance on preparing inventories of hexachlorobutadiene (HCBD)*
[120]UNEP (2017). *Draft guidance on preparing inventories of polychlorinated naphthalenes (PCNs)*
[121]UNEP (2017). *Draft guidance on preparing inventories of polychlorinated naphthalenes (PCNs)*

2.3.6 Assessment of Short chained chlorinated paraffins (SCCPs)

Chlorinated paraffins have been used since the 1930s as plasticiser in rubber, sealants, coatings, textiles, leather fat, paints, adhesives, flame retardants for plastics, and high-pressure lubricants. Of these, short chained chlorinated paraffins (SCCPs) are persistent in the air and undergo long-range transport. They bioaccumulate, for instance in fish, and can lead to significant adverse environmental and human health effects. They can be toxic to aquatic organisms and are possible human carcinogens. PCB and PCN alternatives are now commercially available for all former uses of SCCPs. Because of their widespread use for a very long time, and their persistence, SCCPs will probably be present in Tonga. Huge quantities were produced until recently with 165,000t/year being produced world-wide in 2016, and while global production is being phased out, it has not ended. SCCPs are still detected in foodstuffs such as fish, and vegetable oil, absorbed in the grain contained in plastic feed bags, and are also detected in the air, and vehicle, office, and house dusts. They will also be potentially in products that are being imported. Their earlier widespread use will mean they are probably also present in breakdown products from old waste dumping areas.

2.3.7 Assessment of DDT (Annex B, Part II)

DDT was widely used during World War II to protect soldiers and civilians from malaria, typhus, and other diseases spread by insects. After the war, DDT continued to be used to control disease, and it was sprayed on a variety of agricultural crops, especially cotton. DDT continues to be applied against mosquitoes in several countries to control malaria. Its stability, its persistence, and its widespread use have meant that DDT residues are still found worldwide.

DDT was used in Tonga between 1947 and 1985 by over 450 farmers for the control of the *Lamprosema octosema* moth in banana crops in Tongatapu, Vava'u, Ha'apai and 'Eua.[122] DDT was often combined with dieldrin for insect control in banana plantations. DDT was also previously approved for use in Tonga for the vector control of Dengue Fever,[123] but there is no information available on the quantities that were used in the past.[124] The pesticide was formally withdrawn from use in 1995 upon a recommendation from the Secretariat of the Pacific Community that biological agents be used instead to target the specific pest to be eliminated. Bifenthrin and deltamethrin are now used in its place. The importation and use of POPs pesticides in Tonga were banned in 1973, but lack of appropriate legislation resulted in 20 tonnes of donated DDT being imported from Samoa as an aid initiative in 1982.[125] Currently, there is no intention to use or import DDT into Tonga.

DDT residues have been detected in samples of vegetables, groundwater, milk and human fat in 1980,[126] and in sediment and groundwater samples collected between 1990 and 2000.[127] The POPs in PICs project (2003) did not detect any stockpiles of DDT in Tonga, although interviews conducted in 2006 as part of the original Tonga NIP indicated that approximately five tonnes of DDT had been buried within the catchment boundary of Fanga'uta Lagoon at the former MAFF research station in Tokomololo, Tongatapu in 1974.[128,129] Further testing at

[122]Manu and Vi (2009). POPs pesticides in Tonga: DDT and Dieldrin. *Tonga POPs inventory*
[123]Chow, C (1967). *Aedes aegyptii* in the western Pacific region. *Bull World Health Organisation* 36, 544-546
[124]Government of Tonga (2008). *National Implementation Plan*
[125]Government of Tonga (2009). *National Implementation Plan*
[126]Chesher *et al*. (1984). *Pollution sources survey of the Kingdom of Tonga.* SPREP. 110pp
[127]Manu and Vi (2009). POPs pesticides in Tonga: DDT and dieldrin. *Tonga POPs Inventory 2006/2007*
[128]Government of Tonga (2009). *National Implementation Plan*. 161pp
[129]Chesher (1984). *Pollution sources survey of the Kingdom of Tonga*. SPREP. 110pp

this site (now the Tonga Timber and Hardware Compound, Tongatapu) in 2011,[130] detected low concentrations of DDT and dieldrin in sediment samples (Table 23). The site of the former MAFF offices in Pangai, Ha'apai were also sampled in 2011 but no pesticides were detected.

DDT has been detected in breast milk monitoring in 2008 in Tonga (Appendix 5). Given the ubiquitous nature of the worldwide distribution of DDT, monitoring of environmental matrices in Tonga for DDT should continue as part of the GMP.

Table 23: DDT and dieldrin concentrations at the former MAFF research station in Tokomololo, Tongatapu (mg/kg dry weight), 2011

Location	Surface sample	Composite 0.5m depth	0.5m depth	0.5m depth	0.5m depth
Analyte					
4,4'-DDD	0.015				
2,4-DDE	0.018			0.25	0.39
4,4'-DDE	0.66	0.186	0.119		
2,4'-DDT	0.039	0.012		0.025	0.013
4,4'-DDT	0.38	0.065	0.018	0.097	0.041
Dieldrin	0.013			0.047	

2.3.8 Assessment of Perfluorooctane sulfonic acids, its salts and perfluorooctane sulfonyl fluoride (Annex B, Part III)

Perfluorooctane sulfonic acids (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOS-F) are industrial chemicals widely used in electrical and electronic parts, fire-fighting foam, medical imaging (principally X-ray photography), hydraulic fluids, toners and printing inks, coatings and coating additives, and in textiles and upholstery for their water and oil repellent properties. They are also the unintended degradation product of certain chemicals. The current global production of PFOS is estimated at 200 tonnes/year,[131], none of which occurs in Tonga. However, PFOS-related substances may be present in imported products, including fire-fighting equipment and foams (in particular aqueous film forming foam, AFFF), and aviation hydraulic fluid.

PFOS along with its salts and PFOS-related compounds, were added to Annex B of the Stockholm Convention in May 2009. This requires countries to act to "restrict the production and use" of these chemicals. At COP9 in May 2019, the list of specific exemptions was reduced to the production and use in metal plating (hard-metal plating) only in closed-loop systems and in firefighting foam for liquid fuel vapour suppression and liquid fuel fires (Class B fires) in installed systems, including both mobile and fixed systems and, the list of acceptable purposes was reduced to the production and use for insect baits with sulfluramid (CAS No. 4151-50-2) as an active ingredient for control of leaf-cutting ants from *Atta* spp. and *Acromyrmex* spp. for agricultural use only. Alternatives to PFOS-containing foam should be used "where available, feasible and efficient". Moreover, each Party that has registered for an exemption pursuant to Article 4 for the use of PFOS, its salts and PFOSF for fire-fighting foam shall: (a) ensure that

[130]SPREP (2012). *Final Report: Capacity Building for the Implementation of Multi-lateral Environmental Agreements in ACP Countries (FAO Component on Pesticide Risk Reduction: Components 2 and 3).* 3pp.
[131]UNEP (2017). *Guidance for the inventory of perfluorooctane sulfonic acid (PFOS) and related chemicals listed under the Stockholm Convention on Persistent Organic Pollutants.* 125 pp

fire-fighting foam that contains or may contain PFOS, its salts and PFOSF shall not be exported or imported except for the purpose of environmentally sound disposal; (b) not use fire-fighting foam that contains or may contain PFOS, its salts and PFOSF for training; (c) not use fire-fighting foam that contains or may contain PFOS, its salts and PFOSF for testing unless all releases are contained; (d) by the end of 2022, if it has the capacity to do so, restrict uses of fire-fighting foam that contains or may contain PFOS, its salts and PFOSF to sites where all releases can be contained; (e) make determined efforts designed to lead to the environmentally sound management of fire-fighting foam stockpiles and wastes that contain or may contain PFOS, its salts and PFOSF.

The Tonga Airport Corporation operates 3 fire suppression tankers (two 1200-litre AFFF airfield suppression tankers donated by New Zealand and a smaller German made tanker containing 725 litres of AFFF). The airport fire service also has in reserve 5000 litres of AFFF contained in 200-litre drums stored at the fire station (Table 24). AFFF is retained for incidents at the airport or the fuel storage depots and has a shelf-life of 10 years. The airport fire service conducts regular training using water. No foam is used in training exercises.

Table 24. AFFF repositories (Danfo Fomtec and Kerr Fire), Tonga (2019)

Foam Specifications	Total	Pacific Energy	Urban Fire Service	Aviation Fire Service
Product Name	AFFF 3% Ultra	Unknown	Unknown	FilmFoam 916 6% AFFF
Manufacturer	Danfo Fomtec	Unknown	Unknown	Kerr Fire
Contains PFOS/PFOA	No[132]	Unknown	Unknown	No[133]
Product website	www.formtec.com			http://kerrfire.co.uk/
Quantity Held (lts)	6000	Not provided	25	5000
Quantity in tankers (litres)	NA	NA	0	1925
Date manufactured	16/01/2017		unknown	2011-2019
Batch No	170301			110-06/01/Q
Shelf life	10 years			10 years
Quantity used in training exercises	10-20 lts, although most training exercises use only water		0	NA
Location of training	Bunded area around tank farm	Tank farm	Total tank farm	Airfield
Frequency of training	Monthly	Annual	Infrequent	Daily

The foam stored by the airport fire service is Foamfilm (c6) 916 AFFF Foam Liquid Concentrate (Active ingredient 2-(2-butoxyethoxy)ethanol CAS No.112-34-5)[134] and is diluted at 6% with fresh or saline water prior to use. Foam was purchased between 2011 and 2019 and stocks held were manufactured by Kerr Fire Fighting Chemicals, Liverpool (http://kerrfire.co.uk/), and have a shelf life of at least 10 years.[135] A description of the foam is attached at Annex 6. It does not contain PFOS or any longer chain PFAS, but it does contain "Fluorinated Surfactants", which should not be sprayed on the ground as these are persistent.[136]

[132]See Appendix 6, this document
[133]See Appendix 7, this document
[134]Kerr Fire: FilmfoamC6 916 AFFF 6%
[135]Kerr Fire: FilmfoamC6 916 Safety Data Sheet
[136]Government of the Cook Islands (2019). *National Implementation Plan*.

Similarly, TOTAL (Tonga) also holds stockpiles of AFFF and also routinely trains in their use. The AFFF (Danfo Fomtec) held by this bulk fuel importer does not contain PFAS/PFOA (Table 24). The Urban Fire Service hold 25 litres of unidentified AFFF. They have been instructed to return it to TOTAL for disposal. As AFFF typically has a shelf-life of 10 years, older stocks may need to be appropriately disposed of in 2021. There is no current support for the disposal of expired AFFF in Tonga.

Data on AFFF held by Pacific Energy, the second bulk fuel importer located in Tonga was not available at the time of the Tongan inventory.

2.3.9 Assessment of the Releases of unintentionally produced chemicals (uPOPs) (Annex C)

UPOPs are formed as the result of reaction between organic molecules and chlorine, often as a result of thermal processes or as by-products in chemical manufacturing. The uPOPs listed under the Stockholm Convention are:

- polychlorinated dibenzo-p-dioxins (dioxins) and dibenzo-furans (furans);
- hexachlorobenzene (HCB);
- hexachlorobutadiene (HCBD);
- polychlorinated biphenyls (PCBs);
- pentachlorobenzene (PeCB); and
- polychlorinated naphthalenes (PCNs).

Under the Stockholm Convention, Parties must take measures to reduce the unintentional release of these chemicals, with the goal of continuous minimisation and, where feasible, ultimate elimination. It should be noted that dioxins and furans are indicative of the presence of other uPOPs and are considered to constitute a sufficient basis for identifying and prioritizing sources of all uPOPs, and for devising control measures for all Annex C POPs. This means that efforts to address dioxins and furans under this uPOPs Action Plans will be deemed sufficient to address all Annex C POPs.

2.3.9.1 Description of the uPOPs[137]

2.3.9.1.1 Hexachlorobenzene (HCB)

HCB has been used as a pesticide to protect the seeds of onions and grains against fungus, in wood preservation, and in the production of fireworks, ammunition, rubber, aluminium and dyes. In high doses, HCB is lethal to some animals and, at lower concentrations, can adversely affect their reproductive success. HCB has been found in food of all types.

2.3.9.1.2 Hexachlorobutadiene (HCBD)

HCBD was used for a variety of purposes including as a pesticide, fungicide, a solvent, heat transfer fluid, and hydraulic fluid. It is unintentionally formed as the by-product of several chemical processes, and during incineration of wastes containing high chlorine content. The United States Environmental Protection Agency has classified HCBD as a possible human carcinogen.

[137]UNEP. (2013). *Toolkit for identification and quantification of releases of dioxins, furans and other unintentional POPs under Article 5 of the Stockholm Convention, January 2013*. Geneva, Switzerland: UNEP Chemicals.

2.3.9.1.3 Pentachlorobenzene (PeCB)

PeCB was used in polychlorinated biphenyl (PCB) products, in dyestuff carriers, and as a fungicide and a flame retardant. It is also produced unintentionally during combustion, and in thermal and industrial processes. In the environment, PeCB is moderately toxic to humans and very toxic to aquatic organisms.

2.3.9.1.4 Polychlorinated biphenyls (PCBs)

PCBs are used in industry as heat exchange fluids, in electric transformers and capacitors, and as additives in paint, carbonless copy paper, and plastics. There are 209 different types of PCBs, of which 13 are of concern. PCBs are toxic to fish and are linked to reproductive failure and suppression of the immune system in various wild animals. PCBs also suppress the human immune system and are listed as probable human carcinogens.

2.3.9.1.5 Polychlorinated dibenzo-p-dioxins (PCDDs or dioxins)

Dioxins are produced unintentionally during incomplete combustion of healthcare waste, domestic and municipal waste, and hazardous waste, during paper manufacture using chlorine bleaching, and from automobile emissions, and peat, coal, and wood combustion, including forest fires. There are 75 different dioxins, of which seven are of concern. Dioxins are classified as possible human carcinogens and have been associated with several adverse effects in humans, including immune and enzyme disorders and chloracne. Laboratory animals given dioxins suffered a variety of effects, including an increase in birth defects and stillbirths. Fish exposed to dioxins died shortly after the exposure ended. Food (particularly that derived from animals) is the major source of exposure for humans.

2.3.9.1.6 Polychlorinated di-benzofurans (PCDFs or furans)

Furans are closely related to dioxins and are produced unintentionally from many of the same processes that produce dioxins. They have been detected in emissions from waste incinerators and automobiles. Although structurally similar to dioxins and sharing many of their toxic effects, Furans are typically much less toxic than dioxins. There are 135 different types, and their toxicity varies. Furans persist in the environment for long periods and are classified as possible human carcinogens. Food, particularly animal products, is the major source of exposure for humans. Furans have also been detected in breast-fed infants.

2.3.9.1.7 Polychlorinated naphthalenes (PCNs)

PCNs include up to 75 different compounds and have been historically used as wood preservatives, paints and engine oils additives, heat exchange fluids, in capacitors and for cable insulation, and a range of other uses. While the use of PCN has ceased, they are also present in PCB formulations and more significantly, they are unintentionally produced during combustion processes. Many PCNs persist in the environment, and acute exposure causes chloracne. Chronic exposure increases the risk of liver disease and is suspected of increasing cancer risks.

2.3.9.2 Sources of POPs in Tonga

There are a number of potential sources of uPOPs emissions in Tonga (Table 25). Estimates of the releases of uPOPs from these sources were first derived in 2006 (Table 26). This was recalculated in 2019 (Table 27) using the 2013 UNEP Toolkit and repeated again in 2019 using the 2013 UNEP Toolkit and activity data derived from contemporary desktop reviews and on ground investigations (Table 28).

Table 25. Potential priority sources of uPOPs emissions in Tonga

Source category	Activity
Waste incineration	• Municipal waste incineration • Quarantine waste incineration • Medical waste incineration • Waste wood & biomass incineration
Metal production	• Not applicable
Heat & power generation	• Diesel generators • Domestic heating (biomass)
Production of mineral products	• Not applicable
Transport	• 2- & 4-Stroke petrol engines • Diesel engines
Open burning processes	• Waste dump burning • Accidental house fires • Domestic waste burning • Domestic cooking (biomass) • Agricultural burning
Miscellaneous	• Tobacco smoking • Wood burning for copra production • Fish smokehouses
Disposal & landfills	• Landfill hazardous wastes • Landfill mixed wastes • Landfill domestic wastes • Sewage disposal • Composting • Waste oil disposal
Contaminated sites & hotspots	• Accidental fires • PCB containing equipment • Waste incinerator operation sites • Dumpsites

Table 26. Tonga uPOPs estimated emissions summary (2006)[138]

Group	Source Groups	Annual Releases (g TEQ/a)				
		Air	Water	Land	Product	Residue
1	Waste Incineration	0.418	0.000	0.000	0.000	0.000
2	Metal Production	0.980	0.000	0.000	0.000	0.000
3	Heat and Power Generation	0.079	0.000	0.000	0.000	0.000
4	Production of Mineral Products	0.005	0.000	0.000	0.000	0.000
5	Transportation	0.005	0.000	0.000	0.000	0.000
6	Open Burning Processes	20.452	0.000	0.033	0.000	3.200
7	Production of Chemicals and Consumer Goods	0.000	0.000	0.000	0.000	0.000
8	Miscellaneous	0.000	0.000	0.000	0.000	0.000
9	Disposal	0.000	0.224	0.000	0.000	0.000
10	Potential Hot Spots				0.000	
1-10	**Total**	**21.100**	**0.224**	**0.033**	**0.000**	**3.200**
	Grand Total	**24.5**				

[138]Government of Tonga (2008). *National Implementation Plan*. 103pp

Table 27. Recalculation of Tonga uPOPs estimated emissions summary (2006) calculated using the 2013 Toolkit[139]

Group	Source Groups	Annual Releases (g TEQ/a)				
		Air	Water	Land	Product	Residue
1	Waste Incineration	0.418	0.000	0.000	0.000	0.002
2	Metal Production	0.230	0.000	0.000	0.000	0.005
3	Heat and Power Generation	0.079	0.000	0.000	0.000	0.000
4	Production of Mineral Products	0.005	0.000	0.000	0.000	0.000
5	Transportation	0.005	0.000	0.000	0.000	0.000
6	Open Burning Processes	5.883	0.000	0.217	0.000	3.200
7	Production of Chemicals and Consumer Goods	0.000	0.000	0.000	0.000	0.000
8	Miscellaneous	0.000	0.000	0.000	0.000	0.000
9	Disposal	0.000	0.224	0.000	0.022	0.000
10	Potential Hot Spots				0.000	
1-10	**Total**	**6.620**	**0.000**	**0.217**	**0.022**	**0.007**
	Grand Total	**7**				

Table 28. Tonga estimated uPOPs emissions summary (2019)

Group	Source Groups	Annual Releases (g TEQ/a)				
		Air	Water	Land	Product	Residue
1	Waste Incineration	0.6	0.0	0.0	0.0	0.0
2	Metal Production	0.0	0.0	0.0	0.0	0.0
3	Heat and Power Generation	0.1	0.0	0.0	0.0	0.0
4	Production of Mineral Products	0.0	0.0	0.0	0.0	0.0
5	Transportation	0.0	0.0	0.0	0.0	0.0
6	Open Burning Processes	0.5	0.0	0.1	0.0	0.0
7	Production of Chemicals and Consumer Goods	0.0	0.0	0.0	0.0	0.0
8	Miscellaneous	0.0	0.0	0.0	0.0	0.0
9	Disposal	0.0	0.0	0.0	0.0	0.0
10	Potential Hot-Spots				0.0	0.0
1-10	**Total**	**1.3**	**0.0**	**0.1**	**0.3**	**0.0**
	Grand Total	**2.0**				

[139]Government of Tonga (2008). *National Implementation Plan*. 103pp

2.3.9.3 Comparison of uPOPs inventories

Total uPOPs emissions for Tonga were calculated to be 24.5g TEQ/a in 2006. The 2006 inventory was recalculated using the 2013 Toolkit which reduced this original estimate of uPOPs significantly to 7g TEQ/a. This can be directly compared with the 2018 emission estimation of 2g TEQ/a. Open burning was the primary source of the uPOPs emissions reported in 2006 compared with (medical) waste incineration in 2019. Regular waste collection services are now (2019) in operation on the two most populated Tongan islands (Tongatapu and Vava'u), and this has significantly reduced the amount of open burning practiced in the community. Scrap wire is no longer reported to be burnt to harvest copper, which has also resulted in a small reduction in national uPOPs emissions.

2.3.9.3.1 Waste Incineration

Poor management of hazardous healthcare waste (including syringes, live vaccines and cultures, laboratory samples, body parts and fluids, and sharps) poses occupational and public health risks to patients, health workers, waste handlers, waste transporters and communities.[140] In addition, healthcare waste disposal via low temperature incineration is estimated to be the second largest contributor to Pacific uPOPs releases, accounting for 17% of the emissions reported by PICs in their NIPs.

Healthcare waste can contain high concentrations of organic (polyvinyl chloride and specific pharmaceuticals) and inorganic (saline solution and body fluids) chlorine that may alter combustion characteristics and enhance PCDD/PCDF formation in lower temperature burns. Under these conditions, stack emissions can include both "conventional" pollutants such as particulate matter, sulfur oxides, nitrogen oxides, volatile organic compounds and carbon monoxide, as well as dioxins and furans. The incinerator ash will also usually contain dioxins, furans and heavy metals. Progressive installation and enforcement of best available technology (BAT) for healthcare waste destruction (i.e. double incinerator chamber, and 850-1100°C incineration) is essential to minimise formation of dioxins and furans from this source.

The MoH is responsible for the collection, storage, transfer, treatment, and disposal of healthcare waste in Tonga. There are four major hospitals in Tonga. Only one of these (Vaiola Hospital, Tongatapu) currently incinerates waste using high temperature incineration. The other three hospitals dispose of healthcare wastes at the landfill. A PacWaste survey undertaken in 2014 determined that around 1,000 kg of healthcare waste was generated by the Vaiola Hospital per month.[141] However, more recent data indicates that an average of 358 kg of healthcare waste were produced and incinerated weekly by the Vaiola Hospital in 2018. It is likely that around 16,000 kg of healthcare waste is currently incinerated per annum using low temperature incineration in the outer Tongan islands (Table 29).

Table 29: Summary of Tonga's healthcare waste generation

Hospital	Location	Healthcare waste generation (kg/year)	Waste disposal mechanism
Vaiola Hospital	Tongatapu	18,600	High temperature incineration
Prince Ngu Hospital	Vava'u	9,880	Low temperature incineration (at landfill)
Niu'eiki Hospital	'Eua	676	Low temperature incineration (at landfill)
Niu'ui Hospital	Ha'apai	5,460	Low temperature incineration (at landfill)

[140]SPREP (2013). *Pacific health care waste: A regional management strategy and action plan 2013-2015*. SPREP, Apia, Samoa.
[141]ENVIRON Australia Pty Ltd (2014). *Baseline Study for the Pacific Hazardous Waste Management Project - Healthcare Waste Tonga.* 65pp

2.3.9.3.2 Heat and Power Generation

Use of conventional fuel sources for power generation and heating results in emissions of uPOPs (primarily to the air) from a range of sources including fossil fuel power plants; household cooking with biomass (wood, coconut husks/shells); and from household cooking with fossil fuels (gas). Overall, uPOPs emissions from heat and power generation sources contribute approximately 10% of the total uPOPs emissions reported from Pacific Islands.

2.3.9.3.2.1 Power generation

Tonga remains dependent on the use of fossil fuel (diesel) to generate the bulk (>90%) of its electricity. In doing so it consumed almost 16M litres of diesel fuel in 2018 (Table 30). It is expected that diesel fuel consumption for electricity generation will decrease in the future as Tonga approaches a 50% solar power generation target. UPOPs generation from diesel generation of electricity is included in transportation uPOPs calculations.

Table 30: Summary of Tonga's electrical energy generation fuel sources (2018)[142]

Location	Annual Diesel Consumption (Lts)	Diesel Energy Production (KwHrs)	Renewable Energy Production (KwHrs)	Number of Customers
Tongatapu	13,430,664	60,600,878	5,620,960	
Vava'u	1,636,795	6,505,466	351,181	
Ha'apai	396,397	1,862,645	450,511	
Eua	390,530	1,584,137	156,289	
Total	**15,850,000**	**70,553,126**	**6,165,000**	**23,561**

2.3.9.3.2.2 Gas cooking

Most households (84%) rely on gas or electricity for cooking in Tongatapu, although the traditional *Umu* is still carried out by most families each week. In 2017 and 2018, 2,069,613 litres and 2,832,236 litres of LPG respectively were imported into Tonga for domestic cooking. In 2018, LPG combustion for household cooking created 70.805 TJ of energy.

2.3.9.3.2.3 Wood cooking

It is estimated that each Tongatapu household uses approximately 40kg of firewood per week for cooking. On the outer islands, approximately 55% of all households use gas or electricity for cooking, but also use wood for the weekly family *Umu* (Table 31). It is estimated that 96,000 tonnes of firewood are used annually for cooking, generating 1,344 TJ of Heat.[143]

Table 31: Summary of estimation of Tonga's wood consumption for cooking[144]

Location	Number of households	Estimated annual wood consumption (tonnes/household)	Annual wood consumption for cooking (tonnes)
Tongatapu	12,953	2.1	26,942
Outer islands	5,053	8.3	69,092
Total	**18,005**		**96,034**

[142]Steven Esau, TPL personal communication
[143]UNEP. (2013). *Toolkit for identification and quantification of releases of dioxins, furans and other unintentional POPs under Article 5 of the Stockholm Convention, January 2013*. Geneva, Switzerland: UNEP Chemicals.
[144]Government of Tonga (2016). *2016 Census*

2.3.9.3.3 Transportation

UPOPs emissions from transport (road and off-road vehicles) result from incomplete combustion of fuel in engines. The presence of dioxins in car exhaust was first reported in 1978, although the exact magnitude of dioxin in vehicles emissions remains uncertain. Worldwide, motor vehicle emissions can account for up to 12% of total national annual national dioxin emissions. The levels of dioxins and furans in exhaust gases emitted from vehicles depend on many factors including the type of engine, its maintenance condition and age, technologies of emission reduction applied (catalysts), type and quality of fuel (gasoline, diesel, heavy fuel oil, biofuel), driving conditions, and ambient conditions.[145] Based on the available data, uPOPs emissions from transportation comprise about 0.1% of total reported emissions, or 115 mg TEQ/year in the Pacific. Approximately 29.22M litres of diesel and 26.52M litres of unleaded petrol were imported into Tonga in 2018 for transportation and electrical generation purposes (Table 32).

Table 32: Summary of Tonga's fuel imports (2015-2018)

Fuel type	Imported 2015	Imported 2016	Imported 2017	Imported 2018
Unleaded Fuel (L)	17,314,611	20,620,830	21,978,699	26,516,686
Diesel (L)	28,419,660	33,244,420	30,589,405	29,224,237
LP Gas (L)	1,691,579	2,045,326	2,069,613	2,832,236

2.3.9.3.4 Open Burning

Open burning is the largest contributor to uPOPs emissions in the Pacific, contributing around 63% of the total reported emissions.[146] Open burning includes uncontrolled burning of biomass (forests, grasslands, and agricultural crop residues including sugarcane which may or may not have been treated with pesticides); and waste (mainly domestic or municipal solid waste burned in landfills, dumps, backyards, public spaces). The resulting uPOPs are primarily released directly to air and land, with indirect releases to water if rainfall washes away the uPOPs contaminated ash particles into receiving waters. Fires on open dumpsites and burning (in backyards and public spaces) are still common occurrences in the Pacific, especially in areas that lack access to reliable waste collection services.

2.3.9.3.4.1 Domestic open burning

Twenty five percent (4,556) of Tonga's 18,005 households reported using open burning to dispose of household rubbish in 2015 (Table 33).[147] Since then, regular rubbish collection services have commenced throughout Tongatapu and in Vava'u, and this is likely to have significantly decreased the amount of rubbish being burnt in Tonga to around 3,900 tonnes per annum (Table 34).

[145]UNEP (2012). *Toolkit for Identification and Quantification of Dioxins and Furans and Other Unintentional POPs*
[146]Richards (2015). *Pacific Regional Action Plan to Reduce Unintentional Persistent Organic Pollutants*. 34pp
[147]Government of Tonga (2016). *2016 Census*

Table 33: Summary of Tongan household waste disposal practices (2015)[148]

Disposal Method	Tongatapu	Vava'u	Ha'apai	'Eua	Total
Dumpsite (collected)	11,722	596	19	20	12,358
Dumpsite (not collected)	240	354	52	95	749
Open Burning	**786**	**1,695**	**1,056**	**759**	**4,556**
Compost	75	36	25	8	148
Bury	123	31	26	2	182
Other	7	3	1	1	12
Total	12,953	2,715	1,179	885	18,005

Table 34: Comparison of Tonga's domestic burning of waste (2015 and 2018)[149]

Waste disposal method	No. of house-holds (2015)	No. of house-holds (2018)	Waste generation (kg/person/day)	No. of people (2015)	No. of people (2018)	Mass of waste combusted (2015, tonnes)	Mass of waste combusted (2018, tonnes)
Non-incineration	13,449	15,404	0.6	73,969	84,722	0	**0**
Incineration	4,556	2,601	0.75*	25,058	14,305	6,860	**3,916**

*Rural rubbish generation rates are estimated to be 25% higher than urban rubbish generation rates[150]

2.3.9.3.4.2 Landfill open burning

Accidental fires at the rubbish dump in Tukutonga were common until 2006 with the construction of the Tapuhia sanitary landfill located 1.5km northwest of Vaini.[151] Improved management and resourced with the heavy equipment needed to properly compact and cover landfill waste, only one landfill fire has occurred since its commissioning (a 10-day fire that ignited at the landfill in December 2016). This has resulted in a huge reduction in the amount of uPOPs released into the air since 2006.

2.3.9.3.4.3 Agricultural burning

Subsistence and semi-commercial agriculture undertaken in Tonga is based around small bush allotments of 3.6 ha (8 acres).[152] Allotments are generally initially cultivated by tractor pulled ploughs after either application of a knockdown herbicide, fire or both. Some farmers plough all vegetation into the soil directly. Farmers who cannot afford contract ploughing use fire and hand cultivation which generally occurs over smaller areas. Post-ploughing cultivation is generally undertaken by hand with areas of dead grass accumulation removed by fire. It is estimated that 11,700 tonnes of vegetation are burnt annually by agricultural operations in Tonga (Table 35). It has been observed that in recent years more agricultural land is left fallow in any one year (50% of agricultural land) as people move to the city or overseas instead of continuing traditional farming. This partially explains the decrease in agricultural burning (Interview with Nishi Trading) rather than assuming a move to sustainable (non-burning) practices.

[148] Government of Tonga (2016). *2016 Census*
[149] Government of Tonga (2016). *2016 Census*
[150] Lea, Vi and Heimuli (2006). *Landfill fires, house, vehicles and domestic waste burning. Tonga POPs inventory 2006/2007.*
[151] Government of Tonga (2009). *Tonga enabling activities for the development of a national implementation plan for the Stockholm Convention on persistent organic pollutants: Draft National Implementation Plan*. 156 pp.
[152] SPREP (2017). *Pesticide Container Management in the Pacific Tonga Feasibility Study and Integrated Waste Management Strategy for Pesticide Containers*. GHD. 104 pp.

Table 35: Summary of Tonga's agricultural burning (2016)

	Total Area (acres)	% Area	Dry matter (t/ha/year)[153]	Burnt biomass (dry matter tonne/year)
Total	66,202	100		
Fallow (long-term)	33,717	51	4.8	
Annual cropping	23,999	36	1.2	11,663
Pasture	4,858	7	>6.3	
Perennial cropping	3,207	5		
Livestock	421	1		

2.3.9.3.4.4 House and Car Fires

Approximately 100 house and car fires occur per year in Tonga.[154] There are no estimates available of the quantity of materials burnt in these fires, so they are not included in uPOPs calculations.

2.3.9.3.5 Public cigarette and cigar smoking

Total reported emissions of dioxins from sources including drying of biomass, crematoria, smoke houses, dry cleaning residues, and tobacco smoking account for 171 mg TEQ/year, or 0.2% of the total reported dioxin emissions from Pacific Island countries. Tobacco leaf naturally contains both organic carbon and chloride ions (regardless of the presence or absence of pesticide residues or chemical/flavouring additives in the tobacco) and consequently, as for any thermal process, smoking of cigarettes and cigars produces dioxins.

Emissions from popular cigarette brands are estimated at 0.1–1.0 pg I-TEQ/cigarette.[155,156] Cigars are estimated to release higher dioxin emission of approximately 0.3 pg I-TEQ. Essentially, this means that dioxin intake from smoking could be up to one third of that coming from food, and smokers are likely to have a measurably elevated dioxin intake compared to non-smokers. Non-smokers are also likely to be exposed to dioxins from passive intake of cigarette smoke. Smokers also place themselves at significant health risk from the many other toxic and carcinogenic components present in cigarette smoke.

Tonga customs data for tobacco imports is presented in Table 36. Based on this data, it is estimated that tobacco from over 65,137,000 cigarettes was imported into Tonga over a two-year (2017-2018) period and smoking of this represents a significant public health risk.

Table 36. Tonga tobacco import data (2017-2018)

	2017		2018	
	Weight (kg)	Number	Weight (kg)	Number
Cigarettes	36,057	36,057,000	29,080	29,080,000
Tobacco	0		7	
TOTAL (kg)	**36,057**		**29,087**	

[153]Palm *et al*. (1996). Soil biological dynamics in slash and burn agriculture. *Agriculture, Ecosystems and Environment,* 58:61-74
[154]Tonga Fire department, pers comm.
[155]Ball M., Päpke O. & Lis A. (1990). Polychlordibenzodioxine und Polychlordibenzofurane in Zigarettenrauch. *Beitr Tabakforsch Int* 14: 393–402
[156]Löfroth G & Zebühr L (1992). Polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) in mainstream and sidestream cigarette smoke. *Bull Environ Contam Toxicol* 48: 789-94.

2.3.9.3.6 Waste disposal

Waste disposal is not a source of uPOPs, but rather a pathway whereby uPOPs from other sources already present in waste becomes concentrated and is released to air, water and land.[157] Based on the available data, waste disposal and landfilling contribute approximately 9% of the total reported uPOPs releases in Pacific island countries.

Waste disposal to land is the predominant method of solid waste disposal in Tonga. It is particularly important that waste management practices are implemented to ensure that polystyrene packaging and building materials, leather, fabric, upholstery and carpets, floor polish, photographic film, denture cleaners, shampoos, paints, and carpet cleaners and fire-fighting foams are temporarily stored and disposed of safely. This will help ensure that wastes potentially containing uPOPs, POP-PBDEs, HBCD and PFOS are contained and safely managed.

Limited sampling of soil collected from the Tukutonga dumpsite in 2006 following its decommissioning indicated that low levels of a range of POPs (including PCBs, dioxins and PBDEs) were detectable.[158] The dumpsite operated since the mid-1920s and was subject to frequent unintentional fires.

2.3.9.3.7 Composting

Waste generation rates in Tonga are not accurately known but have been estimated to be between 5,000 and 18,000 tonnes per year. Past data indicates that around 30–50% of this waste is green matter,[159] producing up to 6,000 tonnes of compost per year.

2.3.9.3.8 Sewage discharges

An average of 4.8M litres of septic effluent is disposed of per annum at the Tapuhia sanitary landfill,[160] although this figure can range between 2.4 and 7.3M litres of septic effluent per year.[161]. Two septic sludge tankers are operated by WAL, delivering collected septic effluent to the drying beds located at the Tapuhia landfill facility.

2.3.9.3.9 Used oil

Two major companies (TOTAL and Pacific Energy) supply lubricating and hydraulic oil to Tonga. The quantity of lubricating oil imported into Tonga each year is unknown, but was estimated as 450,000L per year in 2014.[162] Pacific Energy offers a used oil take-back service for its retail customers and exports around 10,000L of used oil per month to Fiji, depending on local shipping schedules. The used oil is transferred in IBCs and shipped on its local trading vessel. Assuming that 50% of new oil volumes create used oil, approximately 110 tonnes of used oil is generated per annum.[163]

2.3.9.4 Improved management of e-waste

E-waste is made from sophisticated blends of plastics, metals, and other materials and may contain a range of hazardous substances including heavy metals (such as mercury, cadmium and lead), Brominated Flame Retardants (BFRs, including those that are listed under the Stockholm Convention) and other substances. Consequently, planned management and disposal of e-waste in Tonga is important for the maintenance of long-term community and

[157]UNEP (2012). *Toolkit for Identification and Quantification of Dioxins and Furans and Other Unintentional POPs. 445pp*
[158]Vi *et al.* (2009). *Assessing the levels of dioxins and furans, dioxin like PCBs and PBDE in Tukutonga Garbage Dump*. 8pp.
[159]https://www.adb.org/sites/default/files/publication/42660/solid-waste-management-tonga.pdf
[160]WAL data, June 2018-Oct 2019
[161]Neil Jenkin, Landfill Operations Manager, Pers Comms.
[162]Golder Associates (2014) *Contemporary used oil audit, Tonga*. SPREP. 18pp.
[163]http://convert-to.com/628/used-old-dirty-15w-60-motor-engine-oil-conversion.html

environmental health. The e-wastes of concern are those items containing a significant portion of circuit boards, or with external cases that may contain brominated flame retardants (POP-PBDEs and HBCD) such as television and computer housings. It is critical that e-waste is not burnt to prevent production of uPOPs.

National e-waste generation rates are increasing rapidly due to the introduction of televisions, computers and mobile phones. These items are technically straightforward to recycle, but the challenge is initially collecting them for export. This will require a dedicated system targeted at e-waste management, and a clear pathway to communicate to the public that e-waste should be recycled. No shredding of plastic cases or circuit boards or burning of cables to remove insulation must take place, so to minimise releases of uPOPs from the recycling operations. BFRs, typically of the POP-PBDE class of chemicals, should not be widespread in electronic consumer goods imported into Tonga. Furthermore, equipment compliant with the European Union Directive on Restriction of Hazardous Substances in Electrical and Electronic Equipment should not contain BFRs, and this is likely the case with e-waste that might be collected in the future in Tonga.

2.3.9.5 National frameworks implemented by trained and empowered officials

A number of high-level strategies which explicitly address uPOPs management are required to successfully reduce uPOPs emissions at the national level. This includes development and enforcement of national policies, strategies, plans and legislation, and strengthening of institutional arrangements to support and promote best practice waste management, including uPOPs emission reduction. Regular collection, collation and release of data related to uPOPs management practices is also critical to this process.

2.3.9.6 Improved public awareness and worker safety and training

Implementation of best practice occupational health and safety measures for workers in the waste management sectors, and improved public awareness of the health impacts of uPOPs are priority management initiatives for national uPOPs reduction. This includes dissemination of information about resource recovery programmes that increase e-waste recycling and composting rates. It is also important that open burning of waste continues to be minimised in Tonga through ongoing public education campaigns and continuing green waste collection.

2.3.9.7 Projected uPOPs emissions

Tonga's uPOPs emissions are likely to decrease into the future based on on-going waste management programmes, and other activities being implemented or forecast (Table 37). UPOPs management priorities are summarised in Table 38.

Table 37. Qualitative assessment of projected uPOPs emissions in Tonga post 2019

Source Group	Source Group Description	Likely future trend in uPOPs emissions
1	Waste incineration	Decrease due to improved healthcare waste incineration
2	Metal production	Not relevant to Tonga
3	Heat and Power	Decrease due to attainment of national renewable electricity generation targets
4	Mineral product production	Not relevant to Tonga
5	Transportation	Likely to increase as more motor vehicles are imported into Tonga
6	Open Burning	Decrease in uPOPs emissions likely due to universal public waste collection services in the future
7	Production of consumer and chemical goods	Not relevant to Tonga
8	Miscellaneous	Implementing measures for reductions in smoking rates would decrease uPOPs emissions
9	Disposal	Decrease in uPOPs emissions likely due to improvements in solid, liquid and hazardous waste management anticipated under the NIP
10	Potential Hotspots	Decrease in uPOPs emissions likely due to the identification of potential hot-spots and progressive site safeguarding and remediation

Table 38: Tonga uPOPs management priority summary

No	uPOPs Chemical (listed alphabetically)	Use	Annex	Tonga use or unintentional production	Action required	Chemical use
11	Hexachlorobenzene (HCB)	Pesticide and by product	A & C	None known	uPOPs Management	First introduced in 1945 to treat seeds, HCB kills fungi that affect food crops.
12	Hexachlorobutadiene (HCBD)	Industrial chemical	A & C	None known	uPOPs Management	No longer internationally produced. HCBD was used as intermediate in the chemical industry
17	Pentachlorobenzene (PeCB)	Pesticide and Industrial chemical	A & C	None known	uPOPs Management	No longer internationally produced
19	Polychlorinated biphenyls (PCBs)	Industrial chemical	A & C	Detected in the past in electrical transformers	uPOPs Management	Used as heat exchange fluids, in electric transformers and capacitors
20	Polychlorinated naphthalenes (PCNs)	Industrial chemical	A & C	None known	uPOPs Management and Improved Waste Management	Combustion (primarily waste incineration) is considered the most significant current source. Releases from former uses (PCN or impurities of technical PCB) contained in landfills or old appliances (stockpiles) are plausible but difficult to assess
27	Polychlorinated dibenzo-p-dioxins (PCDDs)	By products	C	Release inventories for dioxins and furans should be updated at least once every 5 years (Article 5)	uPOPs Management	There are 75 different dioxins. These chemicals are produced unintentionally due to incomplete combustion, as well during the manufacture of pesticides
28	Polychlorinated dibenzofurans (PCDFs)	By products	C	Release inventories for dioxins and furans should be updated at least once every 5 years (Article 5)	uPOPs Management	There are 135 different types of furans. These chemicals are produced unintentionally due to incomplete combustion, as well during the manufacture of pesticides

2.3.10 Information on the state of knowledge on stockpiles, contaminated sites and wastes, identification, likely numbers, relevant regulations, guidance, remediation measures, and data on releases from sites

Contaminated sites are believed to be a potential issue in Tonga, although the extent of the problem is yet to be fully determined. The preliminary investigations under the 2008 NIP enabling project and other studies identified a number of potentially contaminated sites, which required full characterisation to assess the actual contamination risk.[164] However, these investigations have not been undertaken. The potentially contaminated sites reported are summarised below.

2.3.10.1 Potentially contaminated site: Tonga Forests Products Ltd Compound, Tokomololo, Tongatapu

Ten thousand litres of copper chrome arsenate (CCA) were imported into Tonga in 2015 for timber treatment by Tonga Forestry Products (formally Tonga Timber and Hardware Ltd).[165] The company produces small, regular quantities of CCA sludge, which it stores on-site in 200 litre plastic drums. CCA was previously disposed of by mixing with concrete and burying, and sludges produced prior to 2000 may have been dumped. Soil samples taken in the past have revealed widespread CCA contamination over an area of approximately 600 square metres.[166] There is currently no disposal option for CCA sludge in Tonga. The site was also used as a pesticide storage warehouse in 1974.[167] Sampling of adjacent soil and ground water failed to detect DDT (<0.001mg/kg). However, repeat sampling of the site completed in 2011 detected DDT (and its metabolites) and dieldrin in low concentrations in soil samples (Table 39).

Table 39: Tongatapu 2011 contaminated site sampling results[168]

POP measured in soil sample	Tonga Forest Products Compound, Tokomololo, Tongatapu (mg/kg dry weight)
4,4'-DDD	0.015
2,4"-DDE	0.018
4,4'-DDE	0.119–0.66
2,4'-DDT	0.012–0.039
4,4'-DDT	0.018–0.38
Dieldrin	0.013–0.047

2.3.10.2 Potentially contaminated site: former Tukutonga dumpsite

The Tukutonga dumpsite operated from the mid-1920s through to its closure in 2006. The dumpsite accepted all wastes including healthcare wastes. The dumpsite was subject to frequent unintentional fires caused by methane build up. Limited sampling of soil collected from the Tukutonga dumpsite in 2006 following its decommissioning indicated that low concentrations of a range of POPs (including PCBs) were detectable (Table 40).[169]

[164]Government of Tonga (2008). *National Implementation Plan*. 103pp
[165]GHD (2017). *Tonga: Feasibility study and integrated waste management strategy for pesticide containers*. 104 p.
[166]SPREP (2003). *Tonga POPs Project Country Plan*. 18 pp.
[167]Government of Tonga (2008). *National Implementation Plan*. 103pp
[168]Haynes (2011). *Final Report: Capacity Building for the Implementation of Multi-lateral Environmental Agreements in ACP Countries (FAO Component on Pesticide Risk Reduction: Components 2 and 3).* SPREP, Apia, Samoa. 3pp
[169]Vi *et al.* (2009). *Assessing the levels of dioxins and furans, dioxin like PCBs and PBDE in Tukutonga Garbage Dump*. 8pp.

Table 40: Tukutonga dumpsite sediment analysis (2006)

Congener	Concentration (pg/g dr wt)
ΣPCDD/PCDF	7,720
OCDF	180
OCDD	2,710
PCB 105	13,400
PCB 118	28,300
ΣPBDE	270
PBDE 47	13
PBDE 209	160

2.3.10.3 Potentially contaminated site: Tapuhia sanitary landfill

A dedicated waste cell located at the southern end of the Tapuhia sanitary landfill is used to dispose of a range of hazardous wastes including asbestos, e-waste, lead acid batteries and used oil. This practice is no longer carried out (except for the disposal of disaster wastes), but no records of past disposal have been maintained and the site is probably contaminated with a range of potentially hazardous materials.

2.3.10.4 Potentially contaminated site: Vava'u Former bulk fuel terminal (waste oil spillage)[170]

The former bulk fuel terminal in Vava'u has been reported as being contaminated with petroleum products.

2.3.11 Future production, use, and releases of POPs – requirements for exemptions

As a country that does not produce chemicals, Tonga has no plans to intentionally produce any of the POPs chemicals. In addition, Tonga does not have any plans to import any of these chemicals for use or release in the country and as such no exemptions are required.

2.3.12 Existing programmes for monitoring releases and environmental and human health impacts, including findings

Tonga participated in the GMP, which analysed POPs in human breast milk in 2008. The results are presented in Table 41. Tonga is currently participating in the second GMP. Samples of parrot fish were collected from the local fish market, local chicken eggs were collected from an outlet of Matalupe Company Ltd., water samples were taken from a groundwater tank used for firefighting practice at the International airport (approx. location: -21.247816, -175.143778), and from a lagoon in Popua (approx. location: -21.155266, -175.162822) for analysis in July 2018. Analysis have been completed (2019) but are still to be interpreted (December 2019). The results of the 2008 survey have not been widely used. It is suggested that sampling of human breast milk, passive air sampling and sampling of local produce for Stockholm Convention listed POPs be undertaken at regular intervals into the future, and the results used to assess national population exposure trends and for public education purposes.

[170] O'Grady (2018). *Regional Distribution and Status of Asbestos-Contaminated Construction Materials and Best Practice Options for its Management in Pacific Island Countries. SPREP. 163p.*

Table 41. Summary of GMP Results for Tonga, 2008[171]

Chemical	Breast Milk (2008) (ng g^{-1} fat)
Aldrin	<LOQ
Chlordane	1.2 (oxychlordane)
Sum of 6 DDTs	716.4
Dieldrin	2.2
Endrin	<LOQ
Heptachlor	<LOQ
HCB	5.7
Sum 2 Heptachlorepoxides (cis+trans)	0.6
Mirex	<LOQ
2,3,7,8 TCDD	0.4
2,3,7,8 TCDF	0.4
Sum 17 PCDDs/Fs	42.4
Sum of 6 PCBs	7.3
Sum of 12 PCBs	1809.4
Toxaphene	<LOQ
Alpha-HBCD	1.5
Gamma-HBCD	0.1
Alpha-HCH	<LOQ
Beta-HCH	1.3
BDE	0.1-15.2
Gamma-HCH	0.5
Endosulphan	<LOQ

<LOQ = less than the limit of quantification; ND = Not Detected

2.3.13 Information, awareness, education, and communication among target groups

Current level of information, awareness, education and communication among target groups; existing systems to communicate such information to the various groups

The POPs in PICs Project and 2008 NIP development were assessed as increasing the general knowledge and awareness of POPs issues in Tonga. This was achieved through information exchange during workshops with communities, businesses, local corporations, women's groups and government ministries; and through the development, production and distribution of an information pamphlet and posters on POPs. The UNEP/GEF-PAS Pacific POPs Release Reduction Project had a component in Tonga, including a successful schools composting programme, and this project could be usefully extended. WAL conducts community education and awareness programmes on improved community waste management and recycling across a number of social media platforms. Additional information about POPs could be easily incorporated into this programme at little additional cost.

The Tonga Department of Environment coordinates an annual Environment Awareness Week to coincide with World Environment Day (5th June). The event includes the display and distribution of POPs brochures and talks with interested teachers and students as well as press releases and TV/Radio awareness programmes. The Environment Department also runs weekly radio programmes on

[171]UNEP (2015). *Global monitoring plan for persistent organic pollutants second regional monitoring report annex Asia-Pacific region*. 134pp.

environmental and pollution issues and has also released a series of television advertisements highlighting environmental issues for the nation.

WAL carries out extensive public education programmes on waste management in Tongatapu and Vava'u. Education programmes to improve awareness and participation rates in recycling programmes associated with waste collection services are due to commence in 2020 after reconstruction of the cyclone damaged Taupuhia sanitary landfill is completed. A major education and training programme is required to improve healthcare workers management of healthcare wastes.

2.3.14 Mechanism to report under Article 15 on measures taken to implement the provisions of the Convention reporting and for information exchange with other Parties to the Convention

Due to the limited technical capacity, Tonga has not sent any reports to the Stockholm Convention Secretariat.[172] Tonga is planning to submit its first report after the submission of this updated NIP. Tonga attends COP meetings where the national status of chemical management is disseminated. A more integrated mechanism to manage Stockholm Convention requirements is required into the future, and this is addressed in Action Plan 1.

2.3.15 Relevant activities of non-governmental stakeholders

Many NGOs and private sector businesses are actively involved in promoting environmental issues nationally and implementing related activities, especially at the local community level. Many provide opportunities for children, youth and community members to engage in environmental discussions and actions. Those NGOs with specific interests relevant to POPs and/or hazardous chemicals generally include: The Association of Tonga University Women in the Region; Methodist Women Regional Conference; *Langafonua 'a Fafine* Tonga; Tonga Research Association; Tonga National Youth Congress; Tonga Family Health Association; Tonga Association of Non- Government Organisation; Tonga Chamber of Commerce; and the Tonga Trust.

2.3.16 Overview of technical infrastructure for technical infrastructure for POPs assessment, measurement, analysis, alternatives and prevention measures, research and development – linkage to international programmes and projects

Tonga has no suitable laboratory that can test for POPs. Water quality analyses are undertaken at the Tonga Geological Division in small-scale laboratories. Analytical facilities for POPs are available in Hawaii, Australia or New Zealand. It is recommended that a small facility be established to manage sampling, packaging and offshore shipment of collected POPs samples. On-going training should be provided to a selected number of officers with an appropriate background to help build the national basis of pesticide and industrial POPs monitoring expertise in the country. Tonga should continue to engage and participate in the GMP.

2.3.17 Overview of technical infrastructure for POPs management and destruction

There is currently no infrastructure to manage and destroy POPs in Tonga. All materials requiring future disposal or destruction would need to be shipped to Hawaii, Australia or New Zealand.

[172]http://ers.pops.int/eRSodataReports2/ReportSC_Submit_Status.html

2.3.18 Identification of impacted populations or environments, estimated scale and magnitude of threats to public health and environmental quality, and social implications for workers and local communities

The potential threat posed to Tonga from POPs is expected to be extremely low due to the absence of these chemicals on the island. Any reduction in open burning of wastes and in public cigarette smoking rates would reduce this exposure still further.

2.3.19 Details of any relevant system for the assessment and listing of new chemicals

The Pesticide Act (2002) prohibits the supply, sale, or use any pesticide in Tonga which is not registered under the Act. The Act also establishes the Office of Registrar of Pesticides that is responsible for the registration of pesticides and who keeps a Register of Pesticides (name, their chemical names and concentration of active ingredients, the name and place of business of the manufacturer, and the name and place of the business of the importer). The Registrar determines the conditions of use of any pesticide and issue guidelines for the storage, distribution, use and disposal of pesticides in the Kingdom, and may list any pesticide as a banned pesticide.

The Environment Management Act (2010) prohibits any person from manufacturing, producing, storing, importing or using any regulated persistent organic pollutant in the Kingdom, unless the manufacture, production, storage or use is in accordance with the NIP and the requirements of the Stockholm Convention.

2.3.20 Details of any relevant system for the assessment and regulation of chemicals already in the market

The Pesticide Act (2002) prohibits the supply, sale, or use any pesticide in Tonga which is not registered under the Act. The Act also establishes the Office of Registrar of Pesticides that is responsible for the registration of pesticides. The Environment Management Act (2010) prohibits the manufacture, import or use any regulated persistent organic pollutant in the Kingdom, unless the manufacture, production, storage or use is in accordance with the National Implementation Plan and the requirements of the Stockholm Convention. The Hazardous Wastes and Chemicals Act (2010) prohibits the manufacture, produce, import or use any prohibited persistent organic pollutant in the Kingdom;

2.4 Implementation Status

Tonga developed its first NIP in 2008 to address management of the 12 initial POPs.[173] This current NIP represents the first update to the initial NIP, and it covers the 28 POPs chemicals listed under the Stockholm Convention as of 2017. Table 42 presents the progress made since 2008 in completing original NIP Action Plan programmes.

[173]Government of Tonga (2008). *National Implementation Plan*. 103pp

Table 42. National progress summary (2009-2019) of NIP activities

Action	Action Plan Components (2008)	Implementation Status (2019)
Strategy for National Coordination, management, reporting, information exchange and public information and awareness and education	1. Ratification of the Stockholm Convention 2. Processing of the Hazardous Wastes and Chemicals Bill (2009) and drafting of associated regulations 3. Promotion of public awareness of POPs legislation and Tonga's obligations under the Stockholm Convention 4. Formulate strategies to control the importation and use of all POPs 5. Improve Port of Entry Practices for POPs and pesticide handling, storage and disposal 6. Improve the level of information available on POPs and pesticide handling, storage and disposal 7. Develop licencing system for users of chemicals 8. Establish a project coordination unit in MECC	1. Achieved 2. Achieved 3. Ongoing awareness programmes run through Environment Department, particularly during National Environment week 4. No progress 5. Training has been completed 6. Public information pamphlets and community consultation completed 7. All pesticide imports must be approved by the CEO of MAFF 8. Coordination unit has been established, but is under-resourced and has multiple commitments
Assessment with respect to Annex A, part I chemicals	9. Investigate and remediate DDT contaminated sites in Tokomololo (Tongatapu) and Panai (Ha'apai) 10. Conduct a POPs inventory	9. Contaminated sites assessed in 2011, and no further action required 10. No progress
Assessment with respect to Annex A, part II chemicals (PCBs)	11. Screen 10 obsolete transformers for PCBs 12. Promote safe handling of equipment containing PCBs 13. Undertake a national inventory of all PCB containing equipment 14. Promote awareness of PCBs	11. All transformers are now managed through a New Zealand contract 12. See above 13. See above 14. See above
Strategy for the Reduction and Elimination of the release of Unintentional POPs (uPOPs)	15. Establish a landfill at Vava'u 16. Establish a landfill at Ha'apai 17. Establish a landfill at 'Eua 18. Ongoing support of recycling and composting on outer islands 19. Promotion of recycling and composting at the household level 20. Training of agricultural workers in minimisation of agricultural burning 21. Undertake community fire awareness and improve fire-fighting services 22. Reduce emissions for motor vehicles via regulation and public education 23. Reduce maritime pollution incidents 24. Reduce cigarette smoking	15. Landfill constructed and household waste collections offered on a fee for service basis 16. Temporary landfill constructed, run by MoH, no rubbish collection services 17. Temporary dumpsite established, run by MOH, no rubbish collection services 18. Recycling initiatives established on Vava'u and Tongatapu 19. Composting at household, school and community levels promoted 20. No progress 21. Fire awareness programs completed by fire services 22. Annual visual inspection of motor vehicle exhaust 23. NATPLAN Training completed by SPREP 24. Ban on smoking in public places and workplaces enforced
Strategy for the Reduction and Elimination of Releases from Stockpiles and Contaminated Sites	25. Include chlordane and hexachlorobenzene in monitoring programmes 26. Identify potential stockpile sources of chlordane and hexachlorobenzene 27. Identify sources of recently added POPs 28. Dispose of any stockpiles of chemicals overseas for destruction	25. GMP samples have been collected in 2018 26. No progress 27. No progress 28. Not required
Strategy for Research, Development and Monitoring	29. Repeat Monitoring of POPs in human breast milk 30. Join GMP for POPs 31. Train local staff in GMP participation 32. Report on NIP implementation progress	29. Not repeated under second GMP 30. GMP samples collected in 2018 31. Completed in 2018 32. No progress
Strategy for increased capacity	33. Update POPs website 34. Update key stakeholders on National POPs developments 35. Hold workshops to improve public understanding of POPs issues 36. Develop school curriculum materials in POPs and at the diploma level 37. Train school teachers in the safe handling of school chemicals 38. Develop school chemical laboratory manual	33. No progress 34. Website no longer regarded as the best communication mechanisms in Tonga 35. Completed 36. Completed 37. Completed under GEFPAS project 38. Completed

3 Gender Dimensions relevant to NIP implementation[174]

3.1 Background

Susceptibility to the impacts of chemicals is a consequence of both exposure and biological factors. Chemical exposure depends on many diverse factors including geographical location and behavioural patterns, and biological factors that can include physiological differences between women and men, age, and nutritional status.[175]

3.2 The Gender Dimension

While exposures to chemicals pose a constant risk, there are windows of susceptibility for both women and men when these exposures can have critical effects regarding development and disease. Some chemicals have been shown to have different physiological impacts depending on the sex of the person. However, there is only limited data on how different gender roles differentially expose men and women to hazardous chemicals.[176] Pregnancy, and lactation are windows of susceptibility for women where they can transfer toxic chemicals to their children.[177] PCBs, organochlorine pesticides, PFCs, phenols, PBDEs, phthalates, polycyclic aromatic, hydrocarbons (PAHs) and perchlorate are detectable in almost all tested pregnant women.[178] For both girl and boy infants, the weeks just before and after birth are high-risk, as is puberty for both. Foetal, infant, adolescent periods are windows of susceptibility for men where several disorders can occur at different periods throughout life as a result of exposure to a given endocrine disrupting chemical (EDCs) (or mixture) at one of these periods.[179]

3.3 Chemical Exposure

Men and women are often exposed to differing concentrations and types of toxic chemicals and they have different health reactions to this exposure. Thus, gender is a critical component to consider when formulating policies and programmes in the area of sound management of chemicals (SMC).[180] One way to consider the gender differences in exposures is by looking at the occupation and domestic roles of men and women.

[174]BRS Conventions at Gender Action Plan of the Secretariat of the Basel, Rotterdam and Stockholm conventions (BRS-GAP) for 2016-2017 Updated version http://www.brsmeas.org/Gender/BRSGenderActionPlan/tabid/3652/language/en-US/Default.aspx

[175] European Chemicals Agency (ECHA) definition at https://echa.europa.eu/chemicals-in-our-life/hottopics/chemical-mixtures-and-the-cocktail-effect

[176]SAICM (2017). Gender and the sound management of chemicals and waste: Paper prepared for the intersessional process considering the Strategic Approach and the sound management of chemicals and waste beyond 2020. SAICM/IP.2/1. 21pp

[177]Ostojic and Natalija (2016). UNDP "Health Risks and Impacts of Hazardous Chemicals in Products on Women and Children"

[178]Woodruff, T. J., Zota, A. R., & Schwartz, J. M. (2011). Environmental Chemicals in Pregnant Women in the United States: NHANES 2003–2004. *Environmental Health Perspectives*,119(6), 878-885. doi:10.1289/ehp.1002727

[179]Diamanti-Kandarakis, E., Bourguignon, J., Giudice, L. C., Hauser, R., Prins, G. S., Soto, A. M., Zoeller, R., &Gore, A. C. (2009). Endocrine-Disrupting Chemicals: An Endocrine Society Scientific Statement. *Endocrine Reviews*, 30(4), 293-342. doi:10.1210/er.2009-0002

[180]Tyrkko and Gaba (2011). Energy & Environment Practice Gender Mainstreaming Guidance Series Chemicals Management. UNDP. 28pp

3.3.1 Occupational Exposure

Of concern is the exposure of workers in areas where chemical use is rapidly expanding, including electronics, textiles, construction, agriculture, and services such as cleaning, maintenance, hairdressing, manicure and pedicure.[181,182] While men and women are generally both involved in all these professions, women tend to have a higher level of informal employment than men, and therefore less access to benefits and social protection, low representation and more occupational hazards.[183]

3.3.2 Domestic Exposure

Personal care products such as soaps, creams, deodorants, shampoos, and cosmetics contain many chemicals that impact women and men differently. Women and men often have separate personal care products, with women and girls more likely to use more personal items per day than men, increasing dermal exposure to toxins. Safety data is lacking for most chemicals in personal care products (which may include lead, toxic metals, parabens, triclosan phthalates, mineral oils, nanomaterials and formaldehyde).[184] Many chemicals found in cosmetics have been linked to breast cancer, asthma, allergies, and reproductive disorders.[185] Domestic work using household cleaning products can lead to exposure to a wide range of chemicals. Common cleaning substances, such as bleaches, ammonia and various cleaning fluids containing solvents, may cause irritation of eyes and lungs, give off poisonous gases when combined with each other, and - in the case of some cleaning solvents - are suspected carcinogens.[186] As well, a perception of reduced severity can result in little attention to the chemicals used in for example, cleaning, cooking, drinking water and food packaging.[187]

3.4 Gender Dimension within the Tonga NIP

The Secretariat of the Basel, Rotterdam, and Stockholm (BRS) Conventions have integrated gender equality into their activities through a Gender Action Plan (2016). One of the Plan's objectives includes *promotion of the consideration of gender issues in hazardous chemicals and waste management at the national and regional levels.* [188] This NIP update can be utilized to incorporate gender-considerations into revised implementation plans. Specifically, this can help:

- raise awareness of the linkages between chemical exposures, the effects on human health and the environment, and gender differences in risks and impacts
- promote a multi-stakeholder approach to ensure the participation of women and vulnerable populations in policy development and decision-making processes.

For Tonga, Table 43 highlights the key national chemical management issues and their possible linkages to gender.

[181] Ostojic and Natalija (2016). UNDP Health Risks and Impacts of Hazardous Chemicals in Products on Women and Children
[182]Scientific American at https://www.scientificamerican.com/article/these-4-chemicals-may-pose-the-most-riskfor-nail-salon-workers/
[183]WECF (2015). Women and Chemicals: the impact of hazardous chemicals on women
[184]Women in Europe for a Common Future (2015). Women and Chemicals: the impact of hazardous chemicals on women
[185]Ostojic and Natalija (2016). UNDP "Health Risks and Impacts of Hazardous Chemicals in Products on Women and Children
[186]WHO (1999). Women and Occupational Health: issues and policy paper for the global commission on women's health
[187]UNEP (2016). Global Gender and Environment Outlook. UN Environment, Nairobi, Kenya
[188]BRS Conventions at Gender Action Plan of the Secretariat of the Basel, Rotterdam and Stockholm conventions (BRS-GAP) for 2016-2017 Updated version http://www.brsmeas.org/Gender/BRSGenderActionPlan/tabid/3652/language/en-US/Default.aspx

Table 43: Gender aspects of chemical exposure in Tonga

Chemical of Concern	Key Activities	Output/Outcome
• Mosquito control chemicals • Wood-fired cooking (uPOPs generation) • Tobacco smoking (uPOPs generation) • Chemicals present in consumer products (PFCs, EDCs)	Raise awareness of the linkages between chemical exposures, the effects on human health and the environment, and gender differences in risks and impacts (AP9.3, AP9.5, AP 10.9, AP 10.22, AP 11.2, AP 12.10, AP 13. 7)	Improved support for minimising exposure to pesticides, and reduced uPOPs exposure among women
	Promote a multi-stakeholder approach to ensure the participation of women in policy development and decision-making processes (AP1.2, AP3.1)	Gender perspectives are incorporated into environmental decision-making
	Strengthening the focus on developing, collecting and analysing national gender-disaggregated data, indicators and other information (AP 10.10, 10.22, AP13.7, AP13.9)	Increased understanding of gender roles in relevant sectors

4 Socio-economic Assessment

4.1 Background

Socio-economic impact analysis is one of the key components of the complex management process in which risks resulting from environmental contamination by chemicals are identified and assessed.[189] The aim of socio-economic analysis within the field of chemical risk management is to assist the decision-making process by making explicit the implications of choosing one risk management option over another. Within the NIP context, this helps inform decision makers of the social and economic costs and benefits of reduction in POPs use and exposure through implementation of the Stockholm Convention requirements.[190] A transparent socio-economic analysis can help inform decision makers and stakeholders of what will be involved in terms of positive and negative effects, both across social groups and across the economy.[191] A risk assessment helps characterise the risk posed (to humans and to the environment) by chemical exposure and a socio-economic analysis evaluates change within the socio-economic situation based on various combinations of potential risk mitigation measures. In the context of risk management of chemical exposure, the social and economic impacts may include impacts on human health; impacts on the environment; and impacts on economic development.[192,193] Whilst all three aspects are important, the minimisation of the impact of POPs chemicals on human health is typically paramount, especially for the general population and for workplace exposure.[194]

4.2 Assessment methodology

Typically, an analysis of the socio-economic impact of POPs management under the Stockholm Convention will encompass:

1. The characterisation of the societal problems leading to POPs use (identified during the NIP baseline)
2. The characterization of the impacts of POPs use (identified during the NIP baseline)
3. The assessment of the impacts (positive or negative) of producing or using specific POPs (identified during the NIP baseline)
4. The analysis of alternative/best practice management options (identified during the NIP baseline)
5. The analysis of the economic and social effects and the cost of POPs reduction or phase-out
6. Recommendations on meeting the social and economic cost of controlling or banning POPs.

[189]Zvonko *et al.* (2015). Assessment of the Socio-economic Impact of the Chemicals Environmental Contamination. *International Review* (1-2), 113-18.
[190]UNEP (2014). *Interim guidance for developing a national implementation plan for the Stockholm Convention*. 51pp
[191]UNEP (2017). Guidance on Socio-Economic Assessment for National Implementation Plan Development and Implementation under the Stockholm Convention. 70pp
[192]Zvonko *et al.* (2015). Assessment of the Socio-economic Impact of the Chemicals Environmental Contamination. *International Review* (1-2), 113-18.
[193] Brnjaš *et al.* (2015). Socio-economic aspect of hazardous chemicals environmental impacts. *3rd International Conference. New Functional Materials and High Technology NFMaHT*, Tivat, Montenegro.
[194]Brnjaš *et al.* (2015). Socio-economic aspect of hazardous chemicals environmental impacts. *3rd International Conference. New Functional Materials and High Technology NFMaHT*, Tivat, Montenegro.

4.3 Tonga socio-economic assessment

A systematic qualitative analysis, where the relative magnitude, significance and relative importance of the risks, costs and benefits are described but not quantified was used to complete the Tonga NIP assessment (Table 44). Management of uPOPs and POPs-BBDEs, HBB, HBCD HCBD, PCNs and SCCPs are predicted to increase national chemical management costs. National management of modern agricultural pesticidea will also incur additional costs. In contrast, national management of all other Stockholm listed chemicals will have no immediate direct cost implications for the nation.

Table 44. Tonga Stockholm POPs socio-economic assessment summary

Stockholm Chemical(s)	Proposed NIP Management Action	Environmental Benefit	Human Health Benefit	Relative Cost Implication of Improved Management*
POPs pesticides	• Maintain national ban on importation of listed POPs pesticides • Continue monitoring under GMP	Protects the environment from impacts of POPs	Protects human health from potential effects on endocrine and immune systems, liver, reproductive system and the cancer impacts of POPs	No additional cost
Agricultural pesticides	• Implement education campaigns and used pesticide container collection services	Reduces environmental release of horticultural pesticides	Reduces human exposure to horticultural pesticides	Additional costs associated with improved pesticide container management
Mosquito vector control insecticides	• Continue vector control on an "as need" basis based on routine insect larval monitoring	Minimises environmental release of carbamate-based insecticide	Minimises national human exposure to insecticide Minimises risk of Dengue outbreak	No additional cost (insecticide provide at no cost by WHO)
PCBs	• Continue monitoring under GMP	Prevent further loss of PCBs to soil and groundwater	Prevents any further exposure of TPL workers to PCBs	No additional cost
POP-PBDEs	• Improved domestic waste management • Improved E-waste management • Improved EOL vehicle management • Continue monitoring under GMP	Prevent further loss of PBDEs to soil and groundwater	Reduces exposure of workers in the waste management and recycling sector to PBDEs	• No immediate additional cost (improved waste management practices funded by community rates) • Implementation of an advanced disposal fee will increase cost of domestic purchase of electrical, electronic equipment and motor vehicles
HBB	• Improved domestic waste management • Improved E-waste management • Improved EOL vehicle management	Prevent further loss of HBB to soil and groundwater	Minimise human exposure to HBB	• Costed under PBDE management costs
HBCD	• Improved domestic waste management	Prevent further loss of HBCD to soil and groundwater	Minimise human exposure to HBCD	Costed under PBDE management costs

HCBDs	• Contunue monitoring under GMP	Prevent further loss of HCBDs to soil and groundwater		Costed under PCB management actions (including uPOPs reductions)
PCNs	• Minimise uPOPs releases from low temperature waste incineration and open burning	Minimise loss of dioxins, furans and other uPOPs to the environment	Minimise exposure to dioxins, furans and other uPOPs	Costed under uPOPs management
SCCPs	• Improved domestic waste management	Prevent further loss of PBDEs to soil and groundwater	Minimise human exposure to SCCPs	Costed under improved waste management practices
DDT	• Maintain national ban on importation of listed POPs pesticides • Continue monitoring under GMP	Prevent loss of DDT to soil and groundwater, impacts on fauna	Prevents human exposure to DDT	DDT not used in malaria vector control. No additional cost
PFOS, its salts and PFOSF	• Maintain national ban on importation of listed POPs • Continue monitoring under GMP	Prevent loss of PFOS to soil and groundwater, impacts on fauna	Prevents human exposure to PFOS	PFOS not used in national fire suppression. No additional cost
uPOPs	• Maximise renewable energy generation rates • Continue monitoring under GMP	Minimise uPOPs generation and loss to environment	Minimise human exposure to uPOPs emissions	• Reduced household electricity costs • No additional waste disposal costs • Decreased community medical intervention cost
	• Increase Ewaste recycling rates • Minimise open burning			• Implementation of an advanced disposal fee will increase cost of domestic purchase of electrical, electronic equipment and motor vehicles • Increased community waste management costs
	• Minimise low temperature waste incineration • Minimise cooking with wood fired stoves • Increase motor vehicle pollutant emission standards • Minimise national tobacco smoking rates			• Increased healthcare waste disposal costs • Increased household cooking costs • Increased motor vehicle purchase costs • Increased tobacco prices

*Green: no additional cost; Orange: eventual cost increase; Red: immediate cost increase

5 Strategy and Action Plan Elements of the NIP

5.1 Policy Statement

Tonga recognises the national and global environmental and public health risks of POPs and other hazardous chemicals and wastes, and is committed to taking national action to reduce and eliminate the consumption and unintentional releases of these chemicals, in accordance with its obligation as a Party to the Stockholm Convention, and its responsibility as a global citizen.

The Tongan Government also recognises that economic development will likely lead to an increase in the importation of chemicals and articles potentially containing POPs, and if improperly managed, chemicals will potentially have immediate and prolonged adverse impacts to the national environment and health of Tongans.

Faced with these realities, the Tongan Government believes that a core focus of the NIP must be to improve the management of all chemicals and wastes in the country, in order to protect human health and the environment. The revision and subsequent implementation of this NIP helps to achieve a clear pathway for the management of POPs and thereby reduce the potential economic and environmental costs that result from their mismanagement.

Building on the initial NIP implementation process, the Government is committed to addressing identified shortcomings and to strengthen the updated NIP implementation process, focusing on enhancing co-operation and co-ordination among stakeholders. The Government is committed to the implementation of this NIP through the lead agency, the Department of Environment. The Government endorses this NIP to reaffirm its commitment to addressing the national management of POPs in accordance with its obligations under the Stockholm Convention.

The Tongan Government is aware that POPs management is just a small part of national chemicals and waste management. It is the Government's view that an integrated approach that uses financial and human resources more efficiently for national chemicals and waste management would assist in attracting interested donors in this area of endeavour. The Government will identify and attempt to attract additional funding to successfully implement the NIP and Stockholm Convention by matching Tonga's priorities with those of potential donor areas including SDGs, climate change, and biodiversity protection activities.

5.2 Implementation Strategy

The implementation of this NIP is based around six key strategies as detailed below.

Strategy 1: Create appropriate legal and institutional frameworks to manage POPs. Tonga requires a modern legal and institutional framework that could provide the basis for complying with national obligations under the Stockholm Convention. This strategy presents measures to prohibit the importation, manufacture and use of Annex A POPs; better regulate the importation, distribution and

use of new chemicals; regulate, manage and minimise waste incineration and open burning processes; and provide greater oversight and coordination of national chemicals management.

Strategy 2: Improve data collection and management of POPs. While this NIP has identified minor sources and quantities of POPs in Tonga, and further work is needed to identify and quantify additional sources of POPs, particularly those contained in waste disposal sites and from far-field sources. Accurate and updated data helps to inform policy- and decision-making and provides the basis for monitoring the effectiveness of such policies and decisions. Improved data also helps Tonga to meet its reporting obligations under the Stockholm Convention and other wastes and chemicals conventions. Moreover, appropriately interpreted data and information underpins the transfer of information in appropriate and easy-to-understand formats to target groups under Strategy 5.

Strategy 3: Institute sound management of POPs. The sound management of POPs is key to minimising, and ultimately avoiding, the adverse health, environmental, and economic impacts associated with mismanagement of POPs. This strategy seeks to ensure the implementation of best practices to reduce, and where possible eliminate, the environmental release of POPs and other hazardous chemicals. It addresses the entire chemical management chain, from importation, through to transportation, storage, use, and disposal.

Strategy 4: Develop national human capacity for POPs management. The management of POPs and other chemicals is a specialised and sometimes technical area, which requires knowledgeable and capable human resources to effectively implement management strategies and sustain successful implementation outcomes. This strategy seeks to develop a critical mass of human capacity in a range of sectors involved in POPs chemicals management including health, environment, waste, mining and customs services. Human capacity needs to be developed not only in technical aspects of POPs and other chemicals management, but also in areas such as environmental communications, environmental project management, contract management, project/program monitoring and evaluation. This requires targeted short- to medium-term capacity development activities, supported by longer-term activities that seek to embed capacity development in relevant subject matters into the culture of responsible institutions and organisations.

Strategy 5: Raise stakeholder awareness levels for POPs management. Full cooperation and participation of stakeholders in POPs management initiatives is critical to the success of such initiatives. People are more likely to support and comply with laws, procedures, guidelines, and requirements for POPs management if they understand the consequences of action and in-action and the personal impact of those consequences. This requires targeted short- to medium-term awareness campaigns supported by longer-term initiatives that embed good practice implementation into the national culture, until best practice implementation becomes routine, accepted practice.

Strategy 6: Improve implementation, monitoring, evaluation and reporting of NIP activities. Many of the activities of the previous Tonga NIP have not been implemented. This strategy seeks to address some of the previous implementation issues, for example, by requiring NIP activities to be embedded into the corporate work plans and budgets of relevant government departments, and by requiring implementation of awareness campaigns targeting politicians, Finance officials, and other high-level decision makers and potential champions.

These six strategies have been used to shape 12 Action Plans, which are described in detail in the subsequent sections.

5.3 Action Plans, including respective activities and strategies

Twelve Action Plans (AP1 to AP12) totalling approximate US$ 4,288,500 have been identified in this NIP, to enable the Tonga Government to meet its obligations as a Party to the Stockholm Convention (Table 45). As part of the annual work planning and budgeting process, the Department will select relevant Action Plan items to be implemented in the financial year, and endeavour to incorporate these items into its annual work programme and budget.

Table 45. Summary of Action Plans to implement the revised NIP

Action plan	Action Plan name	NIP component	Cost (US$)
AP1	Institutional and Regulatory Strengthening Action Plan	Institutional and regulatory strengthening measures	120,000
AP2	Technical and financial assistance Action Plan	Technical and financial assistance	55,000
AP3	POPs Pesticides Action Plan	Identification and management of POPs pesticides and related wastes	1,215,000
AP4	PCBs/PCNs/SCCPs Action Plan	Identification and disposal of PCBs and equipment containing PCBs/PCNs	150,000
AP5	POP-PBDEs and HBCD Action Plan	Identification and appropriate management of articles/products and wastes containing deca-BDE, HBCD, hexaBDE and heptaBDE, tetraBDE and pentaBDE	650,000
AP6	PFOS, its salts and PFOSF Action Plan	Identification and appropriate management of PFOS, its salts and PFOSF	225,000
AP7	DDT Action Plan	Management of DDT	30,000
AP8	uPOPs Action Plan	Releases from unintentional production of PCDD/F, HCB, PCBs, HCBD, PCNs	983,000
AP9	Contaminated Sites Action Plan	Identification and appropriate management of contaminated sites (Annex A, B and C Chemicals)	176,000
AP10	Public Awareness, Information and Training Action Plan	Public awareness, information and training	167,500
AP11	Monitoring, Evaluation and Reporting Action Plan	Implementation, monitoring and reporting	392,000
AP12	Research and Development Action Plan	Promote research and development on POPs	125,000
		Total Action Plan costs	**4,288,500**

5.3.1 Institutional and Regulatory Strengthening Action Plan (Action Plan 1)

Activity	Responsibility	Timeframe and Budget (US$)					Budget comments
		2020	2021	2022	2023	2024	
1. Improve national oversight of POPs and other chemicals in Tonga							
Institutional Measures							
1.1. Establish a National Chemical Unit within the Department of Environment to serve as the National Focal Point for integrated chemical management	DoE	5,000	5,000	5,000	5,000	5,000	Operating costs
1.2. Prepare a National Chemical Profile on chemical management and update the national chemical registration list	DoE, MAFF	20,000					Consultant fees
1.3. Establish a centralised system for licensing and permitting chemical imports and use	DoE, MAFF	10,000					Develop using existing government human resources
1.4. Train Customs, Agricultural and Environment Officers in the detection and classification of potentially illegal imports and export of POPs and other non-approved chemicals and wastes	DoE, Customs	20,000					Consultant fees
2. Establish a comprehensive legal and administrative system to manage all chemical related issues in Tonga							
Regulatory Measures							
2.1. Review and update the national waste management strategy and associated regulations to improve co-ordinated management of wastes (and chemicals)	DoE, WAL	10,000					Legal consultant
2.2. Review and update legislation, regulations and protocols to improve management (importation controls, transport, storage, application and disposal) of all imported chemicals (including Stockholm listed chemicals)	DoE, MAFF	20,000					Legal consultant
3. Improve engagement with the agricultural sector and retailers on POPs and chemical related issues in Tonga							
Education and Awareness Activities							
3.1. Establish an industry liaison group to coordinate and drive (in association with Government Agencies), implementation of relevant NIP activities in their respective sectors	DoE, MAFF, WAL	5,000		5,000		5,000	Initial consultations, domestic travel, meeting facilitation, etc
TOTAL		**90,000**	**5,000**	**10,000**	**5,000**	**10,000**	

5.3.2 Technical and Financial Assistance Action Plan (Action Plan 2)

Activity	Responsibility	Timeframe and Budget (US$)					Comments
		2020	2021	2022	2023	2024	
4. To reduce and ultimately eliminate use and releases of all Stockholm listed chemicals							
Institutional measures							
4.1 Complete assessment of technical and financial requirements to complete all Tonga NIP Action Plans	DoE	20,000					Consultant fees
4.2 Prioritise Action Plan activities for which technical and financial assistance is needed, considering potential synergies of the prioritised activities	DoE	10,000					Consultant fees
4.3 Complete an assessment of potential financial and technical assistance sources/donors, to complete NIP implementation, including the conditions that may apply to successful funding applications	DoE	15,000					Consultant fees
4.4 Apply for financial assistance to complete NIP Action Plans from identified donors and funding sources	DoE	10,000					Consultant fees
	TOTAL	**55,000**					

5.3.3 POPs Pesticides Action Plan (Action Plan 3)

Activity	Responsibility	Timeframe and Budget (US$)					Comments
		2020	2021	2022	2023	2024	
5 To eliminate releases of POPs pesticides							
Regulatory measures							
5.1 Review and revise legislation to give legal effect to an administrative framework for the management of chemicals (Pesticide Act 2002)	Refer to Action 2.2						
5.2 Enact national legislation to enforce the management of POPs pesticides	Refer to Action 2.2						
5.3 List POPs pesticides as banned/restricted imports under the Customs Act (2008)	Refer to Action 2.2						
5.4 Develop regulatory measures to combat illegal traffic of banned pesticides and counterfeit pesticides	Refer to Action 2.2						
5.5 Develop/update the regulatory framework for good agricultural practice, IVM and organic farming	Refer to Action 2.2						
Environmentally sound management measures							
5.6 Update the POPs pesticides inventory annually	Refer to Action 2.2						
5.7 Establishing of an empty pesticide container collection and management system to address the use and recycling of pesticides empty containers	MAFF, WAL, DoE	50,000	10,000	10,000	10,000	10,000	
5.8 Establish dedicated personnel addressing integrated waste management policy issues	WAL	100,000	100,000	100,000	100,000	100,000	Staffing costs
5.9 Strengthen the inspection of pesticide imports by Customs (market survey, sales, storage, usage and disposal including counterfeit and illegal pesticides)	DoE, Customs, MAFF	100,000	100,000	100,000	100,000	100,000	Staffing costs
Capacity building measures							
5.10 Train customs officers on the detection of POPs pesticides and on checking exports for compliance with the Basel (and Waigani) Conventions	Refer to Action 1.4						
5.11 Education and capacity building on POPs pesticides alternatives and organic farming		25,000	25,000	25,000	25,000	25,000	
	TOTAL	**275,000**	**235,000**	**235,000**	**235,000**	**235,000**	

5.3.4 PCBs/PCNs/SCCPs Action Plan (Action Plan 4)

Activity	Responsibility	Timeframe and Budget (US$)					Comments
		2020	2021	2022	2023	2024	
6 To eliminate releases of PCBs/PCNs/SCCPs							
Regulatory measures							
6.1 Ban the importation, manufacture, reuse, recycling, and export (except export for environmentally sound waste management) of PCBs and PCNs in closed and open application, including SCCPs in open applications	Refer to Activity 2.2						
6.2 Developing legislative framework, policies and measures to control and manage PCB/PCN in closed and open applications, including penalties/fines for the improper management of PCB/PCN containing equipment	Refer to Activity 2.2						
6.3 Prohibit the landfill disposal and burning of PCB and PCN-containing equipment and oils	Refer to Activity 2.2						
6.4 Strengthening the control/inspection for PCB/PCN containing equipment still in use, and any existent interim storages	Refer to Activity 1.4						
Environmentally sound management measures							
6.5 Prepare comprehensive inventory of PCBs/PCNs containing equipment, including PCBs/PCNs/SCCPs in open applications		20,000					Consultant costs
6.6 Arrange for the containment and offshore shipment of any PCB/PCN contaminated oil and equipment		Not costed					One off action
6.7 Assess and promote sustainable alternatives for PCBs, PCNs and SCCPs in closed and open applications		20,000	10,000	10,000	10,000	10,000	
Capacity building measures							
6.8 Train Customs Officers on meeting Basel and Waigani Convention export requirements, as well as in the identification of illegal imports of PCB and PCN contaminated oils/equipment	Refer to Activity 1.4						
6.9 Train Environment Department and TPL specialists in PCB/PCN/SCCP testing, containment and contaminant management, including transformer oil management	DoE, TPL	15,000		15,000		5,000	POPs Consultant
6.10 Train waste management industry workers on environmentally sound management of PCBs and PCNs in open and closed applications, including SCCPs open applications	WAL, DoE	15,000		15,000		5,000	POPs Consultant
	TOTAL	**70,000**	**10,000**	**40,000**	**10,000**	**20,000**	

5.3.5 POP-PBDEs and HBCD Action Plan (Action Plan 5)

Activity	Responsibility	Timeframe and Budget (US$)					Comments
		2020	2021	2022	2023	2024	
7 To eliminate releases of POP-PBDEs and HBCD							
Regulatory measures							
7.1 Ban the importation, manufacture, reuse, recycling, and export (except export for environmentally sound waste management) of POP-PBDEs and HBCD	Refer to Activity 2.2						
7.2 Restrict the importation of vehicles and electrical and electronic products manufactured between 1975 and 2004 as these may contain elevated concentrations of POP-PBDEs	Refer to Activity 2.2						
Institutional measures							
7.3 Develop and maintain a directory of regional and international facilities with the capability for environmentally sound disposal of POP-PBDEs and HBCD containing materials/articles	DoE, WAL	2,000	2,000	2,000	2,000	2,000	Operating costs
7.4 Develop strategies for the registration of electronic devices, vehicles, and materials, including wastes containing POP-PBDEs, as well as insulation materials containing HBCD, entering in Tonga	DoE, WAL	10,000		10,000		10,000	Operating costs
Environmentally sound management measures							
7.5 Undertake a national inventory of EEE/WEEE	DoE, WAL	50,000	10,000	20,000	10,000	20,000	
7.6 Identify and quantify existing POP-PBDEs containing product/articles stockpiles in use and in storage	DoE	20,000					Consultant costs
7.7 Establish secure temporary storage at the landfill facility for e-wastes, while waiting for final destruction	WAL	10,000					
7.8 Develop and implement a national e-waste management program, which includes sustainable financing measures for environmentally sound management and disposal	WAL	20,000	5,000	5,000	5,000	5,000	Operating costs
7.9 Undertake a national inventory of vehicles/end of life vehicles (EOL), by year of manufacture	WAL, DoE	50,000	50,000	5,000	5,000	5,000	Operating costs
7.10 Identify and quantify the POP-PBDEs quantities in WEEE and ELVs	WAL, DoE	50,000	50,000	5,000	5,000	5,000	Operating costs
7.11 Establish secure storage at the landfill facility for EOL vehicles, prior to export for recycling	WAL	20,000					

Activity	Responsibility	Timeframe and Budget (US$)					Comments
		2020	2021	2022	2023	2024	
7.12 Develop and implement a national end-of-life vehicle management program, which includes sustainable financing measures for environmentally sound management and disposal	DoE, WAL	20,000	10,000	10,000	10,000	10,000	
7.13 Identify and quantify existing HBCD containing products/article stockpiles in use and in storage	DoE	20,000				20,000	
7.14 Promote the implementation of BAT/BEP for use of building insulation materials containing HBCD	DoE	5,000	5,000	5,000	5,000	5,000	
7.15 Promote the use of alternative insulation materials	DoE	5,000	5,000	5,000	5,000	5,000	
Capacity building measures							
7.16 Train waste management workers in environmentally sound management of POP-PBDEs and HBCD wastes	Refer to Activity 6.7						
7.17 Train Customs Officers on the detection of articles containing POP-PBDEs and HBCD and on checking exports for compliance with the Basel (and Waigani) Conventions	Refer to Activity 1.4						
7.18 Build knowledge and capacity for management of POP-PBDEs and HBCD impacted materials and waste categories, including improved co-ordination in national data collection initiatives	DoE	5,000		5,000		5,000	
Education and awareness measures							
7.19 Deliver public education and health campaigns on POP-PBDEs and HBCD sources management (e-waste, used motor vehicle and construction and demolition waste management) in collaboration with other agencies	Refer to Activity 12.8						
7.20 Raise awareness of relevant stakeholders (policy makers, authorities, industry, recyclers, and public) on POP-PBDEs and HBCD containing products/articles/wastes management and disposal practices	DoE, WAL	5,000		5,000		5,000	
	TOTAL	**292,000**	**137,000**	**77,000**	**47,000**	**97,000**	

5.3.6 PFOS, its salts and PFOSF Action Plan (Action Plan 6)

Activity	Responsibility	Timeframe and Budget (US$)					Comments
		2020	2021	2022	2023	2024	
8 To reduce and ultimately eliminate releases of PFOS, its salts and PFOSF							
Regulatory measures							
8.1 Ban the importation, manufacture, use, and export (except export for environmentally sound waste management) of PFOS and PFOS-containing articles	Refer to Activity 2.2						
Institutional measures							
8.2 Identify safer alternatives to aqueous film-forming foams (AFFF) containing PFOS, its salts and PFOSF	Fire Service	10,000					Consultant costs
8.3 Develop and maintain a directory of regional and international facilities capable of the environmentally sound disposal of PFOS, its salts and PFOSF contaminated articles and foams	Refer to Activity 6.3						Costed under Activity 6.3
Environmentally sound management measures							
8.4 Undertake a national inventory of articles potentially containing PFOS, its salts and PFOSF	DoE	50,000		50,000		50,000	
8.5 Establish storage areas at the landfill site for PFOS-containing articles/wastes and foam, prior to export for final disposal	WAL	20,000	5,000	5,000	5,000	5,000	Operating costs
8.6 Promote safer alternatives to PFOS, its salts and PFOSF containing articles (in particular fire-fighting foams)	DoE	5,000	5,000	5,000	5,000	5,000	
Capacity building measures							
8.7 Train Customs Officers on the detection of PFOS-containing products and on checking exports for compliance with the Basel Convention	Refer to Activity 1.4, 5.12						
	TOTAL	**85,000**	**10,000**	**60,000**	**10,000**	**60,000**	

5.3.7 DDT Action Plan (Action Plan 7)

Activity	Responsibility	Timeframe and Budget (US$)					Comments
		2020	2021	2022	2023	2024	
9 To reduce and ultimately eliminate releases of DDT							
Regulatory measures							
9.1 Ban the importation and use of DDT and DDT-containing mixtures	Refer to Activity 2.2						
Institutional measures							
9.2 Establish a national position on the efficacy of use of specific chemicals for national mosquito vector control		10,000				10,000	Consultant Fees
Environmentally sound management measures							
9.3 Complete a review of the scientific and medical literature connected with the efficacy of different mosquito control strategies	DoE, MoH	10,000					
9.4 Undertake routine monitoring of DDT concentrations in air, sediment, human breast milk and food items under the GMP	Refer to Activity 13.5						Costed under the GMP
Capacity building measures							
9.5 Implement routine chemical management training for public health workers engaged in mosquito control	Refer to Activity 12.4						
9.6 Train customs officers on the detection of DDT and DDT-containing products and on checking exports for compliance with the Basel and Waigani Convention	Refer to Activity 1.4						
	TOTAL	**20,000**				**10,000**	

5.3.8 uPOPs Action Plan (Action Plan 8)

Activity	Responsibility	Timeframe and Budget (US$)					Comments
		2020	2021	2022	2023	2024	
10 Progressive reduction in releases from unintentional production of POPs							
Regulatory measures							
10.1 Establish a policy and legal framework for reduction and minimisation of unintentional POPs formation within an integrated pollution prevention and control approach identify emission standards or limits for uPOPs for sources and in environmental media and food	Refer to Activity 2.2						
10.2 Develop comprehensive waste management regulations, including prohibition on open burning of waste and associated infringement penalties	Refer to Activity 2.2						
10.3 Implement tobacco initiatives in compliance with national obligations under the WHO Framework Convention on Tobacco Control[195] and the Tobacco Control Act 2010	Ministry of Health	10,000	10,000	10,000	10,000	10,000	Education and awareness
10.4 Restrict the importation of motor vehicles without pollution control technology	Refer to Activity 2.2						
10.5 Enforce appropriate standards for septic tank installation and servicing	WAL	50,000	50,000	50,000	50,000	50,000	
Institutional measures							
10.6 Implement a national waste management strategy that promotes environmentally sound waste management	WAL						Funded by rates
10.7 Develop and enforce the implementation of national landfill management guidelines that include measures to prevent waste generation and landfilling, and to reduce the occurrence of dump fires and restrict public access to waste tipping faces	WAL, DoE	10,000	2,000	2,000	2,000	2,000	Develop by 2021 Consultancy and maintenance costs
10.8 Introduce an Advanced Recycling Fee on vehicles to pay for end-of-life recycling costs	WAL, DoE	50,000	10,000	10,000	10,000	10,000	Consultancy and implementation costs
10.9 Development of an integrated database of national pollutant releases (e.g. dioxin/uPOPs, mercury, greenhouse gases) and/or of a pollutant releases transfer register (PRTR)	DoE	10,000	10,000	10,000	10,000	10,000	
10.10 Participate in the Global Monitoring Plan (GMP) of POPs in order to obtain information on trends and comparisons with other Pacific countries in the region	Refer to Activity 13.7						
Environmentally sound management measures							

[195] http://apps.who.int/iris/bitstream/10665/42811/1/9241591013.pdf?ua=1

Activity	Responsibility	Timeframe and Budget (US$)					Comments
		2020	2021	2022	2023	2024	
10.11 Update the uPOPs inventory annually	DoE	1,000	1,000	1,000	1,000	1,000	
10.12 Implement relevant recommendations of PacWaste for healthcare waste management in Tonga	Ministry of Health	50,000	50,000	20,000	20,000	20,000	
10.13 Implement BAT/BEP for the operation of healthcare waste incinerators to manufacturer's specifications	DoA, Health	50,000	50,000	50,000	50,000	50,000	
10.14 Designate areas in the landfill for safe reclamation of recyclable materials	WAL						
10.15 Require holders of environmental permits relating to wastes and chemicals to collect and report data specific to their sector (e.g. quantity of wastes incinerated, and average incineration temperatures for healthcare waste incineration)	DoE, DoA	2,000	2,000	2,000	2,000	2,000	
10.16 Promote the adoption of BAT/BEP in the waste management sector and open burning to minimise uPOPs releases	WAL	5,000	5,000	5,000	5,000	5,000	
10.17 Maintain and promote 5-year national composting programme	WAL	5,000	5,000	5,000	5,000	5,000	
10.18 Maintain and promote adoption of renewable energy generation practices	Energy						
10.19 Investigate and implement a national used battery recycling programme	WAL, TPL	10,000	5,000	5,000	5,000	5,000	
Capacity building measures							
10.20 Provide uPOPs-related training at regular intervals to environment, waste, agriculture and health workers to enable them to provide a minimum level of sound waste management advice to communities during normal duties	Refer to Activity 11.4, 11.5, 11.6, 11.10						
10.21 Develop, distribute and raise awareness of guidelines on selection and use of PPE in the waste and chemical management sector	WAL, DoA	10,000		5,000		5,000	
Education and awareness measures							
10.22 Deliver public education and health campaigns on uPOPs prevention, in collaboration with other agencies (e.g. health, transportation)	Refer to Activity 11.10. 11.11						
	TOTAL	**263,000**	**200,000**	**175,000**	**170,000**	**175,000**	

5.3.9 Contaminated Sites Action Plan (Action Plan 9)

Activity	Responsibility	Timeframe and Budget (US$)					Comments
		2020	2021	2022	2023	2024	
11 To reduce POPs releases from contaminated sites							
Regulatory measures							
11.1 Amend the legislation if required, to require proponents of development proposals or chemical import licences to demonstrate what infrastructure will be put in place to ensure safe storage and containment of chemicals and wastes	Refer to Activity 2.2						
11.2 Develop and enforce regulations requiring chemical and hazardous waste facilities to develop oil and chemical spill response plans and procedures	DoE, Marine	5,000	5,000	5,000	5,000	5,000	
Institutional measures							
11.3 Establish a national contaminated site registry/inventory	DoE, WAL	1,000					
11.4 Develop and implement a chemicals compliance inspection program to assess compliance of chemical storage practices with best practices.	DoE, DoA	5,000	500	500	500	500	Operating costs
11.5 Develop/update legislation to set criteria for determining contaminated sites for relevant POPs, including on liability (polluter pays principle).	Refer to Activity 2.2						
11.6 Develop methodology to identify and prioritize POPs contaminated sites considering available guidance documents.	DoE	10,000					
Environmentally sound management measures							
11.7 Contain and remove asbestos contaminated materials from Tonga	DoE						Not included in NIP costs
11.8 Where possible, restrict activities on, and public access to potentially contaminated sites, based on the risks and level of contamination	DoE	1,000		1,000		1,000	
11.9 Maintain and monitor used oil recycling activities and ensure regular shipment offshore of collected used oil for recycling	DoE, DWM						
11.10 Secure POPs contaminated sites, and were feasible progressively remediate contaminated sites commencing with the highest priority sites	DoE, WAL						Not included in NIP costs
Capacity building measures							
11.11 Provide relevant officers with accredited training in field investigation and contaminated site assessment techniques	DoE	10,000		10,000		10,000	

Activity	Responsibility	Timeframe and Budget (US$)					Comments
		2020	2021	2022	2023	2024	
Education and awareness measures							
11.12 Educate communities in proximity to contaminated sites of the potential health impacts and actions to minimise exposure to the contamination	DoE, DWM	20,000	20,000	20,000	20,000	20,000	Operating costs
	TOTAL	**52,000**	**25,500**	**36,500**	**25,500**	**36,500**	

5.3.10 Public Awareness, Information and Training (Action Plan 10)

Activity	Responsibility	Timeframe and Budget (US$)					Comments
		2020	2021	2022	2023	2024	
12 To cultivate a level of awareness and capacity in stakeholders that reduces POPs releases and supports implementation of the NIP							
Regulatory measures							
12.1 Require holders of chemical import/export permits, and environmental permits to report activity data to DoA at regular intervals (e.g. quarterly or semi-annually)	DoA	1,000	1,000	1,000	1,000	1,000	Operating costs
Institutional measures							
12.2 Establish a training and outreach unit within DoE dedicated to provision of training (including training identified in this NIP) to government, public and private sector stakeholders	DoE	5,000	5,000	5,000	5,000	5,000	Operating costs
Capacity building measures							
12.3 Train specialist government staff in GMP practices and procedures	DoE, DoA	2,000	2,000	2,000	2,000	2,000	Operating costs
12.4 Provide training to waste management workers, hospital, agriculture and teaching staff on safe handling, storage and disposal of chemicals and other hazardous wastes	DoE, DoA, DoH, Education	10,000		10,000		10,000	
12.5 Implement the activities to raise awareness and training for inspectors and customs, on POPs substances and POPs containing materials/articles	DoE, Customs	10,000		10,000		10,000	
Education and awareness measures							
12.6 Conduct an annual national "Chemicals in Tonga" forum to raise high-level political awareness of POPs and chemical management issues in Tonga	DoE	5,000	5,000	5,000	5,000	5,000	Operating costs
12.7 Conduct regular awareness campaigns on used oil recycling	DoE, DWM	500	500	500	500	500	
12.8 Developing a school curriculum to include POPs and the effects of hazardous chemicals to ensure long term public awareness and education	DoE, Education	10,000					
12.9 Deliver public education and health campaigns on PBDE sources management (e-waste, used motor vehicle management) in collaboration with other agencies	DoE	10,000					

Activity	Responsibility	Timeframe and Budget (US$)					Comments
		2020	2021	2022	2023	2024	
12.10 Prepare and promote education and training materials on POPs & hazardous chemicals tailored for target groups (policy makers, industry, public, curricula) considering available materials and translate selected materials into national language	Doe	10,000					
12.11 Compile and disseminate information materials available on alternatives to POPs	DoE	10,000					
	TOTAL	**73,500**	**13,500**	**33,500**	**13,500**	**33,500**	

5.3.11 Monitoring, Evaluation and Reporting Action Plan (Action Plan 11)

Activity	Responsibility	Timeframe and Budget (US$)					Comments
		2020	2021	2022	2023	2024	
13 To ensure timely implementation and continuing relevance of the NIP over its implementation period							
Institutional measures							
13.1 Embed activities from this NIP into relevant departmental work plans and budgets to ensure implementation	DoE, DoA, Customs, DoH	2,000	2,000	2,000	2,000	2,000	Operating costs
13.2 Prepare an annual progress report of NIP implementation against the NIP Action Plans	DoE	1,000	1,000	1,000	1,000	1,000	Operating costs
13.3 Revise NIP activities as needed to, for example, to reflect changing priorities and emerging issues	Refer Activity 1.1						
13.4 Provide periodically training on reporting obligations and reporting format and data collection and compilation processes	Refer to Activity 1.1						
13.5 Compile information for reporting (qualitative and quantitative)	Refer to Activity 1.1						
13.6 Submit four-yearly national reports and other reports (POP-PBDEs, DDT and PFOS continued need, PCBs elimination progress) to the Stockholm Convention Secretariat	DoE	1,000				1,000	
13.7 Review and implement Tonga sampling plans for ambient concentrations of POPs (including PCBs and PFOS) in air, land, water, food, animals and humans within the GMP framework	DoE	5,000	5,000	5,000	5,000	5,000	Operating costs
13.8 Establish a small facility to be used as a focal point for collecting and storing pesticide and POPs samples before overseas analysis	DoE	10,000					
13.9 Commence and maintain a national database on POPs and other chemical management	DoE	50,000	50,000	50,000	50,000	50,000	Operating costs
13.10 Undertake regular asbestos air sampling with a focus in high risk residential areas	DoE	50,000	10,000	10,000	10,000	10,000	Consultant fees
	TOTAL	**119,000**	**68,000**	**68,000**	**68,000**	**69,000**	

5.3.12 Research and Development Action Plan (Action Plan 12)

Activity	Responsibility	Timeframe and Budget (US$)					Comments
		2020	2021	2022	2023	2024	
14 To undertake appropriate research, development, monitoring and cooperation on POPs							
Institutional measures							
14.1 Establish the policy – science dialog for more targeted research based on national priorities related to POPs and other hazardous chemicals	DoE	5,000	5,000	5,000	5,000	5,000	
14.2 Develop networks among identified research institutions on national and international level on POPs and other hazardous chemicals	DoE	1,000	1,000	1,000	1,000	1,000	
Capacity building measures							
14.3 Establish capacities on health, exposure and risk assessment to POPs and other hazardous chemicals	DoE	50,000			10,000		
14.4 Develop laboratory capacity and/or international cooperation for POPs and other hazardous chemicals considered relevant for the country, including establishing effective quality assurance and quality control system	DoE	5,000			5,000		
Education and awareness measures							
14.5 Improve the communication of POPs and other hazardous chemicals research/scientific findings to the policy and decision makers and to the public	DoE	5,000	5,000	5,000	5,000	5,000	
	TOTAL	**66,000**	**11,000**	**11,000**	**26,000**	**11,000**	

Annex 1: Record of Stakeholder and Public Consultation

Name	Position	Department	Email
Mr Makasini Latu	Principal Land Transport Officer	Motor Registrations Branch	Available on request
Mr Jese Tikomailepanoni	Manager	TOTAL Tonga	
Mr Sau Pulineau Niulala	Senior Assistant Deputy CEO	Tonga Customs Services	
Mr Neil Jenkins	Operations Manager and Advisor	WAL	
Ms 'Ofa Tu'ikolovatu	CEO	Gio Recycling Ltd	
Ms Jasmin Dodge	Pharmacist	Village Mission Clinic and Pharmacy	
Ms Melenaite Mahe	Head Pharmacist	Ministry of Health	
Mr Ifalemi Tauheluhelumau	CEO	Pacific Energy	
Mr Steven Esau	Acting CEO	Tonga Power Ltd	
Mr Filimone Lapao'o	Senior Environmentalist	Department of Environment	
Mr Metui Falesiva	Deputy CEO	MAFF	
Mr Sinamoni Kauvaka	Defence, Fire and Emergency Services Officer	Tonga Fire and Emergency Services	
Mr Malesiale Latu	Laboratory Technician	USP	
Ms Jenny Nishi	Manager	Nishi Trading	
Mr Tiane Tukuafu	Compliance Officer	WAL	
Mr Peioneti Lui	Quarantine Officer	Quarantine	
Ms Rylee James	Volunteer	Department of Environment	
Ms Sulieti Hufanga	Conservation/Waste Officer	Department of Environment	
Ms Lesieli Mahe	PHIG Officer	Public Health	
Ms Mafileo Masi	Chief Environmental Officer	Department of Environment	
Mr Sililo Ali	Chief Fire Officer	Fua'amotu International Airport Corporation	
Mr 'Apolo Taufo'ou	Sanitation Officer	Ministry of Health	
Mr 'Alifeleti Kiola	Public Health Inspector	Public Health	
Mr Minoru Nishi	Managing Director	Nishi Trading	
Ms Lola Tonga	Manager Administration & Special Projects	WAL	

Annex 2: POPs Chemicals

Chemical	Date listed	Pesticide	Industrial chemical	By product
Annex A chemicals (elimination)				
Aldrin	May 2004	●		
Chlordane	May 2004	●		
Chlordecone	May 2009	●		
Decabromodiphenyl ether (commercial mixture, c-decaBDE	May 2017		●	
Dieldrin	May 2004	●		
Endrin	May 2004	●		
Heptachlor	May 2004	●		
Hexabromobiphenyl	May 2009		●	
Hexabromocyclododecane (HBCDD)	May 2013		●	
Hexabromodiphenyl ether & heptabromodiphenyl ether (Hexa BDE& Hepta BDE)	May 2009		●	
Hexachlorobenzene (HCB)	May 2004	●	●	●
Hexachlorobutadiene (HCBD)	May 2015		●	●
Alpha-hexachlorocyclohexane (α-HCH)	May 2009	●		
Beta-hexachlorocyclohexane (β-HCH)	May 2009	●		
Lindane (Ɣ-HCH)	May 2009	●		
Mirex	May 2004	●		
Pentachlorobenzene (PeCB)	May 2009	●	●	●
Pentachlorophenol and its salts and esters (PCP)	May 2015	●		
Polychlorinated biphenyls (PCBs)	May 2004		●	●
Polychlorinated naphthalenes	May 2015		●	●
Short-chain chlorinated paraffins (SCCPs)	May 2017		●	
Technical endosulfan and its related isomers	May 2011	●		
Tetrabromodiphenyl ether (tetraBDE) and pentabromodiphenyl ether (pentaBDE)	May 2009		●	
Toxaphene	May 2004	●		
Annex B chemicals (restriction)				
DDT	May 2004	●		
Perfluorooctane sulfonic acids and salts (PFOS) and Perfluorooctane sulfonyl fluoride (PFOS-F)	May 2009	●	●	
Annex C chemicals (unintentional production)				
Hexachlorobenzene (HCB)	May 2004			●
Hexachlorobutadiene (HCBD)	May 2017			●
Pentachlorobenzene (PeCB)	May 2009			●
Polychlorinated biphenyls (PCBs)	May 2004			●
Polychlorinated dibenzo-p-dioxins (PCDD)	May 2004			●
Polychlorinated di-benzofurans (PCDF)	May 2004			●
Polychlorinated naphthalenes	May 2015			●

Annex 3: uPOPs generation in Tonga

Source category	Activity rate	Annual release (g TEQ/year, unless stated otherwise)					
1. Waste incineration	tonnes/year	Air	Water	Land	Product	Fly ash	Bottom Ash
Quarantine waste							
Medical waste	35	0.641				0.003	0.003
Waste wood/biomass							
Animal carcasses							
Total							
2. Ferrous and non-ferrous metal production	tonnes/year	Air	Water	Land	Product	Residue	
Iron and steel plants							
Hot dip galvanising plants							
Copper production							
Aluminium production							
Lead production							
Zinc production							
Brass and bronze production							
Magnesium production							
Thermal non ferrous metal production (e.g. Nickel)							
Thermal wire reclamation and e-waste recycling							
3. Heat and power generation	Terajoules/ year	Air	Water	Land	Product	Residue	Ash (tonnes/ year)
Fossil fuel power plants							
Biomass power plants							
Household cooking with biomass	1,344	0.135	0	0	0	0.0	
Household cooking with propane							
Total							
4. Production of mineral products	tonnes/year	Air	Water	Land	Product	Residue	
Cement kilns							
Lime							
Brick							
Glass							
Asphalt mixing							
Total							

Source category	Activity rate	Annual release (g TEQ/year, unless stated otherwise)					
5. Transport	tonnes/year	Air	Water	Land	Product	Residue	
4-Stroke engines	196,223	0	0	0	0	0	
2-Stroke engines							
Diesel engines – regular diesel	248,406	0.025	0	0	0	0	
Heavy oil fired engines							
Total							
6. Open burning processes	tonnes/year	Air	Water	Land	Product	Residue	
Biomass burning (forest fires)							
Biomass burning (agriculture)	11,663	0.350	0	0.117	0	0	
Open burning of domestic waste	3,916	0.157	0	0.004	0	0	
Waste dump fires							
Total							
7. Production/use of chemicals and consumer goods	tonnes/year	Air	Water	Land	Product	Residue	
Pulp and paper mills							
Chlorinated inorganic chemicals							
Chlorinated aliphatic chemicals							
Chlorinated aromatic chemicals							
Other chlorinated and non-chlorinated chemicals							
Petroleum refining							
Textile plants							
Leather plants							
Total							
8. Miscellaneous processes	tonnes/year	Air	Water	Land	Product	Residue	
Drying of biomass							
Crematoria							
Smoke houses							
Dry cleaning							
Tobacco smoking	29.08	0	0	0	0	0	
Total							
9. Waste disposal & composting	tonnes/year	Air	Water	Land	Product	Residue	
Landfills and waste dumps							
Sewage/sewage treatment	4,800,000	0	0	0	0	0	
Open water dumping							
Composting	6,000	0	0	0	0.3	0	
Waste oil disposal							
Total		**1.3**	**0.0**	**0.1**	**0.3**	**0.0**	
Grand total	**2**						

Annex 4: POPs background information

Aldrin

Listed under Annex A

A pesticide applied to soils to kill termites, grasshoppers, corn rootworm, and other insect pests, aldrin can also kill birds, fish, and humans. In one incident, aldrin-treated rice is believed to have killed hundreds of shorebirds, waterfowl, and passerines along the Texas Gulf Coast when these birds either ate animals that had eaten the rice or ate the rice themselves. In humans, the fatal dose for an adult male is estimated to be about five grams. Humans are mostly exposed to aldrin through dairy products and animal meats.

Chlordane

Listed under Annex A

Used extensively to control termites and as a broad-spectrum insecticide on a range of agricultural crops, chlordane remains in the soil for a long time and has a reported half-life of one year. The lethal effects of chlordane on fish and birds vary according to the species, but tests have shown that it can kill mallard ducks, bobwhite quail, and pink shrimp. Chlordane may affect the human immune system and is classified as a possible human carcinogen. It is believed that human exposure occurs mainly through the air.

Chlordecone

Listed under Annex A

Chlordecone is a synthetic chlorinated organic compound, which was mainly used as an agricultural pesticide, miticide and fungicide. It had been used extensively in the tropics for the control of banana root bore. Currently, no use or production of the chemical is reported.

Decabromodiphenyl ether (commercial mixture, c-decaBDE)

Listed under Annex A

DecaBDE is used as an additive flame retardant and has a variety of applications including in plastics/polymers/composites, textiles, adhesives, sealants, coatings and inks. DecaBDE containing plastics are used in housings of computers and TVs, wires and cables, pipes and carpets. Commercially available decaBDE consumption peaked in the early 2000's, but c-decaBDE is still extensively used worldwide. The decaBDE is highly persistent, has a high potential for bioaccumulation and food-web biomagnification, as well as for long-range transport. Adverse effects are reported for soil organisms, birds, fish, frog, rat, mice and humans.

Dieldrin

Listed under Annex A

Used principally to control termites and textile pests, Dieldrin has also been used to control insect-borne diseases and insects living in agricultural soils. Its half-life in soil is approximately five years. The pesticide aldrin rapidly converts to Dieldrin, so concentrations of Dieldrin in the environment are higher than dieldrin use alone would indicate. Dieldrin is highly toxic to fish and other aquatic animals, particularly frogs, whose embryos can develop spinal deformities after exposure to low levels. Dieldrin residues have been found in air, water, soil, fish, birds, and mammals, including humans. Food represents the primary source of exposure to the general population.

Endrin

Listed under Annex A

This insecticide is sprayed on the leaves of crops such as cotton and grains. It is also used to control rodents such as mice and voles. Animals can metabolize endrin, so it does not accumulate in their fatty tissue to the extent that structurally similar chemicals do. It has a long half-life, however, persisting in the soil for up to 12 years. In addition, endrin is highly toxic to fish. The primary route of exposure for the general human population is through food, although current dietary intake estimates are below the limits deemed safe by world health authorities.

Heptachlor

Listed under Annex A

Primarily used to kill soil insects and termites, heptachlor has also been used more widely to kill cotton insects, grasshoppers, other crop pests, and malaria-carrying mosquitoes. It is believed to be responsible for the decline of several wild bird populations, including Canadian Geese and American Kestrels in the Columbia River basin in the US. Laboratory tests have also shown high doses of heptachlor to be fatal to mink, rats, and rabbits, with lower doses causing adverse behavioural changes and reduced reproductive success. Heptachlor is classified as a possible human carcinogen. Food is the major source of exposure for humans, and residues have been detected in the blood of cattle from the US and from Australia.

Hexabromobiphenyl (HBB)

Listed under Annex A

Hexabromobiphenyl is no longer produced or used in most countries. Hexabromobiphenyl is an industrial chemical that was used as a flame retardant, mainly in the 1970s as a component of: acrylonitrile-butadienestyrene (ABS) thermoplastics for constructing business machine housings and in industrial (e.g. motor housing), and electrical (e. g. radio and TV parts) products; as a fire retardant in coatings and lacquers, and in polyurethane foam for auto upholstery.

Hexabromocyclododecane (HBCD)

Listed under Annex A

HBCD is currently used in four principal product types: expandable polystyrene (EPS), extruded polystyrene (XPS), high impact polystyrene (HIPS) and in polymer dispersions for coating textiles. By far the dominant use is in expandable polystyrene, which is often referred to as Styrofoam. This is used for insulation in buildings and refrigerated trucks and containers, as a fill and shape material in concrete construction, in packaging, and as the filling material for bean bags. The HBCD is usually present at levels of about 0.5 to 2%. The chemical is not used for food-based applications, such as seafood boxes and clamshell food containers (as used with some takeaway food). Use in textile applications and electric and electronic appliances is smaller. HBCD is used a flame-retardant additive, providing fire protection during the service life of vehicles, buildings or articles, as well as protection while stored. At the end of their service life, products containing HBCD are likely to be disposed of in landfills, incinerated, recycled, or remain as waste in the environment. Insulation boards form the majority of HBCD containing waste. Packaging waste was found to be the main contributor to potential releases to soil due to uncontrolled landfill or compost, recycling of empty paper packaging, substances going to unknown destinations and the unprotected storage of packaging.

Hexabromodiphenyl ether and Heptabromodiphenyl ether

Listed under Annex A

Hexabromodiphenyl ether and heptabromodiphenyl ether are the main components of commercial octabromodiphenyl ether. They are used as flame retardant additives typically in housings of office equipment and business machines. Other uses include nylon and low-density polyethylene, polycarbonate, phenol-formaldehyde resins and unsaturated polyesters and in adhesives and coatings.

Hexachlorobenzene (HCB)

Listed under Annex A and Annex C

First introduced in 1945 to treat seeds, HCB kills fungi that affect food crops. It was widely used to control wheat bunt. It is also a by-product of the manufacture of certain industrial chemicals and exists as an impurity in several pesticide formulations. In high doses, HCB is lethal to some animals and, at lower levels, adversely affects their reproductive success. HCB has been found in food of all types.

Hexachlorobutadiene (HCBD)

Listed under Annex A and Annex C

HCBD was used as intermediate in the chemical industry or as a product. It was applied as a solvent (for rubber and other polymers); as a “scrubber” to recover chlorine containing gas or to remove volatile organic components from gas; as hydraulic, heat transfer or transformer fluid; or in gyroscopes. HCBD was also used in the production of aluminium and graphite rods.

Alpha and Beta Hexachlorocyclohexane (HCH)

Listed under Annex A

These two 'chemicals' are listed separately under the Convention, but in practice they are normally only encountered together as the commercial mixture of HCH isomers. The Convention listing for Hexachlorocyclohexane covers the alpha and beta isomers, and the Listing for Lindane covers the gamma isomer. Alpha-HCH and beta-HCH were not intentionally produced or commercialised but were produced as the main constituent of technical HCH (in the 1940s) which was used as an organochlorine insecticide. Technical HCH consists of 70 % alpha-HCH, 7 % beta-HCH and 13 % gamma-HCH (Lindane). There has been a gradual replacement of technical HCH by Lindane.

Lindane (gamma-HCH)

Listed under Annex A with a specific exemption for use as a human health pharmaceutical for control of head lice and scabies as second line treatment

Lindane is the common name for the gamma isomer of hexachlorocyclohexane (HCH). Lindane has been used as a broad-spectrum insecticide for seed and soil treatment, foliar applications, tree and wood treatment and against ecto-parasites in both veterinary and human applications. Human health pharmaceutical use for control of head lice and scabies is still allowed as a specific exemption under the Convention. It is applied usually in the form of shampoos or lotions, with the Lindane typically present at a concentration of around 1%.

Mirex

Listed under Annex A

This insecticide is used mainly to combat fire ants, and it has also been used against other types of ants and termites. It has also been used as a fire retardant in plastics, rubber, and electrical goods. The main route of human exposure to Mirex is through food, particularly meat, fish, and wild game. Direct exposure to Mirex does not appear to cause injury to humans, but studies on laboratory animals have caused it to be classified as a possible human carcinogen. It is considered to be one of the most stable and persistent pesticides, with a half-life of up to 10 years.

Pentachlorobenzene (PeCB)

Listed under Annex A and Annex C

PeCB was used in PCB products, in dyestuff carriers, as a fungicide, a flame retardant and as a chemical intermediate e.g. for the production of quintozene. PeCB is also produced unintentionally during combustion, thermal and industrial processes. It is also present as an impurity in products such as solvents or pesticides.

Pentachlorophenol (PCP) and its salts and esters

Listed under Annex A with specific exemptions for use in utility poles and cross-arms

Pentachlorophenol (PCP) is an organochlorine compound primarily used as an oil-based wood preservative. PCP is currently allowed worldwide only for wood preservation uses. By 1990s, widespread use was discontinued in most countries and at present it is banned in a number of countries. PCP consumption for wood preservation appears to concentrate in Canada and the USA (restricted to industrial use only), whereas Na-PCP appears to be mainly used in India, mainly for wood preservation purposes.

Polychlorinated biphenyls (PCBs)

Listed under Annex A with specific exemptions and under Annex C

These compounds are used in industry as heat exchange fluids, in electric transformers and capacitors, and as additives in paint, carbonless copy paper, and plastics. Of the 209 different types of PCBs, 13 exhibit a dioxin-like toxicity. Their persistence in the environment corresponds to the degree of chlorination, and half-lives can vary from 10 days to one-and-a-half years. PCBs are toxic to fish, killing them at higher doses and causing spawning failures at lower doses. Research also links PCBs to reproductive failure and suppression of the immune system in various wild animals, such as seals and mink. PCBs also suppress the human immune system and are listed as probable human carcinogens.

(Poly) Chlorinated Naphthalenes

Listed under Annex A and C with specific exemptions for use in the production of polyfluorinated naphthalenes, including octafluoronaphthalene

PCN have been used mainly for their chemical stability, including low flammability, their (electrically) insulating properties and recalcitrance, including resistance to biodegradation and biocidal function. PCN have historically been used as wood

preservatives, paints and engine oils additives, heat exchange fluids, high-boiling point specialty solvents, engine crank case additives and ingredients in motor tune-up compounds, in capacitors and for cable insulation, chemical-resistant gauge fluids, instrument seals and colour dispersions. While the use of PCN has ceased, they are also present in PCB formulations and are unintentionally produced during combustion processes and in industrial installations. PCN are also unintentionally generated during high-temperature industrial processes in the presence of chlorine. Of the known releases, combustion (primarily waste incineration) is considered the most significant current source.

Short-chained chlorinated paraffins

Listed under Annex A

Chlorinated paraffins are produced by chlorination of straight-chained paraffin fractions and are complex mixtures of certain organic compounds containing chloride: polychlorinated n-alkanes. The chlorination degree of CPs can vary between 30 and 70 wt %. SCCPs can be used as a plasticizer in rubber, paints, adhesives, flame retardants for plastics as well as an extreme pressure lubricant in metal working fluids. SCCPs are sufficiently persistent in air for long range transport to occur and appear to be hydrolytically stable. Many SCCPs can accumulate in biota. It is concluded that SCCPs are likely, as a result of their long-range environmental transport, to lead to significant adverse environmental and human health effects. The production of SCCPs has decreased globally as jurisdictions have established control measures.

Endosulfan and its related isomers

Listed under Annex A with a specific exemption

Endosulfan is an insecticide that has been used since the 1950s to control crop pests, tsetse flies and ecto-parasites of cattle and as a wood preservative. As a broad-spectrum insecticide, endosulfan is currently used to control a wide range of pests on a variety of crops including coffee, cotton, rice, sorghum and soy.

Tetrabromodiphenyl ether & pentabromodiphenyl ether (commercial pentabromodiphenyl ether)

Listed under Annex A with a specific exemption for use as articles containing these chemicals for recycling

Penta-BDE is a brominated flame retardant that inhibits or suppresses combustion in organic material. It has been used mainly was as a fire retardant in polyurethane foams for automotive seats and fittings and in the foams used for domestic furniture, mattresses and carpet underlay, and to a smaller extent non-foamed PUR in casings and electric and electronic equipment including computer casings. Use of PBDEs in electrical and electronic appliances was phased out from 1 July 2006.

Toxaphene

Listed under Annex A

This insecticide is used on cotton, cereal grains, fruits, nuts, and vegetables. It has also been used to control ticks and mites in livestock. Toxaphene was the most widely used pesticide in the US in 1975. Up to 50% of a toxaphene release can persist in the soil for up to 12 years. For humans, the most likely source of toxaphene exposure is food. While the toxicity to humans of direct exposure is not high, toxaphene has been listed as a possible human carcinogen due to its effects on laboratory animals.

DDT

Listed under Annex B with acceptable purpose for disease vector control

DDT was widely used during World War II to protect soldiers and civilians from malaria, typhus, and other diseases spread by insects. After the war, DDT continued to be used to control disease, and it was sprayed on a variety of agricultural crops, especially cotton. DDT continues to be applied against mosquitoes in several countries to control malaria. Its stability, its persistence (as much as 50% can remain in the soil 10-15 years after application), and its widespread use have meant that DDT residues can be found everywhere; residual DDT has even been detected in the Arctic. Perhaps the best-known toxic effect of DDT is egg-shell thinning among birds, especially birds of prey. Its impact on bird populations led to bans in many countries during the 1970s. Although its use had been banned in many countries, it has been detected in food from all over the world. Although residues in domestic animals have declined steadily over the last two decades, food-borne DDT remains the greatest source of exposure for the general population. The short-term acute effects of DDT on humans are limited, but long-term exposures have been associated with chronic health effects. DDT has been detected in breast milk, raising serious concerns about infant health.

Perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOS-F)

Listed under Annex B with a range of acceptable purposes

Perfluorooctane sulfonic acid (PFOS) is a highly fluorinated substance which can act as a highly effective repellent of both oil and water. These properties have provided PFOS with a wide variety of uses, for example PFOS has been used for the protection of paper, leather, fabric, upholstery and carpets, as a surfactant in the mining industry, and in floor polishes, photographic film, denture cleaners, shampoos, surface coatings (paints), and carpet cleaners. PFOS has also been used as an insecticide, specifically as bait for leaf-cutting ants, red fire ants and termites and as a component of fire-fighting foams. PFOS and PFOS-related substances can be released to the environment at their manufacture, during their use in industrial and consumer applications and from disposal of the chemicals or of products or articles containing them after their use. Acceptable purposes for the use of the chemical include: Photo-imaging, photo-resist and anti-reflective coatings for semi-conductor, etching agent for compound semi-conductor and ceramic filter, aviation hydraulic fluids, metal plating (hard metal plating) only in closed-loop systems, certain medical devices (such as ethylene tetrafluoroethylene copolymer (ETFE) layers and radio-opaque ETFE production, in-vitro diagnostic medical devices, and CCD colour filters), fire-fighting foam, insect baits for control of leaf-cutting ants.

Polychlorinated dibenzo-p-dioxins (PCDD)

Listed under Annex C

These chemicals are produced unintentionally due to incomplete combustion, as well during the manufacture of pesticides and other chlorinated substances. They are emitted mostly from the burning of hospital waste, municipal waste, and hazardous waste, and also from automobile emissions, peat, coal, and wood. There are 75 different dioxins, of which seven are considered to be of concern. One type of dioxin was found to be present in the soil 10 - 12 years after the first exposure. Dioxins have been associated with a number of adverse effects in humans, including immune and enzyme disorders and chloracne, and they are classified as possible human carcinogens. Laboratory animals given dioxins suffered a variety of effects, including an increase in birth defects and stillbirths. Fish exposed to these substances died shortly after the exposure ended. Food (particularly from animals) is the major source of exposure for humans.

Polychlorinated dibenzofurans (PCDF)

Listed under Annex C

These compounds are produced unintentionally from many of the same processes that produce dioxins, and also during the production of PCBs. They have been detected in emissions from waste incinerators and automobiles. Furans are structurally similar to dioxins and share many of their toxic effects. There are 135 different types, and their toxicity varies. Furans persist in the environment for long periods and are classified as possible human carcinogens. Food, particularly animal products, is the major source of exposure for humans. Furans have also been detected in breast-fed infants.

Annex 5: Tonga GMP results, 2008[196]

Chemical	Breast Milk (2008) (ng g^{-1} fat)
Aldrin	<LOQ
Chlordane	1.2 (oxychlordane)
Sum of 6 DDTs	716.4
Dieldrin	2.2
Endrin	<LOQ
Heptachlor	<LOQ
HCB	5.7
Sum 2 Heptachlorepoxides (cis+trans)	0.6
Mirex	<LOQ
2,3,7,8 TCDD	0.4
2,3,7,8 TCDF	0.4
Sum 17 PCDDs/Fs	42.4
Sum of 6 PCBs	7.3
Sum of 12 PCBs	1809.4
Toxaphene	<LOQ
Alpha-HBCD	1.5
Gamma-HBCD	0.1
Alpha-HCH	<LOQ
Beta-HCH	1.3
BDE	0.1-15.2
Gamma-HCH	0.5
Endosulphan	<LOQ

<LOQ - less than the limit of quantification
ND - Not Detected

[196]UNEP (2015). *Global monitoring plan for persistent organic pollutants second regional monitoring report annex asia-pacific region* 134pp.

ANNEX 6: Fomtec AFFF 3% ULTRA Foam Liquid Concentrate

fire protection TECHNOLOGIES

Fomtec AFFF 3% Ultra

fomtec

DATA SHEET

FORM NO. 32-FC-0143 ISSUE NO. A DATE: 15/06/2016

FOAM CONCENTRATE

DESCRIPTION

Fomtec AFFF 3% Ultra is an aqueous film forming foam concentrate (AFFF) consisting of fluorocarbon and hydrocarbon surfactants blended with various solvents, preservatives and stabilisers.
The foam forms an aqueous film that rapidly cuts off the oxygen supply and knocks down the fire. The expanded foam, from which the film is drained, forms a stable blanket that suppresses the release of flammable vapours and cools down the fuel surface extinguishing the fire and preventing reignition.
The low surface tension of the water-foam solution enables the aqueous film, although heavier than the burning liquid, to float on top of the liquid surface.
Fomtec AFFF 3% Ultra should be used at 3% proportioned solution (3 part concentrate in 97 parts of water) in brackish, fresh or sea water. It may also be stored as a premix solution in fresh water.

APPLICATION

Fomtec AFFF 3% Ultra is intended for use on class B hydrocarbon fuel fires such as oil, diesel and aviation fuels. It can be used with both aspirating and non-aspirating discharge devices.
Fomtec AFFF 3% Ultra is especially suited whenever rapid fire knock-down is essential. It is compatible with all dry chemical powders and can be used in powder/foam twin agent systems.

6 INSIDE

FIRE PERFORMANCE & FOAMING

The fire performance of this product has been measured and documented according to "International Approvals" stated in this document. The foaming properties are depending on equipment used and other variables such as water and ambient temperatures. Average expansion 8:1, average ¼ drainage time 02:30 minutes using UNI 86 test nozzle.

PROPORTIONING

Fomtec AFFF 3% Ultra can easily be proportioned at the correct dilution using conventional equipment such as:

- Inline inductors
- Balanced pressure, variable flow proportioning systems
- Bladder tanks
- Around the pump proportioning systems
- Water turbine driven foam proportioners
- Self inducting branch pipes and nozzles

The equipment should be designed to the foam type.

COMPATIBILITY

Contact one of the Fomtec sales team with questions.

INTERNATIONAL APPROVALS

- UL standard 162 (7th edition)
- ULC listed

TECHNICAL DATA

Appearance	Clear yellowish liquid
Specific gravity at 20°C	1,02 +/- 0,01 g/ml
Viscosity at 20°C	≤ 20 mPas
pH	6,5 – 8,5
Freezing point	-3°C
Recommended storage temperature	-3 – 55°C
UL-listed storage temperature*	1,7 - 49°C
Suspended sediment (v/v)	Less than 0,2%
Surface tension	≤ 18,0 dynes/cm

*This product is tested according to UL-standard and has passed the specific circumstances in the test.

Unit 1/251 Ferntree Gully Road, Mt Waverley, Victoria, 3149 Australia - P.O. Box 75, Mt Waverley, Victoria, 3149 - Phone: 1300 742 296
Email: enquiries@fire-protection.com.au Web: www.fire-protection.com.au

1

ENVIRONMENTAL IMPACT

Fomtec AFFF 3% Ultra is formulated using specially selected raw materials, selected for their fire performance and their environmental profile. Fomtec AFFF 3% Ultra is biodegradable. The handling of spill of concentrate or foam solutions shall how ever be made according to local regulations. Normally sewage systems will have no problem with a 3% foam solution based on Fomtec AFFF 3% S, but local sewage operators should be consulted in this respect. This product contains NO PFOS or PFOA.
Full details will be found in the Material Safety Datasheet (MSDS).

STORAGE / SHELF LIFE

Stored in original unbroken packaging the product will have a long shelf life. Shelf life in excess of 10 years will be found in temperate climates. As with all foams, shelf life will be dependent on storage temperatures and conditions. If the product is frozen during storage or transport, thawing will render the product completely usable.
Synthetic foam concentrates should only be stored in stainless steel or plastic containers. Since electrochemical corrosion can occur at joints between different metals when they are in contact with foam concentrate, only one type of metal should be used for pipelines, fittings, pumps, and tanks employed in the storage of foam concentrates. We recommend following our guidelines for storage and handling ensuring favourable storage conditions.

PACKAGING

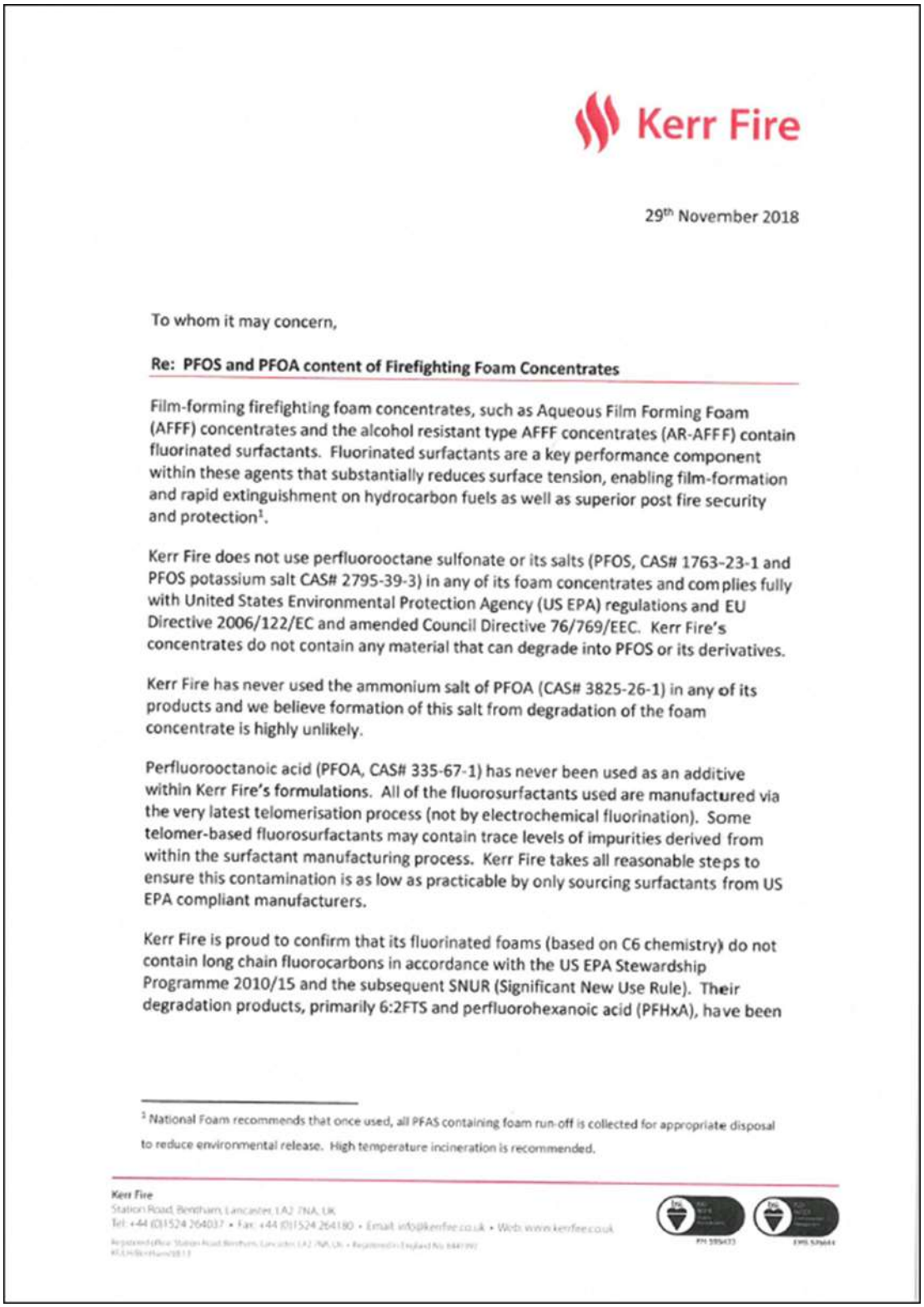
We supply this product in 25 litre cans and 200 litre drums. We can also ship in 1000 litre containers or in bulk.

Litres per piece	Packaging	Part no.:
20 litres	Can	10-3020-01
200 litres	Drum	12-3020-02
1000 litres	Container	12-3020-04
Bulk	Special Request	

DATA SHEET FORM NO. 32-FC-0143 ISSUE NO. A DATE: 15/06/2016

Unit 1/251 Ferntree Gully Road, Mt Waverley, Victoria, 3149 Australia - P.O. Box 75, Mt Waverley, Victoria, 3149 - Phone: 1300 742 296
Email: enquiries@fire-protection.com.au Web: www.fire-protection.com.au

ANNEX 7: Foamfilm 916K AFFF Foam Liquid Concentrate



Kerr Fire

29th November 2018

To whom it may concern,

Re: PFOS and PFOA content of Firefighting Foam Concentrates

Film-forming firefighting foam concentrates, such as Aqueous Film Forming Foam (AFFF) concentrates and the alcohol resistant type AFFF concentrates (AR-AFFF) contain fluorinated surfactants. Fluorinated surfactants are a key performance component within these agents that substantially reduces surface tension, enabling film-formation and rapid extinguishment on hydrocarbon fuels as well as superior post fire security and protection[1].

Kerr Fire does not use perfluorooctane sulfonate or its salts (PFOS, CAS# 1763-23-1 and PFOS potassium salt CAS# 2795-39-3) in any of its foam concentrates and complies fully with United States Environmental Protection Agency (US EPA) regulations and EU Directive 2006/122/EC and amended Council Directive 76/769/EEC. Kerr Fire's concentrates do not contain any material that can degrade into PFOS or its derivatives.

Kerr Fire has never used the ammonium salt of PFOA (CAS# 3825-26-1) in any of its products and we believe formation of this salt from degradation of the foam concentrate is highly unlikely.

Perfluorooctanoic acid (PFOA, CAS# 335-67-1) has never been used as an additive within Kerr Fire's formulations. All of the fluorosurfactants used are manufactured via the very latest telomerisation process (not by electrochemical fluorination). Some telomer-based fluorosurfactants may contain trace levels of impurities derived from within the surfactant manufacturing process. Kerr Fire takes all reasonable steps to ensure this contamination is as low as practicable by only sourcing surfactants from US EPA compliant manufacturers.

Kerr Fire is proud to confirm that its fluorinated foams (based on C6 chemistry) do not contain long chain fluorocarbons in accordance with the US EPA Stewardship Programme 2010/15 and the subsequent SNUR (Significant New Use Rule). Their degradation products, primarily 6:2FTS and perfluorohexanoic acid (PFHxA), have been

[1] National Foam recommends that once used, all PFAS containing foam run-off is collected for appropriate disposal to reduce environmental release. High temperature incineration is recommended.

Kerr Fire
Station Road, Bentham, Lancaster, LA2 7NA, UK
Tel: +44 (0)1524 264037 • Fax: +44 (0)1524 264180 • Email: info@kerrfire.co.uk • Web: www.kerrfire.co.uk

Kerr Fire

shown not to be bioaccumulative and also exhibit low toxicity according to global regulatory standards[2].

Kerr Fire's products are formulated to offer superior performance with the lowest level of fluorinated surfactants to best address possible environmental concerns.

For and on behalf of Kerr Fire,
Yours Sincerely,

David Plant
Global Product Manager – Firefighting Chemicals

[2] DuPont (2012) "DuPont Surface Protection Solutions: Product Stewardship Detail."

Kerr Fire
Station Road, Bentham, Lancaster, LA2 7NA, UK
Tel: +44 (0)1524 264037 • Fax: +44 (0)1524 264180 • Email: info@kerrfire.co.uk • Web: www.kerrfire.co.uk