Gagetown Harmful Chemical Study Commission

Thursday, November 30, 2023
Time: 12:00 p.m. to 4:00 p.m.
Location: State House, Room 437

The meeting will be streamed live at the following link: https://legislature.maine.gov/Audio/#437

AGENDA

I. [12:00 p.m.] Welcome and introductions

II. Overview of new materials and summary of status of requests for information

III. Invited speakers:
- *Barrett Fisher, Veterans Claims Supervisor – DVEM*
- *Meg Sears, PhD (biochemical engineering), Chair, Prevent Cancer Now*
- *Gary Goode, Chair, Brats In The Battlefield*
- *Kelley Porter Franklin*

IV. Discussion of initial findings and possible recommendations

V. Next steps, establish next meeting date

Additional information and materials are available on the Commission's webpage at:
https://legislature.maine.gov/gagetown-harmful-chemical-study-commission

APPROVED | CHAPTER
APRIL 2, 2014 | 100
BY GOVERNOR | RESOLVES

STATE OF MAINE

IN THE YEAR OF OUR LORD

TWO THOUSAND AND FOURTEEN

S.P. 623 - L.D. 1632

Resolve, Directing the Commissioner of Defense, Veterans and Emergency Management To Request the Federal Government To Recognize Environmental Hazards at the Military Training Center in Gagetown, New Brunswick and the Resulting Health Risks and Disabilities Suffered by Certain Members of the Maine National Guard

Sec. 1. Request to United States Department of Veterans Affairs. Resolved: That the Commissioner of Defense, Veterans and Emergency Management shall request the United States Department of Veterans Affairs to recognize the environmental hazards present at the 5th Canadian Division Support Base in Gagetown, New Brunswick, Canada, and the resulting potential health risks and disabilities to veterans who, as members of the Maine National Guard, trained in partnership with Canadian military forces at the 5th Canadian Division Support Base in Gagetown; and be it further

Sec. 2. Report. Resolved: That, no later than January 10, 2015, the Commissioner of Defense, Veterans and Emergency Management, or the commissioner's designee, shall report to the joint standing committee of the Legislature having jurisdiction over veterans and legal affairs on the status of the request submitted to the United States Department of Veterans Affairs pursuant to section 1 and include a summary of any correspondence regarding these issues to and from the State's congressional delegation.

STATE OF MAINE
ONE HUNDRED AND THIRTY-FIRST LEGISLATURE
GAGETOWN HARMFUL CHEMICAL STUDY COMMISSION

November 20, 2023

Senator Susan Collins
413 Dirksen Senate Office Building
Washington, DC 20510

Senator Angus King
133 Hart Building
Washington, DC 20510

Representative Jared Golden
1710 Longworth HOB
Washington, DC 20515

Representative Chellie Pingree
2354 Rayburn House Office Building
Washington DC 20515

Re: Invitation to Attend Meeting of Gagetown Harmful Chemical Study Commission

Dear Senator Collins, Senator King, Representative Golden and Representative Pingree:

We are writing to invite your presence and/or participation at meeting of the Gagetown Harmful Chemical Study Commission, established by Maine Resolve 2023, Chapter 95, which seeks to study the impacts of exposure to harmful chemicals on veterans who served at the Canadian military support base in Gagetown, New Brunswick, Canada. A full version of the legislation is attached to this letter.

A major goal of the Commission is to help bring recognition to the environmental hazards present at the 5th Canadian Division Support Base in Gagetown, New Brunswick, Canada and to those Maine veterans and Maine National Guard service members who have experienced disease and disability as a result of exposure to these environmental hazards when training there and to alleviate some of the roadblocks that exist for Maine veterans and Maine National Guard service members in the claims process.

Recognizing that your offices have been involved in some of the work that has been done to address this issue over the past decade, the Commission understands that any path forward regarding the harmful use of chemical spraying at Gagetown will benefit from the involvement of the Federal Delegation, and the US Dept. of Veterans Affairs. As such we are inviting you or a member of your staff to participate in any proceedings of the Commission. The next scheduled meeting of the Commission will take place on Thursday, November 30th at 12 PM in room 437 of the Maine State House. The ability to attend remotely via Zoom is also possible.

Thank you for your attention to this matter and, should you have any questions, please do not hesitate to contact us. The Commission is staffed by Rachel Olson and Eli Murphy and can be contacted at rachel.olson@legislature.maine.gov and elias.murphy@legislature.maine.gov.

Sincerely,

President Troy Jackson
Senate Chair

Ronald Russell
House Chair

Agent Orange Investigations at Base Gagetown

Agent Orange is an unregistered herbicide and chemical defoliant that was created by the U.S. military in the 1960s for U.S. military brush control and vegetation management. For three days in June 1966 and four days in June 1967, Agent Orange, Agent Purple, Agent White, and other herbicides were sprayed by the U.S. military at 5th Canadian Division Support Base Gagetown to test their effectiveness for vegetation management. These tests were conducted with the permission of Canada, and are the only known instances in which Agent Orange was tested on CAF property.

These barrels of herbicides were transported to Base Gagetown by the U.S. military, and records indicate that they returned to the U.S. with the U.S. military once its testing was completed in 1967. While there is no evidence that Agent Orange barrels were disposed of at Base Gagetown, the standard practice of the time was to dispose of chemical waste, including herbicides, by burying them in barrels. Environmental practices have changed considerably since then, and all of these former disposal sites are being maintained in accordance with federal environmental regulations and guidelines. No barrels of Agent Orange have been found at Base Gagetown to date.

Former disposal sites

There are five former waste disposal sites at Base Gagetown: the Shirley Road main dump, the drum disposal area, the asbestos dump area, the chemical container disposal area, and the ash disposal site. All of these sites were used to dispose of barrels of herbicides, with the exception of the ash disposal site, which was only ever used to dispose of ash from Base Gagetown's former central heating plant. Following research into the testing and use of herbicides at Base Gagetown, the Tank Firing Point was identified as a potential former barrel disposal site. This area was investigated in 2005, and results of this investigation confirmed that no barrels of herbicides were found at the site.

These sites were all closed by the mid-1990s, and have been capped with fresh soil to form a barrier between the contaminated materials and the surface. Capping ensures that precipitation runs along the surface of the cap into surrounding ditches, reducing the potential for contaminated materials to migrate. These sites are currently undergoing long-term environmental monitoring to ensure that federal environmental standards for soil and surface water or groundwater are being met. The only site that was not capped was the former chemical container disposal area, which was excavated and remediated in 1984. All barrels found at this site were removed at the time, and none of these barrels had markings indicating they contained Agent Orange.

Agent Orange Investigations at Base Gagetown

Since the 1980s, DND has conducted extensive research into the use and testing of herbicides, including Agent Orange, to better understand the circumstances and effects of their use at Base Gagetown.

August 2018 barrel investigation

In June 2018, a retired CAF member identified a new area of interest near the former Shirley Road dump. Following this site visit, an independent third-party expert, MRS Management Ltd., in a joint venture with Gemtec Consulting Engineers and Scientists Ltd., conducted a thorough investigation of this site in August 2018. The area identified was about 223 hectares, or roughly 182 Canadian football fields, including end zones. This investigation began with a detailed aerial survey to scan the ground for magnetic anomalies that could have represented buried barrels. The results of this aerial survey identified several metallic anomalies buried at the site requiring further investigation. The aerial survey was followed by a ground survey, which involved the use of magnetic sensors to identify additional metallic anomalies below ground. 105 anomalies were identified and manually excavated as part of the ground survey. Items found at these target locations included an ammo box, scrap metal, cable, a 10-inch spike, and some wire and steel piping, however, no barrels were found. These results match those from previous investigations, and confirm that this area is not a former barrel disposal site, and that no barrels of Agent Orange have been found at Base Gagetown to date.

Future Investigations

The results of the August 2018 investigation match those from previous studies, and confirm that there is no evidence of buried Agent Orange barrels at Base Gagetown. As a result, we have no plans for future activities at this time. The results from this investigation have provided greater certainty about the past use of unregistered herbicides at Base Gagetown, and will be used to inform ongoing environmental monitoring and management activities at former barrel and waste disposal sites.

2005-2007 Herbicide Fact-Finding Investigation

In 2005, DND, along with Veterans Affairs Canada, Health Canada, and various other departments and agencies, began an exhaustive fact-finding investigation to understand the health and environmental risks associated with the past use of registered and unregistered herbicides at Base Gagetown. Research for this investigation was conducted by highly-qualified, non-government experts, and was peer-reviewed by independent specialists in the field. This entire investigation was overseen by Dr. Dennis Furlong, who was named as the Independent Fact-Finding and Outreach Coordinator.

This investigation involved a comprehensive approach in order to understand the past testing and use of herbicides at Base Gagetown, and included several fact-finding tasks, including:

- compiling a list of individuals and military units who were present at Base Gagetown during the testing of herbicides in 1966 and 1967;
- a historical records review of past herbicide use at Base Gagetown between 1952 and 2005, including water and soil sampling;
- consulting with current and former CAF/DND personnel, contractors, local community members, and members of the public about areas to investigate;
- barrel investigations, excavation, and analysis of former disposal sites;
- human health risk assessments, including how individuals may have been exposed to herbicides, and how the herbicides may have migrated through the air and groundwater/surface water at specific sites;
- an epidemiological literature review to understand the relationship between herbicides and human health; and
- testing the tissue of fish and freshwater clams from Base Gagetown for dioxin concentrations.

The results of this investigation concluded that, aside from the two instances of testing in 1966 and 1967, all herbicides used at Base Gagetown were regulated and used in accordance with all federal and provincial regulations and scientific policies at the time. Additionally, while soil testing identified levels of dioxins exceeding Canadian soil guidelines, further testing confirmed that their levels posed no risk to human health. Water sample testing confirmed that surface and groundwater from Base Gagetown never exceeded government water guidelines. Results from testing the tissue of fish and freshwater clams confirmed that dioxin levels were consistent with, or below regulated limits for fish and freshwater clams from other locations.

As part of the barrel investigation and excavation work, 14 sites across Base Gagetown were investigated between 2005 and 2006. This involved geophysically surveying the sites for metallic anomalies that may have represented buried barrels of herbicides. Metallic anomalies were identified at six sites and were excavated. Only scrap metal was found at these sites – no barrels were found.

The results from the human health risk assessments concluded that most people who lived and worked at or near Base Gagetown were not at risk of exposure to herbicides. These results also indicated that only specific populations, including those directly involved with herbicide applications and brush clearings soon after application, were at a greater risk for developing adverse health outcomes. As compensation for the possible exposure to unregistered U.S. herbicides between 1966 and 1967, the Government of Canada provided eligible individuals with a one-time, tax-free ex gratia payment of $20,000.

2006 DND-Wide Herbicide Use Project

In 2006, Public Services and Procurement Canada contracted Golder Associates Ltd. to research, organize, and analyze all available information on the use of herbicides at all DND locations across Canada. The purpose of this investigation was to determine whether Agent Orange and other

unregistered U.S. herbicides were tested at other Canadian Armed Forces sites across Canada. The results of this investigation confirmed that, while commercially available herbicides 2,4,5-T and 2,4-D were used and stored at CFB Chatham, CFB Gagetown, CFB Borden, and Canadian Forces Station Carp, Agent Orange and other unregistered U.S. herbicides were only used at Base Gagetown. Additional information on herbicide use was collected and reviewed in 2011, and the results matched previous findings from the 2006 investigation.

Related products

The Use of Herbicides at CFB Gagetown from 1952 to Present Day

Date modified:
2019-01-30

ARCHIVED - The Use of Herbicides at CFB Gagetown from 1952 to Present Day

We have archived this page and will not be updating it.

You can use it for research or reference.

Agent Orange Ex-gratia Payment

The new deadline for applications is June 30, 2011.

On December 22, 2010, the Honourable Jean-Pierre Blackburn, Minister of Veterans Affairs and Minister of State (Agriculture), announced that the Government of Canada is extending the one-time, tax-free ex gratia payment of $20,000 related to the testing of unregistered U.S. military herbicides, including Agent Orange, at Canadian Forces Base (CFB) Gagetown in 1966 and 1967.

For more information on eligibility criteria, contact Veterans Affairs Canada by visiting www.vac-acc.gc.ca or calling 1-866-522-2122.

For three days in June 1966 and four days in June 1967, Agent Orange, Agent Purple and other unregistered herbicides were tested at Canadian Forces Base (CFB) Gagetown in cooperation with the U.S. military to evaluate their effectiveness. These are the only known instances that these military test chemicals were used at CFB Gagetown. Agent Orange, Agent Purple and other unregistered herbicides are not used at the base today. The base uses only federally regulated herbicides for brush control during its annual vegetation management program.

In August 2005 the Department of National Defence, with participation from Veterans Affairs Canada, Health Canada, and additional departments and agencies, initiated a fact-finding mission to gain information on the history of herbicides tested and used at CFB Gagetown from 1952 to the present day, and the potential risks to human health and the environment. A major interdepartmental effort has occurred over the past two years to conduct the analysis necessary to provide all the facts.

An independent Fact-finding and Outreach Coordinator, Dr. Dennis Furlong, was named to oversee this process. His work included providing input on the plans and reports for each fact-finding task, as well as being the principal contact for those seeking information about herbicide testing and use at

CFB Gagetown. The fact-finding tasks were conducted by contracted, highly qualified non-governmental experts.

The draft reports of the scientific research were peer-reviewed by qualified, independent experts. The contractors addressed their comments, and the final reports were provided directly and concurrently to the Ministers of National Defence, Veterans Affairs, and the Fact-finding and Outreach Coordinator. Reports involving human health aspects were also provided to the Minister of Health. The Fact-finding and Outreach Coordinator, accompanied by the appropriate experts, then shared the results of each report with the public.

All of the fact-finding tasks are now complete, and there is a much clearer understanding and greater knowledge of the testing and use of herbicides at CFB Gagetown. Scientific study from the excavations, soil, water and vegetation sampling, human health risk assessments, and the epidemiological study indicates that most people who lived near or worked at CFB Gagetown were not at risk for long-term health effects from the herbicides applied there. The science also indicates that the base is safe today.

Results of the Fact-finding Tasks

Task 1

As part of the fact-finding initiative, the Department of National Defence committed to producing a comprehensive list of individuals and military units who were present at CFB Gagetown during the testing of Agent Orange, Agent Purple and other herbicides in 1966 and 1967, and during the eight to 12 weeks per year (between June and August) from 1952 to the present day when application of herbicides took place.

The contractor for this task, Canadian Development Consultants International Inc, compiled a database with relevant information on more than 115,000 individuals. Information that was not deemed to be of a personal nature (this includes such information as the names, ranks and units of some individuals, as well as the dates they were in Gagetown) was made public. Personal information (this includes such things as age, employee numbers, home addresses and family information) will not be made public.

Any information collected from individuals by the Fact-finding and Outreach Coordinator's office is also considered personal and will not be made public. Individuals who wish to submit a request for personal information may do so under the Privacy Act through the Directorate Access to Information and Privacy at National Defence.

Task 2A

The objective of this task was to review the history of the use of herbicides at the CFB Gagetown range and training area from 1952 to the present day, to compile a comprehensive database for this information, and to provide information on the types of herbicides used and how they were used.

The contractor, Jacques Whitford, determined that aside from the military products used in the herbicide trials in 1966 and 1967, the herbicides applied at CFB Gagetown over the past fifty years were regulated and commonly used across Canada. The herbicide application program at CFB Gagetown followed the policies, science, and best practices of the time, as regulated by Federal and Provincial governments. Where specific information could be obtained from historical records, rates of application of herbicides used at CFB Gagetown were either within, or in many instances lower than, the recommended application rates suggested by the manufacturer.

Task 2B

The purpose of this task was to conduct an environmental site assessment of the range and training area at CFB Gagetown.

Based on the laboratory tests, only concentrations of dioxins and arsenic in some of the soil samples exceeded the Canadian soil quality guidelines. The highest concentrations of dioxins in soil were found in the location of the 1967 test plots. Concentrations slightly above Canadian guidelines of dioxins in soil were also found in the Clones bivouac site, the Murphy bivouac site, the Enniskillen

Range, the 1966 test plots, and four other discrete sites in the range and training area. In a proactive precautionary measure, DND temporarily restricted site access to areas where dioxins concentrations were the highest (1967 test plots), as well as where human exposure to surface soils would be the most concentrated (in the bivouacs) until the results of a site specific risk assessment were completed. Further study determined that the dioxin levels in these areas posed no risk to human health.

Groundwater and surface water samples had concentrations of dioxins less than the Ontario Ministry of the Environment drinking water quality objective, which was used as a comparison due to the absence of a Canadian drinking quality guideline.

Task 2C

This task aimed to conduct a barrel investigation, and excavation program and analysis. During the excavation process, no herbicide barrels were discovered.

Task 2D

This task modelled how herbicides migrated through the air from aerial application in order to provide exposure scenarios for the health risk assessment identified in Task 3A-1.

Task 2E

The goal of this task was to assess whether herbicides and associated contaminants may have migrated through groundwater and/or surface water.

The contractor for this task, Jacques Whitford, concluded that it would be difficult, expensive and take considerable time to quantitatively estimate surface water migration. It is not possible to quantitatively estimate groundwater migration due to the variability of conditions across the base

and the lack of adequate data on soils and geology. Cantox Environmental used the Jacques Whitford scoping report, together with a qualitative approach, to eliminate the water exposure pathway from further consideration in the health risk assessments.

Task 3A-1

The objective of this task was to conduct a historical human health risk assessment to determine how humans may have been exposed to herbicides and military test chemicals at the time of use, and the potential risks to human health. This study was done in three tiers. Tier 1 concentrated on the contaminants related to the 1966 and 1967 testing of unregistered military chemicals. Tiers 2 and 3 concentrated on all other years of registered herbicide use.

The contractor for this task, Cantox Environmental, concluded that the military chemicals tested at CFB Gagetown in 1966 and 1967, the known contaminants in the herbicides used at CFB Gagetown during the annual spray program in the period prior to the late 1960s, and the active ingredients in the herbicides used at CFB Gagetown during the annual spray program posed no long-term risk to human health and safety for most individuals. Those who were directly involved during applications or who worked in the bush immediately after application may have some increased risk. The contractor also concluded that the known contaminants in the herbicides used at CFB Gagetown during the annual spray program after the late 1960s posed no long-term risk to human health and safety.

Task 3A-2

For this task, a present day contaminated site human health risk assessment, using data gathered from Task 2B, was conducted to assess current exposures and human health risks for all contaminants of potential concern identified in the water, soil, sediment, and vegetation environmental media sampled and analyzed at CFB Gagetown.

The results of this task indicate there is currently no risk to human health (as a result of herbicide use) in the areas of the base where access was restricted as a precautionary measure following the environmental site assessment.

Task 3B

The objective of this task was to perform a literature review of all epidemiologic studies examining the relationship between herbicides (those applied at CFB Gagetown) and human health, and to conduct a descriptive epidemiological study to determine whether the communities surrounding CFB Gagetown had a higher incidence of illness as compared to the general population of the province of New Brunswick.

The contractor for Task 3B, Dalhousie University led by Dr. Judy Guernsey, concluded that the communities surrounding CFB Gagetown do not have a significantly higher incidence of illness, as compared to the province of New Brunswick.

Task 3

A consolidated report for all parts of Task 3 was completed. This report includes the results of the epidemiology research integrated with the results of the human health risk assessments.

Task 4

The purpose of Task 4 was to provide information on tissue dioxin concentrations in fish and freshwater clams sampled within the CFB Gagetown Range and Training Area. These data provide estimates to whether there is a potential risk to humans from consumption of fish and freshwater clams at CFB Gagetown.

The contractor for Task 4, G.A. Packman and Associates, concluded that the levels of dioxins in fish and freshwater clams at CFB Gagetown were either below or consistent with regulated limits and values for fish and freshwater clams from other locations.

DND Wide Herbicide Use Project

In 2006, Golder Associates Ltd. (Golder) was retained by Public Works and Government Services Canada on a series of contracts on behalf of the Department of National Defence (DND) to research, organise and analyse all available information concerning the herbicides used at each Canadian Forces (CF) site across Canada. An objective of this undertaking was to confirm whether tactical herbicides such as Agent Orange and Agent Purple tested in 1966 and 1967 at CFB Gagetown were ever tested at other current and former CF Bases, Stations or Wings.

Golder’s review of the information has found no evidence of spray applications of the tactical herbicides Agent Orange or Agent Purple at any Bases, Stations or Wings aside from CFB Gagetown. Records do indicate that the non-tactical and commercially available herbicides 2,4,5-T and 2,4-D were potentially concurrently used, stored or disposed at each of Carp (Ontario), CFB Chatham and CFB Gagetown (New Brunswick), CFB Borden (Ontario) and another unidentified site.

As such, evidence to-date is to the effect that Agent Orange and Agent Purple were only applied at CFB Gagetown.

Health Information Summary for CF Members

The following information was issued on behalf of the Canadian Forces Surgeon General. It was intended to assist CF medical staff in placing the health risk in context and to serve as a direct reference for concerned CF members who desire more detailed and specific information than is available from existing herbicide and dioxin information sheets produced by various health authorities.

This document summarizes the findings of scientific studies and reviews specific to Agent Orange or otherwise relevant to recent concerns regarding human exposure and health effects of unregistered herbicides tested at CFB Gagetown June 14-16, 1966, and June 21-24, 1967. This document is organized into four main sections. The first three sections ("GENERAL INFORMATION" , "HEALTH EFFECTS" , and

"FATE IN THE ENVIRONMENT") provide background information. Much of this background information is related to the United States use of Agent Orange and other herbicides during the Vietnam War and the scientific study of exposed U.S. Vietnam veterans. This background information is necessary to provide context for the discussion in section four ("HEALTH EFFECTS FROM SPRAYING IN GAGETOWN") of health risks related to the testing of Agent Orange and other unregistered herbicides at CFB Gagetown June 14-16, 1966, and June 21-24, 1967.

DND has also used other (registered) herbicides at CFB Gagetown and across Canada since the 1950s. This broader use of registered herbicides will be reviewed over the next several years and relevant health information will be provided separately in the future. Although this document focuses on the testing of unregistered herbicides at CFB Gagetown June 14-16, 1966, and June 21-24, 1967, parts of this document would also be relevant to the discussion of potential health effects from chemical exposures in general (see especially "Under what circumstances might Agent Orange or its ingredients lead to health effects?").

General Information

What is Agent Orange?

The U.S. military used several different herbicide mixtures during the Vietnam War. These mixtures contained herbicides that were commercially available in the 1960's, but the mixtures themselves were made specifically for the U.S. military. In order to readily identify these different mixtures in the field, the storage drums for these mixtures used in Vietnam were painted with coloured bands, such as pink, purple, blue, white, green, and orange. The herbicide in the orange drums was an equal mixture of 2,4-D and 2,4,5-T (2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid). It became known as "Agent Orange", as this was the colour of the bands on the drums it was stored in. In Vietnam, more than 45 million liters of Agent Orange were sprayed (the most of any herbicide formulation) and less than 2 million liters of Agent Purple were sprayed during the war (Stellman et al., 2003).

What is Agent Purple?

Both Agent Orange and Agent Purple were 50-50 mixtures of 2,4-D and 2,4,5-T; the distinction is in the type of 2,4,5-T. Agent Orange was a 50-50 mixture of n-butyl ester 2,4-D and n-butyl ester 2,4,5-T. Agent Purple contained 50% n-butyl ester 2,4-D, 30% n-butyl ester 2,4,5-T, and 20% isobutyl ester 2,4,5-T.

What is TCDD?

TCDD is an abbreviation for 2,3,7,8-tetrachlorodibenzo- p -dioxin (which can also be abbreviated as 2,3,7,8-TCDD). TCDD was an unintended contaminant in the production of 2,4,5-T. Therefore, TCDD was also a component of herbicide mixtures containing 2,4,5-T, such as Agent Orange. According to

the U.S. Institute of Medicine, " TCDD is thought to be the most toxic of the compounds " used in Vietnam (Institute of Medicine, 2005).

TCDD is one specific type of chemical from a family of chemicals known as "dioxins". Some of the chemicals within the dioxin family are considered to be toxic whereas others are much less toxic. TCDD is considered to be the most toxic of the dioxins. Because of this, the toxicity of mixtures of dioxins is usually described in relation to TCDD. The scientific term for this is "toxic equivalent", or TEQ: the toxicity of a mixture of dioxins, expressed as an amount of TEQ, is comparable to the toxicity of the same amount of pure TCDD.

In later parts of this document ("Is Agent Orange the only source of TCDD?" and "Can TCDD be measured in our bodies"), some of the cited references discuss amounts of TEQ and amounts of TCDD. For simplicity, only the term "TCDD" is used in those sections.

How much is a part per million (ppm)?

The term "part per million" is used to describe the concentration of one substance (the "part") contained within another substance (the "per million"). Using the example of 2 ppm TCDD contamination, every million parts of Agent Orange would contain 2 parts of TCDD. If the TCDD contamination were 2 ppm, then a 55-gallon drum of Agent Orange would contain 4 drops of TCDD. If the TCDD contamination were 47 ppm (such as an Agent Purple sample), a 55-gallon drum of Agent Purple would contain about one third of a one-ounce shot glass of TCDD.

How much is a part per trillion (ppt)?

A part per trillion is a very tiny amount. One ppt is equivalent to 1 second in about 32 000 years, 1 drop of water in 40 Olympic size swimming pools, or the distance of 1 centimeter (the width of your "pinkie" fingernail) in 1200 round trips between Fredericton and Vancouver.

How much TCDD did Agent Orange and Agent Purple contain?

It is not known with certainty how much TCDD was in the Agent Orange and Agent Purple used by the United States during the Vietnam War. Because TCDD was an unintended contaminant, it was not routinely measured at the time these herbicide mixtures were made. However, the TCDD content can be estimated from samples collected from these herbicides. A survey of 15 million pounds of Agent Orange (200 samples) conducted by the U.S. Air Force revealed that the average TCDD content of the mixture was 1.91 ppm (parts per million, equivalent to mg/kg), and 68% of the samples contained 0.5 ppm or less of TCDD (Kearney et al., 1973). Four saved samples of Agent Orange left over from testing at Eglin Air Force Base in Florida had a mean TCDD concentration of 2.4 ppm (range 0.04 to 6.4 ppm); an analysis of 490 Agent Orange samples from U.S. and Pacific inventories had an average concentration of 2 ppm (Young et al., 2004b). Recently, it has been suggested that these values are an underestimate, and that an average TCDD contamination of 13 ppm for Agent Orange may be more realistic (Stellman et al., 2003).

Less information is available for Agent Purple. In the testing of 200 Agent Orange samples mentioned above, the four highest TCDD values of 17, 22, 33, and 47 ppm were actually Agent Purple, and not Agent Orange (Stellman, 2003). One saved Agent Purple sample at Eglin Air Force Base contained 45 ppm TCDD (Young et al., 2004b).

Health effects

What health effects are associated with Agent Orange?

In 1991, because of uncertainty about the long-term health effects on Vietnam veterans of herbicide exposure, the U.S. Congress passed legislation that enabled the National Academy of Sciences' (NAS) Institute of Medicine (IOM) to perform a comprehensive evaluation of scientific and medical information regarding the health effects of exposure to Agent Orange.

In response to this legislation, the IOM conducts and publishes extensive reviews of scientific evidence regarding associations between health outcomes and exposures to TCDD and other chemical compounds in herbicides used in Vietnam. The IOM is widely considered to be the definitive source for medical information related to Agent Orange (Frumkin, H., 2003).

The IOM's most recent publication is "Veterans and Agent Orange: Update 2004" (http://www.iom.edu/report.asp?id=25476). The IOM has identified several health outcomes that are statistically "associated" with exposure to Agent Orange. Based on the scientific evidence available, the IOM has not concluded that exposure is the actual "cause" of these health outcomes.

With respect to Agent Orange, the IOM concluded there was "sufficient evidence of an association" for five health outcomes:

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

The IOM has also found "limited or suggestive evidence of an association" for another seven outcomes:

- Respiratory cancer (of lung and bronchus, larynx, and trachea)
- Prostate cancer
- Multiple myeloma
- Early onset transient peripheral neuropathy
- Porphyria cutanea tarda
- Type 2 diabetes
- Spina bifida in the children of veterans

According to the IOM, the designation "limited or suggestive" means that the scientific evidence of an association is limited because chance, bias and confounding could not be ruled out with confidence.

The vast majority of the associations noted above have only been observed in studies of heavily-exposed populations, such as workers involved in chemical manufacturing or who have applied herbicides for many years. The IOM states " many conclusions regarding associations between exposure to TCDD or herbicides and diseases are based on studies of people exposed in occupational and environmental settings rather than on studies of Vietnam veterans ".

What is the difference between an "association" and a "cause"?

As mentioned above (see " What health effects are associated with Agent Orange? "), the IOM has identified illnesses that are statistically associated with exposure to herbicides, but the IOM has not determined that herbicide exposure is the cause of any illnesses. The distinction is based on the quality of scientific evidence. According to the IOM, " factors such as consistency of evidence, biological plausibility, temporality, dose-response, and strength of association may be considered when deciding whether an observed statistical association is actually causal" . For evidence from scientific studies, if the findings between different studies are not the same, or if the connections between exposure and outcomes are not very strong, or if other potential causes of the illness have not been taken into account, or if there are problems in the way the study was designed, then the scientific evidence is too weak to conclude that an exposure is the cause of a health effect, even though an association may exist.

What are chance, bias, and confounding?

Chance refers to "the luck of the draw". To use a practical example, consider flipping a coin. Each time that the coin is flipped, there is an equal chance of it coming up heads or tails. If you flip "heads" 5 times in a row, that may be unusual, but it may simply be due to chance (if you flipped the coin 1000 times in a row, for example, a run of 5 "heads" in a row may occur on a number of occasions). Alternatively, if you flipped the coin 1000 times and it came up "heads" every time, it would be highly unlikely that this pattern would be due to chance and you may suspect that there is another explanation for this observation (some sort of "rigged" coin, perhaps one that has "heads" on both sides). What if the coin came up "heads" 10 times in a row? Without knowing for certain if the coin was "rigged", would you feel confident in concluding that your observation was not due to chance? If an association is observed between an exposure and an outcome, scientific study is required to determine if the observation is a "real" association, or simply due to chance. Scientific study relies on statistics to exclude chance. If a finding is "statistically significant", then it is unlikely that chance is the reason for the finding.

Bias refers to a systematic error in the design or conduct of a study. Continuing the coin example, suppose you flipped the coin and recorded the results each time. However, you only recorded the result when the coin came up "heads" and never recorded it when the coin came up "tails". After a

while, you may notice from your recorded results that you have 100 "heads" in a row, but no "tails". If you then concluded that the coin was "rigged", this would be an incorrect conclusion because your observations were biased. Scientific studies must be carefully designed, conducted, and analyzed so as to ensure that there are no biases that may lead to false conclusions.

Confounding occurs when in addition to the specific exposure and the outcome that are being studied, there is an another factor related to both the exposure and the outcome. For example, perhaps it is observed that after eating roasted marshmallows, itchy bumps appear on the skin. These bumps may last for a few days and then go away, but they reappear after eating roasted marshmallows again. One may then conclude that eating roasted marshmallows is the cause of the itchy bumps on the skin. However, if you are roasting marshmallows, you are likely doing this outside, when the weather is nice, and mosquitoes are present. While you are roasting marshmallows, mosquitoes are also biting you, which is the real cause of the itchy bumps on the skin. In this example, the mosquitoes would be a confounding factor.

Under what circumstances might Agent Orange or its ingredients lead to health effects?

In order for a health effect to be potentially caused by a chemical, several things must happen.

Firstly, an exposure to the chemical must have occurred. "Exposure" means that the chemical entered one's body, usually through inhalation, ingestion, or skin contact. For example, a person walking past a large sealed barrel of Agent Orange would not receive any exposure, and so the risk of any possible health effects from Agent Orange would be zero.

Secondly, the exposure must be of sufficient dose (amount). A central principle of toxicology is the concept of dose-response: at increasing levels of exposure to a harmful substance, health effects become more frequent and/or more severe. For example, consider the use of a painkiller medicine such as morphine. If the prescribed amount is taken, pain will be relieved with minimal side effects. However, if too much morphine is taken, it can lead to breathing problems and death. The only difference between these two scenarios is dose - it is the dose that makes the poison. It is important to consider that we are all exposed to small amounts of TCDD every day, mostly through the food we eat (see " Is Agent Orange the only source of TCDD? " and " Can TCDD be measured in our bodies? "). At present, scientific knowledge cannot determine a specific level of TCDD exposure at which a health effect will occur. The scientific study of TCDD can only determine the level of risk for health effects given a certain exposure to TCDD. The health risk from TCDD exposure will depend on the dose received. At very low doses of TCDD, the risk of health effects is very low and not detectable, but the risk increases as the dose of TCDD increases. For more discussion on "background" TCDD exposure and the amount of TCDD exposure that is associated with increased risks for health effects, please see " Is Agent Orange the only source of TCDD? ", " Can TCDD be measured in our bodies? ", and " What are the health risks associated with large exposures to TCDD? ").

Thirdly, the health effect in question must be associated with the chemical exposure. For example, we know that too much sun exposure is associated with an increased risk of skin cancer. If someone with a great deal of sun exposure develops emphysema (a lung disease), we would not attribute this lung condition with sun exposure, simply because there is no association between sun exposure and lung disease. The IOM has found evidence of an association between Agent Orange and several illnesses (see " What health effects are associated with Agent Orange? "). The IOM has also noted that several scientific studies have not shown any association with some other health problems, such as brain or gastrointestinal cancers. In other words, these cancers have never been associated with any amount of exposure. Therefore, if someone who was exposed to Agent Orange developed brain cancer, current scientific evidence indicates that it would be unlikely that the brain cancer was due to Agent Orange.

In conclusion, before a health effect can be considered to be associated with any substance, 1) there must be exposure, with the substance somehow having gotten inside a person, 2) the exposure must have been of a sufficiently large dose, or amount, to meaningfully increase the risk of a harmful effect (see " What are the health risks associated with large exposures to TCDD? ") and 3) the health effect in question must be scientifically associated with exposure to the substance. Unless these three criteria are satisfied, there is no medical or scientific reason to suspect that a health effect is due to the substance.

What are the health risks associated with large exposures to TCDD?

The adverse health effects associated with Agent Orange are believed to be due to TCDD, which current scientific evidence indicates to be carcinogenic. In other words, sufficient exposure to TCDD under certain conditions is believed to result in an increased risk of developing certain types of cancer. The human evidence that TCDD is carcinogenic is largely based on studies of highly exposed groups of industrial and agricultural workers (Pohl et al., 2002).

For example, one of the largest and most highly exposed industrial groups was made up of 5132 workers at 12 U.S. plants that produced chemicals contaminated with TCDD (Steenland et al., 1999). It was only the workers with the highest cumulative exposure to TCDD that had a greater risk of dying from all cancers combined, as compared with the U.S. general population. In this study, the degree of cumulative exposure depended on the level of TCDD contamination of the manufactured chemicals. For example, to reach the level of exposure of the workers in the highest exposure group, for whom the elevated cancer risk was observed, workers would have to be exposed to a chemical containing 10 ppm TCDD for their entire shift every working day for about 8 years. At a higher TCDD contamination level of 50 ppm, workers would have to be exposed for the entire shift every working day for about 1.5 years to reach the same level of exposure. It was noted that " excess cancer was limited to the highest exposed workers, with exposures that were likely to have been 100 to 1000 times higher than those experienced by the general population " (Steenland et al., 1999).

The magnitude of the increased risk of death from all cancers combined was 1.6 (Steenland et al., 1999). This means that compared to the general population, these highly exposed workers were 1.6 times more likely to die of cancer than the general population (in scientific terms, this comparison is referred to as a "standardized mortality ratio"). The results of this study were consistent with other research into the cancer risks associated with TCDD. A recent scientific review article noted that " a number of large-scale retrospective cohort mortality studies have found significant increases in cancer mortalities (all types of cancer combined). These increases were typically found in workers exposed to the highest levels of dioxin [TCDD] and in workers with the longest follow-up periods. In general, the standardized mortality ratios were low (less than 1.5); however, the high degree of consistency between studies suggests that the increases in mortalities were not due to chance " (Pohl et al., 2002).

For illnesses other than cancer, a recent scientific review article indicates that the evidence from human studies has not been strong enough (for example, the results are inconsistent or the studies are not designed well enough) to estimate specific risks associated with TCDD exposure. A more detailed discussion can be found in the article, which concludes that " although more than a dozen different adverse effects have been reported in various studies of humans in the past 25 years, the most consistent clinically important adverse effect of human exposure appears to be chloracne " (Greene et al., 2003). Chloracne is a skin condition. Typically, this condition is only observed in people when the TCDD level in their blood is several thousand times greater than the levels typically seen in the general population (Greene et al., 2003; Hays et al., 2003).

Have Vietnam veterans in general been harmed by Agent Orange?

Veterans involved in herbicide handling and spraying in the Vietnam War were exposed to a number of different herbicide formulations (see "What is Agent Orange? "). Health studies of these veterans therefore look at the potential long-term health effects of herbicide exposures in general. These exposures were mainly to Agent Orange, but exposure to other herbicide formulations, such as Agent Purple, also occurred.

In comparison to heavily exposed industrial workers, Vietnam veterans were generally exposed to lower levels of TCDD. It is estimated that t he maximum TCDD dose experienced even by the US Air Force personnel directly involved in spraying ("Ranch Hand" veterans) was about one tenth of the maximum predicted dose of industrial workers (Akhtar et al., 2004).

The most recent study of death among U.S. Army veterans in general concluded that death rates due to chronic conditions, such as cancer or heart disease, were no different in veterans who served in Vietnam as compared to non-Vietnam veterans (Boehmer, 2004).

For the vast majority of Vietnam veterans, unless they were directly involved in the handling and spraying of Agent Orange, their exposure to Agent Orange would have been very small (Young et al., 2004a; Young et al., 2004c). A serum TCDD study of US Army Vietnam veterans who served as ground troops concluded that " most US Army ground combat troops who did not handle or spray herbicides

were not heavily exposed to TCDD in Vietnam " (CDC, 1988). The greatest degree of Agent Orange exposure in Vietnam would have occurred among those veterans who directly handled or sprayed Agent Orange: Army Chemical Corps personnel and Air Force Operation Ranch Hand personnel.

Have Army Chemical Corps Vietnam Veterans been harmed by Agent Orange?

Army Chemical Corps veterans were involved in the storage, preparation, and application of a variety of herbicides in Vietnam. In a recent study, the death rate among Vietnam Army Chemical Corps veterans was not significantly different than non-Vietnam veterans for all causes, circulatory disease, or cancer. Vietnam veterans in this group had a higher risk of dying due to digestive system diseases, largely cirrhosis of the liver, as compared to non-Vietnam veterans. The authors noted, however, that their study design did not account for lifestyle factors that can also cause cirrhosis of the liver, such as alcohol use: " it is possible that heavier drinking among the Army Chemical Corps Vietnam veterans than among their non-Vietnam counterparts could account for the excess deaths from cirrhosis of the liver " (Dalager et al., 1997). The Vietnam veterans' risk of death from digestive system diseases, including cirrhosis of the liver, was not higher than the risk for the general U.S. population (Dalager et al., 1997).

Have Air Force Ranch Hand Vietnam veterans been harmed by Agent Orange?

The aerial spraying of herbicides in Vietnam was conducted under the name "Operation Ranch Hand", from 1962 to 1971. U.S. Air Force veterans who took part in Operation Ranch Hand handled and sprayed herbicides, and they are the Vietnam veterans with the greatest exposure to Agent Orange. These veterans have been studied closely in the Air Force Health Study, the purpose of which was to determine if the health of veterans who handled and sprayed herbicides in Vietnam had been harmed by this exposure. The Air Force Health Study was launched in 1980 and t he most recent and reportedly final report was released in July 2005 (see http://www.brooks.af.mil/AFRL/HED/hedb/default.html , click on "Reports" in the left margin, and then select "2002 Follow-up Examination Results: May 2002 to March 2005" to access the full report).

The Air Force Health Study examined more than 300 health-related outcomes in these veterans, grouped broadly into 12 areas. The overall significant findings in each area can be found in the executive summary of the 2005 report and are summarized below.

General Health: Measures of general health were not related to herbicide exposure. The one exception was that body mass index (a crude measure of body fat) was greater with increasing blood TCDD levels. It was noted that this possibly reflected " the pharmacokinetics of dioxin [TCDD] elimination " (higher body fat levels slow down the removal of TCDD from the body - as body fat increases, blood TCDD increases, but TCDD does not cause higher body fat).

Cancer: Mixed patterns of associations were found, but no consistent or meaningful patterns that would suggest that herbicide exposure caused cancer. The report stated that " these patterns did not suggest an adverse relation between cancer and herbicide exposure" . [The enlisted ground crew, the

sub-group with the highest TCDD exposure, had a decreased risk of cancer, but this was not statistically significant (in other words, chance could not be excluded as the reason for the decrease).]

Neurology: Of the many neurological tests that were performed, only differences in pinprick sensation and reflexes were observed in those with the highest TCDD exposure, providing " some support for a relation between dioxin [TCDD] exposure and peripheral nerve function ".

Psychology: No measures of psychological health were associated with herbicides or TCDD exposure.

Gastrointestinal: Of the many tests performed, there was no association between the gastrointestinal test results and herbicide or TCDD exposure. The only exception was a relation between TCDD and higher levels of triglycerides, a type of blood fat. Although measurable, this relationship was not considered to be of any health significance.

Skin: There was no evidence of chloracne (which is associated with TCDD exposure) in the Ranch Hand veterans.

Cardiovascular: A variety of health outcomes were studied, such as heart attacks, heart disease, vascular disease, strokes, and high blood pressure. The 2005 report concluded that " overall, cardiovascular health did not appear to be adversely associated with herbicide or dioxin [TCDD] exposure ".

Blood System: Several factors were measured in the blood of Ranch Hand veterans. Overall, there was no indication of an " adverse relation between herbicide or dioxin [TCDD] exposure and any haematological [blood disease] diagnosis ".

Kidneys: There was no indication of " adverse relation between renal [kidney] function and herbicide or dioxin [TCDD] exposure ".

Hormones (Endocrine System): There was a slightly increased risk of Type 2 (adult-onset) diabetes among the Ranch Hand veterans with the highest exposure. There were no consistent findings relevant to health for thyroid or sex hormones.

Immune System: There was no consistent association of health significance between any measure of immune function and herbicide or TCDD exposure.

Lungs: There was no association between lung health and exposure to herbicides or TCDD.

The 2005 Air Force Health Study report concluded that overall, only type 2 diabetes was associated with exposure to TCDD among these veterans with the greatest herbicide exposure. The Ranch Hand veterans were not more likely to be diagnosed with Type 2 diabetes than the comparison veterans without significant herbicide expsoure, but their risk of Type 2 diabetes increased with increasing blood TCDD level. The study confirmed associations between diabetes and other known risk factors: diabetes was more common in veterans who were older, who were obese, who smoked, and who had a family history of diabetes. The 2005 report noted that " the epidemiologic studies suggest that any increased risk of Type 2 diabetes from herbicide or dioxin [TCDD] exposure is small when compared

to the known predictors - family history, obesity, physical inactivity - for diabetes ". The IOM has also found limited or suggestive evidence of a link between adult-onset (Type 2) diabetes and herbicides used in Vietnam, including Agent Orange, but concluded that other traditional risk factors for diabetes far outweigh the risks of Agent Orange.

The most recent study of causes of death among Ranch Hand Vietnam veterans was published in May 2005. Compared to Vietnam veterans who did not spray herbicides, Ranch Hand veterans did not have a greater risk of death due to cancer. When all Ranch Hand veterans were examined, the risk of death from all causes and from circulatory disease was slightly increased, but this was not statistically significant (in other words, chance could not be excluded as the reason for this slight increase). When only enlisted ground crew were examined, they had a slightly greater risk of death due to circulatory diseases than the comparison veterans. However, when veterans with serum TCDD measurements were examined, the risks of death from all causes, from cancer, or from circulatory disease were not significantly increased. In other words, those with measurable TCDD exposure did not have a greater risk of death from any cause compared to Vietnam veterans without significant herbicide exposure (Ketchum et al., 2005).

More information is available from the Air Force Health Study website (http://www.brooks.af.mil/AFRL/HED/hedb/default.html - click on "Articles" in the left margin for a summary of all published scientific studies of Operation Ranch Hand veterans).

Why have disability pensions been awarded in the US and Canada for illnesses associated with Agent Orange?

As a result of political and policy decisions, the US Veterans Administration automatically presumes that veterans who served in Vietnam were exposed to Agent Orange (http://www.va.gov/pressrel/aoiss400.htm). They are also required by law to presume that, if a veteran develops an illness that is among those associated with Agent Orange, the illness is related to military service (Section 2, US Agent Orange Act of 1991, Public Law No. 102-4). The IOM notes that they have not found that Agent Orange is the cause of any illness, that the associations they found were largely based on studies of heavily-exposed chemical and agricultural workers, and that their conclusions " are not intended to imply or suggest policy decisions ".

Veterans Affairs Canada grants pensions for service-related disabilities, with the pension process designed to give applicants every chance to show how their disability is related to military service. Veterans Affairs Canada requires evidence of exposure and a medical diagnosis of the condition (ie. illness, injury or disease) that the applicant believes is related to the exposure. Pension Adjudicators take into account the latest scientific evidence available to establish an association between the condition and exposure to Agent Orange during service. Pension Adjudicators have flexibility in weighing the evidence presented in individual cases and, in the absence of credible evidence to the

contrary, any doubt that arises in weighing evidence regarding a service-related illness associated with exposure is resolved in the applicant's favour. In fact, the Department is obliged, under the Pension Act, to give the "benefit of the doubt" to the Veteran.

Fate in the Environment

What happens to Agent Orange after it is sprayed?

The environmental fate of Agent Orange has been described in a recent review article (Young et al., 2004a). For Agent Orange to be as effective a herbicide as possible, the maximum amount of spray had to reach the vegetation as quickly as possible. To achieve this, aircraft flew very close to the treetops in calm weather conditions to minimize the amount of spray drifting outside of the target area. Rapid settling of the spray droplets was also important. The spray system used during the Vietnam War used spray nozzles designed to produce a droplet size of 320 to 350 m m (over 98% of the droplets produced were greater than 100 m m). Droplets of this size generally fall rapidly. Tests at Eglin Air Force Base in Florida showed that 87% of sprayed herbicides hit the vegetation within one minute (the remaining 13% took longer to settle due to vortices at the wing tips, drift, or evaporation). US studies showed that even the droplets smaller than 100 m m would have hit the vegetation less than 3 minutes after spraying (Young et al., 2004a).

For spray drift beyond the target area to occur, herbicide would have to remain in the air for extended periods of time, where it would be rapidly degraded by sunlight. Aerial photographs of herbicide-sprayed areas in Vietnam show very distinct and sharp lines between treated (dead) and untreated (healthy) trees. Had there been significant drift either way from the swath of aerial spraying, traces of damage would have been visible as streaks of discoloured foliage (Young et al., 2004a).

The studies showed that little aerially-sprayed Agent Orange reached the forest floor as liquid droplets. In relatively undisturbed dense forests, the forest canopy intercepted 87-97% of the sprayed herbicide. Vegetation below the forest canopy also took up some of the spray, such that the underbrush or forest floor received about 1-6% of the total aerial spray. The Agent Orange that lands on plant surfaces is absorbed into the wax layer of the plant cuticle within minutes and cannot be physically dislodged (Young et al., 2004a) . Agent Orange left on the plant surface breaks down in sunlight within hours (Crosby et al., 1977). It is estimated that very little, if any, Agent Orange can be dislodged from the plant surface 24 hours after spraying (Young et al., 2004a). It is likely that due to the degradation by sunlight of TCDD on leaf surfaces that little material would be left by the time the leaves fall to the ground.

What happens to Agent Orange after it lands on the ground?

The main contaminant of concern in Agent Orange was TCDD. TCDD is not very soluble in water and binds tightly to soil particles. Estimates of the half-life of TCDD (the amount of time it will take for the concentration of TCDD to be reduced by half) on the soil surface range from 9 to 15 years, whereas the half-life in subsurface soil may range from 25 to 100 years (ATSDR, 1998). Because of tight binding to soil particles, TCDD is unlikely to leech into underlying groundwater (ATSDR, 1998). However, TCDD may enter surface water secondary to soil erosion and runoff. Although some of the TCDD that makes its way to surface waters will be broken down by sunlight or evaporate, most will remain strongly attached to small particles of soil or organic matter and eventually settle to the bottom. TCDD attached to this organic matter may enter the aquatic food chain. Small aquatic organisms absorb TCDD that is attached to sediment and organic matter in bodies of water. Larger fish then consume these smaller organisms and accumulate TCDD in their fatty tissues. Human consumption of contaminated fish is thus a potential route of exposure (ATSDR, 1998).

Root uptake and translocation to upper plant parts is very minimal. The ATSDR described a laboratory study in which plants were grown in soil heavily contaminated with TCDD: " the amount of 2,3,7,8-TCDD applied to these soils was many thousands of times greater than that which would occur in soils from herbicide applications containing a few ppm 2,3,7,8-TCDD as an impurity. Even upon exposure to these high concentrations in the soil, significant amounts of 2,3,7,8-TCDD could not be measured in plants " (ATSDR, 1998). The vast majority of TCDD found in plants is due to absorption of airborne TCDD that settles on the plant surface. This has been demonstrated in studies of fruits and vegetables that show TCDD concentrations in the outer peel that are up to ten times greater than the TCDD concentration in the pulp (ATSDR, 1998).

Herbicide testing was conducted at Eglin Air Force Base in Florida from 1962 to 1970, when roughly 75 000 kg of 2,4-D and 76 000 kg of 2,4,5-T (the ingredients of Agent Orange) were aerially sprayed on an area of less than 3 square kilometres. It is estimated that 3.1 kg of TCDD contaminant was released in this area. Because of the extent of the testing, each hectare on the Eglin test grid received at least 1300 times more TCDD than a hectare sprayed with Agent Orange in Vietnam. Much of the vegetation on the test site had been removed, allowing an opportunity to study ground-based residues that would not be affected by interception of the sprayed herbicides by the forest canopy (Young et al., 2004b).

Small but detectable levels of TCDD (in the parts per trillion range) were found in some soil samples 20 years after the last application of herbicide. It was estimated that the vast majority of TCDD that reached the ground had been degraded by sunlight within 24 hours of spraying and would not have persisted in the environment. For the small amounts of TCDD that were detected, the majority of TCDD was confined to the top 15 cm of soil, indicating that there was little travel of TCDD deeper into the soil. In the years that followed the herbicide testing, vegetation growth gradually returned to normal, indicating that there was no persistent herbicide effect. Examination of animal species that lived in close contact with the soil did not reveal significant health effects (Young et al., 2004b).

In summary, very large quantities of herbicides were applied to the Eglin Air Force Base test site, far more than would be applied during typical aerial spraying, and far more that were used during the herbicide tests at CFB Gagetown June 14-16, 1966, and June 21-24, 1967 (see " How much Agent Orange was sprayed at CFB Gagetown? "). These herbicides were applied over areas where vegetation had been removed, thereby maximizing the amount of herbicide that reached the ground. No long-term negative effects on vegetation or wildlife were detected. Although TCDD could be detected in the soil years after the testing, the amounts present were extremely small and did not appear to have a significant adverse effect on the environment (Young et al., 2004b).

Is Agent Orange the only source of TCDD?

Agent Orange is not a significant source of TCDD in the environment. Most of the TCDD released into the environment comes from combustion sources, such as municipal and medical waste incineration, backyard burning of household waste such as plastics, cement kilns, forest and brush fires, and burning of fuel for agricultural purposes and home heating. TCDD can be formed in metals operations, such as aluminum smelting, steel production and scrap metal recovery. TCDD can also be formed as a byproduct in the manufacture of chlorine-bleached wood pulp and chlorinated chemicals (ATSDR, 1998; Hays et al., 2003; Sullivan et al., 2001; Travis et al., 1991).

Because of this past and continued production and release of TCDD, it is everywhere in our environment in very small quantities. Everyone is exposed to small amounts of TCDD every day, mostly through food (Birmingham et al., 1989; Gilman et al., 1991; Travis et al., 1991; Huwe, 2002). Cigarette smoke is also an important source of exposure (Muto et al., 1989). It has been estimated that the average Canadian or American adult takes in about 40-150 picograms of TCDD every day (ATSDR, 1998; Health Canada, 1994; Gilman et al., 1991). A gram is a relatively small amount: one teaspoon of water weighs about 5 grams and there are 450 grams in one pound. A picogram is a trillionth of a gram. Put another way, one picogram is one part per trillion of a gram (see "How much is a part per trillion (ppt)?"). Therefore, 40 to 150 picograms of TCDD is a very small amount, but it is equivalent to about 100 billion molecules of TCDD (see " Calculation "). Every day, the average adult is exposed to about 100 billion molecules of TCDD.

In a study of industrial workers for whom an elevated cancer risk was observed (see " What are the health risks associated with large exposures to TCDD? "), it was noted by the authors that " excess cancer was limited to the highest exposed workers, with exposures that were likely to have been 100 to 1000 times higher than those experienced by the general population " (Steenland et al., 1999).

Recently, the World Health Organization (WHO) established a tolerable daily dioxin intake equivalent to 1 to 4 picograms of TCDD per kilogram of body weight per day (http://www.who.int/mediacentre/factsheets/fs225/en/print.html), which is similar to other international health assessments (Pohl et al., 2002). Health Canada's tolerable daily intake value is currently under review, but will likely be equivalent to the WHO value. Based on the assessment of health authorities, the tolerable daily intake is the amount of TCDD that people can be exposed to

every day of their lives without harm. The tolerable daily intake is expressed in a manner that takes into account differences in body weight between different people. For example, the tolerable daily intake of TCDD for a 70 kilogram adult is 280 picograms (4 picograms of TCDD per kilogram multiplied by 70 kilograms) per day. For a 80 kilogram adult, the tolerable daily intake would be 320 picograms (4 picograms of TCDD per kilogram multiplied by 80 kilograms) per day.

Can TCDD be measured in our bodies?

Because of continuous low-level exposure to TCDD, we all have measurable amounts of TCDD in our bodies, referred to as a "background" level of TCDD. It is estimated that in North America, the average body burden of TCDD (the amount of TCDD contained within our bodies) is 3-7 parts per trillion (ppt), measured either in body fat or in blood lipids (Hays et al., 2003; Travis et al., 1991, ATSDR 1998).

In comparison, the average serum level of TCDD in a sample of Ranch Hand personnel (who handled and sprayed herbicides in Vietnam) was 49 ppt in 1987, many years after exposure had occurred. Because half the TCDD in our bodies is naturally eliminated every 7-12 years (TCDD's half-life), it was estimated that 2 to 4 half-lives had passed since the time of their exposure and that their serum TCDD levels around the time of exposure had probably been several hundred ppt (MMWR, 1988). Other Vietnam veterans who did not directly spray or handle herbicides in Vietnam had body burdens of TCDD that were no different than normal background levels, in the range of 2 to 4 ppt (Young et al., 2005). A serum TCDD study of US Army Vietnam veterans who served as ground troops concluded, " most US Army ground combat troops who did not handle or spray herbicides were not heavily exposed to TCDD in Vietnam " (CDC, 1988).

It is estimated that the maximum TCDD dose experienced by Ranch Hand veterans was only about one tenth of the maximum predicted dose of industrial workers (Akhtar et al., 2004). In a study of heavily exposed industrial workers (for whom evidence of associations between TCDD and cancer was observed), the average estimated serum level of TCDD at the end of exposure was 1589 ppt, with a maximum value of 210 054 ppt (Steenland et al., 2001). People who have serum TCDD levels greater than 12000 ppt develop a skin condition known as chloracne (Greene et al., 2003).

We are all exposed to TCDD. It can be measured in our bodies. The risk of health effects associated with TCDD is entirely dependent on the degree of exposure, or dose (see "Under what circumstances might Agent Orange or its ingredients lead to health effects?").

Health Effects From Spraying in Gagetown

How much Agent Orange was sprayed at CFB Gagetown?

Agent Orange was one of a number of different herbicide mixtures tested at CFB Gagetown June 14-16, 1966, and June 21-24, 1967 . Several of these mixtures, including Agent Orange, contained the herbicide 2,4,5-T, which was potentially contaminated with parts per million of TCDD (see " How much TCDD did Agent Orange and Agent Purple contain? " for discussion). During the tests, records indicate that helicopters sprayed the herbicide in an unused and remote area of the base, not in proximity to any residential or working areas, under strictly controlled conditions, and with little to no wind. The total area sprayed by various herbicides containing 2,4,5-T (eg. Agent Orange, Agent Purple, and others) was 126.5 acres in 1966 and 12.0 acres in 1967, for a total of 138.5 acres, or about 0.6 square kilometres. The total amount of all herbicides containing 2,4,5-T that were sprayed during the 1966 and 1967 tests was 883 kg, of which 338 kg was Agent Orange and 267 kg was Agent Purple (AD 843989 Technical Memo 141, 1968; AD 842825 Technical Memo 145, 1968). On average, 1.6 grams of herbicides containing 2,4,5-T were sprayed per square meter.

What is the health risk for CF members exposed to Agent Orange and Agent Purple at CFB Gagetown?

The greatest amount of herbicide exposure resulting from the June 14-16, 1966, and June 21-24, 1967 tests would likely have occurred among those people who directly handled or were sprayed by herbicides. In considering their health risks, it is important to consider the concept of dose-response (see "Under what circumstances might Agent Orange or its ingredients lead to health effects?" and "What are the health risks associated with large exposures to TCDD?"). Most of the associations between TCDD exposure and health outcomes have been observed in heavily exposed industrial workers. Vietnam veterans with the greatest amount of herbicide exposure (Operation Ranch Hand veterans) had less overall TCDD exposure than heavily exposed industrial workers. Their long-term health outcomes are described above (see " Have Air Force Ranch Hand Vietnam veterans been harmed by Agent Orange?") . Personnel exposed to herbicides during June 14-16, 1966, and June 21-24, 1967 testing at CFB Gagetown would generally have had less exposure than Ranch Hand veterans, who on average spent more than a year in Vietnam (Akhtar et al., 2004).

Without knowing specific details of how the herbicides were handled during the June 14-16, 1966, and June 21-24, 1967 tests, subsequent activities that might have resulted in exposure, and the specific TCDD concentrations of the herbicides used, it is not possible to make definitive statements about the degree of potential exposure and health risks for particular individuals involved. Given the relatively small herbicide quantities applied, relatively brief duration of exposure, and the findings of health studies of more heavily exposed groups, the scientific evidence reviewed above suggests that the health risks would generally be lower than the risk for more heavily-exposed Vietnam veterans and lower still than the risk for the heavily-exposed industrial and agricultural workers on whom most of the Institute of Medicine associations are based.

With respect to CF members travelling through the targeted area after the spraying or conducting activities elsewhere in the training area, the evidence summarized above suggests that, in the absence of an unusual exposure incident, it is unlikely that they would have received a level of exposure significant enough to harm human health (Young et al., 2004a; CDC, 1988). (see "What happens to Agent Orange after it is sprayed?" and "What happens to Agent Orange after it lands on the ground?")

Has the health of CF members living in PMQs or in communities near CFB Gagetown been affected by Agent Orange?

The only study on the question of health effects of people living near CFB Gagetown was conducted in 1981 by Health and Welfare Canada and it looked at limited data and limited health information. In order to assess if the use of Agent Orange and other herbicides had resulted in detectable health effects in the communities surrounding CFB Gagetown, Sunbury County (which borders the area of CFB Gagetown where the June 14-16, 1966, and June 21-24, 1967 herbicide testing occurred) was the area chosen for study. Death rates due to all causes, circulatory diseases, and cancer were either lower or no different than expected (Wigle et al., 1981). Potential reproductive health effects were evaluated by studying the outcomes of babies born around the time of spraying and in the months that followed. The study concluded that the herbicide testing at CFB Gagetown " resulted in no significant increase of adverse pregnancy outcome events in the population adjacent to Camp Gagetown "(Wigle et al., 1981). The study also noted " Based on climatic conditions, spray technique, knowledge of the chemicals used and the results of other studies it is unlikely that persons outside the confines of Camp Gagetown would have received a significant exposure to any of the defoliants tested " (Wigle et al., 1981). DND is assessing what further health study may be required.

The evidence summarized above and what is currently known about the spraying suggest that it is unlikely that the herbicides sprayed at CFB Gagetown June 14-16, 1966, and June 21-24, 1967 would have travelled a significant distance beyond the target area or resulted in sufficient environmental contamination to harm human health (see "What happens to Agent Orange after it is sprayed?" and " What happens to Agent Orange after it lands on the ground?").

I know of people in the communities near CFB Gagetown who are sick or dying - isn't this due to Agent Orange?

Sufficiently great exposure to TCDD-containing herbicides could potentially increase the risk of illnesses associated with Agent Orange (see " Under what circumstances might Agent Orange or its ingredients lead to health effects?" and "What are the health risks associated with large exposures to TCDD ? ").

Unfortunately, it is rare for anyone to live his or her entire life without any sort of health problem. The Public Health Agency of Canada contains a wealth of information on the burden of disease in Canada (http://www.phac-aspc.gc.ca). For example, by the middle of 2005, more than 35 000 Canadians had died of cardiovascular disease and more than 30 000 Canadians had died of cancer (

http://www.phac-aspc.gc.ca/ccdpc-cpcmc/index_e.html). According to Diabetes in Canada Second Edition (2002), it is estimated that 30 000 Canadians die each year from diabetes and diabetes-related complications (http://www.phac-aspc.gc.ca/publicat/dic-dac2/english/01cover_e.html). According to Congenital Anomalies in Canada 2002, roughly 2 to 3% of babies in Canada are born with a serious congenital anomaly, usually with no family history or known risk factors (http://www.phac-aspc.gc.ca/publicat/cac-acc02/index.html). According to Canadian Cancer Statistics 2005 (http://www.cancer.ca/ccs/internet/standard/0,,3172_14291__langId-en,00.html), the lifetime probability of developing cancer for males is 44% and for females is 38%. In other words, the average Canadian male has a 1 in 2.3 chance and the average female has a 1 in 2.6 chance of developing cancer in their lifetimes. Males have a 29% and females a 24% chance of dying from cancer in their lifetime; roughly one chance in four for the two sexes combined. It is estimated that in 2005, 448 out of every 100 000 men in Canada and 355 out of every 100 000 women will develop cancer. Roughly 149 000 Canadians will be diagnosed with cancer and 69 500 Canadians will die from cancer in 2005.

In New Brunswick, it is estimated that 3 900 people will be diagnosed with cancer and 1 800 people will die of cancer in 2005. In order to compare these numbers for New Brunswick with the rest of Canada, it is necessary to look at standardized cancer rates, which take into account differences in age and population size between provinces. The rates of new cancer diagnoses and cancer deaths in New Brunswick are higher than the Canadian average, but the New Brunswick rates are generally the lowest of the Maritime Provinces (Canadian Cancer Statistics, 2005).

There are many potential causes and risk factors for the illnesses that affect Canadians. Of all the people who have or will develop these illnesses, few have been exposed to Agent Orange or Agent Purple.

What about other herbicides used at CFB Gagetown that contained some of the same ingredients as Agent Orange?

A total of 251 products containing 2,4,5-T, which contained TCDD contamination, were registered for use in Canada between 1948 and 1981. The last product was registered in 1981, but thereafter the registration of all of these products was discontinued. For information on 2,4-D, which is still registered for use in Canada, see the following Health Canada website: http://www.pmra-arla.gc.ca/english/consum/2,4-DFAQ-e.html .

DND's use of herbicides will be reviewed over the next several years. Some of the health information noted above would also generally apply to other chemical exposures, in that the risk for adverse health effects would depend on the dose and duration of exposure (see especially "Under what circumstances might Agent Orange or its ingredients lead to health effects?").

What can I do to know more?

Talk to your MO and look at these or any other references for yourself. If you do not see a web link to a reference you would like, ask your MO for a copy and an explanation of any technical language or concepts that are not clear to you. Although there are many other sources of information, the references consulted are trusted by the Surgeon General, are believed to be based on sound scientific evidence and analysis, and are believed to represent the general consensus about Agent Orange in the medical and scientific community. Do not hesitate to consult your MO if you have questions about this or any other health concern.

Resources And References

Calculation

(See discussion in " Is Agent Orange the only source of TCDD? ")

- average daily TCDD intake estimates: 47 pg/day (ATSDR, 1998); 39-147 pg/day (Health Canada, 1994; Gilman et al., 1991): assume 50 pg/day daily intake
- 1 pg = 10 -12 g
- molecular weight of TCDD = 321.96 g/mol
- Avagadro's number = 6.022 x 10 23

50 pg/day) x (10 -12 g/pg) x (1 mol/321.96 g) x (6.022 x 10 23 molecules/mol

= 9.35 x 10 10 molecules/day (93 500 000 000 molecules per day)

Agent Orange, TCDD ("dioxin"), and Herbicide Resources

U.S. Institute of Medicine

- Veterans and Agent Orange 2004 Update: http://www.iom.edu/report.asp?id=25476

U.S. Air Force Health Study

- http://www.brooks.af.mil/AFRL/HED/hedb/default.html (click on "Articles" in the left margin for a summary of all published scientific studies of Operation Ranch Hand veterans; click on "Reports" in the left margin, and then select "2002 Follow-up Examination Results: May 2002 to March 2005" to access the most recent report)

U.S. National Agricultural Library special collection on Agent Orange:

- http://www.nal.usda.gov/speccoll/findaids/agentorange/index.htm

Health Canada

- It's Your Health": http://www.hc-sc.gc.ca/iyh-vsv/environ/dioxin_e.html

Health Canada's Pest Management Regulatory Agency

- Information on 2,4-D and other herbicides: http://www.pmra-arla.gc.ca/

Agency for Toxic Substances and Disease Registry (ATSDR)

- Public Health Statement: http://www.atsdr.cdc.gov/toxprofiles/phs104.html

World Health Organization

- Fact Sheet: http://www.who.int/mediacentre/factsheets/fs225/en/print.html

U.S. Environmental Protection Agency (US EPA)

- Questions and answers: http://www.cfsan.fda.gov/~lrd/dioxinqa.html

European Union

- Dioxin exposure and health: http://europa.eu.int/comm/environment/dioxin/

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Who Do I Contact? / Requests for Information

Do you have information about the use of herbicides at CFB Gagetown?

If you do, the Government of Canada encourages you to share that information and discuss your experience by participating in its Fact Finding Initiative.

The Government of Canada does not consider any information about the use of herbicides (including Agent Orange) at CFB Gagetown to be secret. Disclosure of this information will not be considered a breach of the Security of Information Act (formerly known as Official Secrets Act) or of any other obligation of confidentiality.

If you wish, the information you provide will be kept confidential (unless a court orders otherwise).

The information you provide will not jeopardize your:

- Canada pension plan;
- VAC disability pension; or
- Canadian Forces pension plan

Former Canadian Forces members, DND employees and civilian contractors should follow the steps outlined below if they feel they have suffered health problems stemming from exposure to Agent Orange:

Former and Current CF Members

Veterans Affairs Canada's mandate is to provide disability pension and health care services to Canadian Forces veterans who suffer a service-related illness or disability.

Former and still-serving Canadian Forces members who think they have a service-related illness are encouraged to contact Veterans Affairs Canada.

The Veterans Affairs Canada national referral numbers are 1-866-522-2122 (English) and 1-866-522-2022 (French). Information is also available on their website at http://www.vac-acc.gc.ca/.

Inquiries can also be made to the Centre for the Support of Injured and Retired Members and Their Families (The Centre) at 1-800-883-6094 or by visiting the Centre's website at www.forces.gc.ca/centre.

Former and Current Employees of the Department of National Defence

Current and former employees of National Defence who feel they may suffer from an occupational illness as a result of exposure to Agent Orange during the course of their employment may submit the details of their claim to the DND Civilian Human Resources Office in Gagetown. Current employees should submit their claims through their normal local management contacts to ensure that their claims are processed in the most efficient manner possible. Former employees should submit the details of their claim to:

Civilian Human Resources Office Atlantic Civilian Human Resources Service Centre Compensation Administrator CFB/ASU Gagetown P.O. Box 17000 Station Forces Oromocto, New Brunswick E2V 4J5

Instructions on the completion of claims and the forms can be found at the following website: http://www.whscc.nb.ca/forms_e.asp#frmwrk.

Former and Current Federal Government Employees

The Government Employees Compensation Act (GECA) provides compensation benefits to the employees of federal departments, agencies and Crown corporations for injuries and illnesses arising from their employment. It covers approximately 400,000 employees across Canada. Information on the GECA can be found on the Federal Workers' Compensation Service website at http://www.hrsdc.gc.ca/asp/gateway.asp?hr=en/lp/lo/fwcs/geca.shtml&hs=fxf.

The Minister of Labour and Housing has agreements with the ten provincial workers' compensation boards to adjudicate claims under GECA. Federal employees receive benefits based on the rates and conditions of the province where they are usually employed.

Compensation claims for employees working in New Brunswick should be forwarded to the Regional Injury Compensation Unit, Human Resources Skills Development Canada, in Moncton, New Brunswick, for transmission to the New Brunswick Workplace Health, Safety and Compensation Commission.

Their mailing address is:

1045 Main Street Moncton, New Brunswick E1C 9G8

Former and Current Civilian Contractor Employees

The Workplace Health, Safety and Compensation Commission of New Brunswick provides accident prevention services, occupational health and safety assistance and cost-effective disability and liability insurance to workers and employers in New Brunswick. It also administers pension benefits related to workplace accidents and workplace related illnesses.

Former and current employees of civilian contractors who believe that they may have been exposed to Agent Orange and Agent Purple during the 1966 and 1967 testing conducted at CFB Gagetown can apply for compensation to the Workplace Health, Safety and Compensation Commission of New Brunswick.

Queries should be referred to Mr. Omer Robichaud at (506) 738-4150.

Information can also be found on the New Brunswick Workplace Health, Safety and Compensation Commission website at http://www.whscc.nb.ca.

Our Neighbours

Based on the information we have to date, it is unlikely that civilians outside the base were exposed to Agents Orange or Purple as a result of this testing. Nevertheless, we understand and acknowledge the concerns expressed by some individuals. We take such concerns very seriously. DND will continue to work with key departments to research this issue and to communicate the information to concerned citizens in a timely fashion.

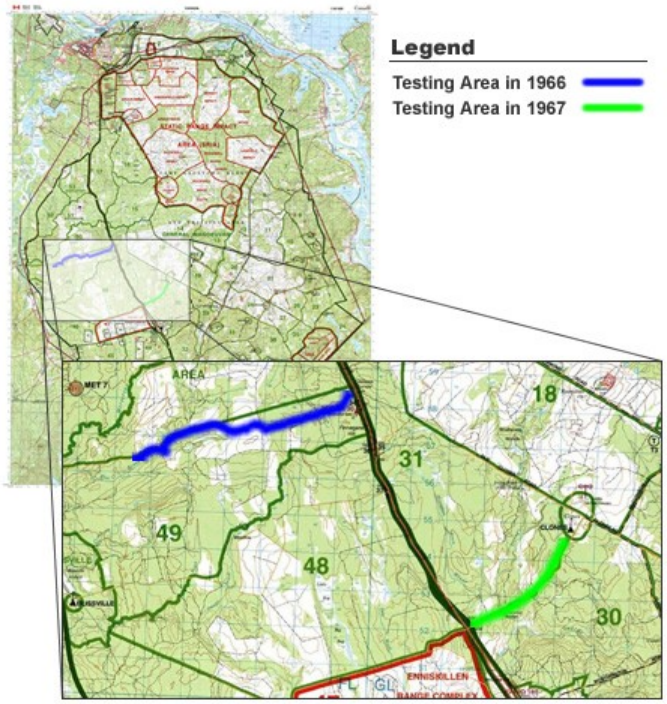
If there is evidence that civilians were exposed to Agents Orange and/or Purple during the testing in 1966 and 1967, the Government of Canada will deal with the issue.

The Government of Canada has also established a toll-free number to assist people with general inquiries related to this matter. The number is 1-866-558-2945 and it is operated from 8:00 a.m. to 4:30 p.m. (EST) daily, Monday to Friday.

Gagetown Range and Training Area

This map is also available for download:

- 762 x 1000 pixels (JPG - 562 Kb)
- 2305 x 3023 pixels (JPG - 3711 Kb)



Frequently Asked Questions

What are dioxins?

Dioxins encompass a large family of about 200 chemicals. Certain types of dioxins (2,3,7,8-TCDD) are much more toxic than others and are classified as "dioxins of concern."

In the past, some herbicides were contaminated with dioxins. In light of emerging knowledge and concerns regarding dioxins, the manufacturing processes of herbicides have been improved to reduce or eliminate such contamination. In the case of 2,4-D for example, manufacturing processes were modified in the early 1980s to essentially eliminate contamination with dioxins of concern.

Is Agent Orange the same as any 50:50 mixture of 2,4-D and 2,4,5-T?

No. Agent Orange and other "Agent" chemicals were never registered for use in either Canada or the U.S. These "Agent" chemicals were manufactured specifically for the U.S. military. Some of the manufacturing processes of these military "Agent" chemicals were different than the manufacturing processes of registered herbicides. Production was accelerated to supply the U.S. military with the large quantities needed for use in Vietnam. There are reports that the accelerated manufacturing processes sometimes resulted in higher dioxin levels for Agents Orange and Purple than for registered herbicides of similar formulation.

Why are the dioxin levels in soil samples from Ripon Road and the Clones and Murphy Bivouacs not a concern if levels are much higher than the Canadian Council of Ministers of

the Environment (CCME) guidelines?

The Canadian Council of Ministers of the Environment (CCME) soil quality guideline for dioxins of 4 parts per trillion is based on the average or background level of dioxins typically found in Canadian soils. The risks associated with background levels of dioxin in soil is considered to be minimal.

It is not uncommon to find levels across the country that are higher than the background levels. These higher levels can be from numerous sources, including forest fires and natural geological anomalies. However, when dioxin levels in soil are higher than average, it does not automatically mean that there would be a risk of adverse health effects. The key to determining whether there is any risk is to look at the combination of the dioxin level in the soil, how people might have been exposed and for how long they may have been exposed.

In the case of CFB Gagetown, a site-specific risk assessment was conducted to estimate the exposures that people could receive from the levels of dioxins measured in the soil. The independent contractor concluded that there is no increased risk of dioxin-related illness from living or working at CFB Gagetown today.

In the task 3A-2 report, it confirms that dioxins were detected in every single soil sample that was taken. Does this mean that the whole base is contaminated with dioxins?

As explained above, dioxins naturally occur in the environment and are released from many sources, including forest fires. They are often found in soils across Canada.

Date modified:
2013-09-06

Olson, Rachel

From: Olson, Rachel
Sent: Friday, December 1, 2023 3:24 PM
To: Babin, Mark; Dana Michaud (dana.michaud@deadriver.com); David Donovan (dadonovan4968@gmail.com); Donald Page (Donpage152@gmail.com); Farrin, Bradlee; Jackson, Troy; Jan McColm (Janmac19@hotmail.com); Jim Gehring (thegrunkas@aol.com); Karen St. Peter; Ronald Russell (ronrussell713@gmail.com); Russell, Ron
Cc: Murphy, Elias
Subject: Web address for Fact-Finding Project Reports shared by Meg Sears

Gagetown Harmful Chemical Study Commission members,

Ms. Meg Sears, PhD, Chair, *Prevent Cancer Now* was able to locate in her own records copies of the various task reports that were a part of the CFB Gagetown *Fact-Finding Project*. Although her files are not currently complete, she has posted them to the *Prevent Cancer Now* website in order to make the reports publicly accessible. You can find them at the following address: https://preventcancernow.ca/canadian-forces-base-gagetown-fact-finding-project-reports-re-herbicide-spraying-1952-2004/

Thank you,

Rachel Olson
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Final Report

Task 2A: The History and Science of Herbicide Use at CFB Gagetown From 1952 to Present

DEPARTMENT OF NATIONAL DEFENCE

PROJECT NO. 1009662.

FINAL REPORT

REPORT TO

Department of National Defence
101 Colonel By Drive
Ottawa, ON
K1A 0K2

ON

Final Report: Task 2A: The History and Science of Herbicide Use at CFB Gagetown From 1952 to Present

May 19, 2006

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EXECUTIVE SUMMARY

Jacques Whitford Limited (Jacques Whitford) was retained by the Department of National Defence (DND), through Defence Construction Canada (DCC) (project number HQ 06220, contract number 31077) to complete work on Task 2A: The History and Science of Herbicide Use at (CFB) Gagetown from 1952 to Present. This is one task of many designed to assess herbicide use on the base. The objectives of this task were three-fold. The first task was to create a database populated with information related to herbicide application (e.g., products applied, areas and rates of application, weather conditions, applicator, etc.) at the RTA. It is the intention of DND that the database be used in other studies designed to assess the possibility of toxicological, epidemiological, or ecological impacts resulting from the use of herbicides in the RTA. The second task was to write a report to provide context for the database by reviewing the history and science of herbicide use at CFB Gagetown, as well as factual information on the management practices of the base and of National Defence Headquarters (NDHQ), of the production, sale, and use of these herbicides in Canada, and a review of the lifecycle management of the used herbicides at CFB Gagetown. The last task was to create a look-up table containing data on the physical and chemical properties of all active ingredients (AIs), and their potential manufacturing impurities, that were applied on the RTA.

In general, herbicides (compounds used for the control of plants) were applied through ground or aerial applications (helicopter or fixed-wing aircraft) from 1956 to 2004 on the RTA. No herbicide applications were conducted prior to 1956, in 1959, 1962, or from 1997-1999. From 1956 to 2004, a total of 24 products and 14 AIs were confirmed to have been applied by DND at the RTA. In some cases, AIs alone were applied, or in a mix with other AIs. Many different herbicide products were applied between 1956 and 2004. Some were used over the course of many years (e.g., Tordon 101 or 10K were used from 1965 until 2003) while others were used only once (e.g., Krovar was used once in 1994).

In 1966, 1967, and 1990, CFB Gagetown was host to herbicide trials designed to test the efficacy of different products and AIs. In 1966 and 1967, the Forestry Branch of the Canadian Forestry Service (CFS) and the US Department of Army (USDoA) conducted separate trials testing various commercially available and military products, as well as various concentrations and mixes of AIs. In 1990, Dow Chemical of Canada conducted its own evaluation of specific commercially available products. Over the course of these trials, 15 additional products (13 AIs), not used by DND in yearly chemical control, were applied.

Including the test plots, 7 manufacturing impurities were associated with the products applied. They were free 2,2′-bipyridyl (found in diqaut), 3,3′,4,4′-tetrachloroazoxybenzene and 3,3′,4,4′-tetrachloroazobenzene (found in diuron), 4-chloro-2-methylphenol (from mecoprop), free 4,4′-bipyridyl (from paraquat), hexachlorobenzene (from picloram) and dioxin (from 2,4-D and 2,4,5-T) (WHO 1975; US EPA 1995; Ambrus et al. 2003; PMRA). Manufacturing impurities may be found in other AIs but their presence is protected by proprietary law in Canada under the current Pest Control Products Act.

Accompanying this report is a Microsoft Access 2000 database that contains a comprehensive overview of pesticide use at CFB Gagetown from 1956 to 2004 (including all test plots) and is separated into various components presented in a single user-friendly form: a multi-field search, text-based search, and a reference search. For convenience, the user will find access to a legend explaining each database field, a legend explaining the numerical assessment of the data sources used, a yearly and cumulative (1956-2004) table presenting the amounts of AIs used, and instructions on how to use the database. In addition, a table containing physical and chemical properties of the AIs

and manufacturing impurities (e.g., chemical names, structures, solubility, log octanol/water coefficients, etc.) encountered at CFB Gagetown is provided as an appendix to this report.

Herbicide regulation and policies surrounding herbicide application can be found at all levels of the Canadian government and within DND itself. During the time of application at CFB Gagetown, herbicide use was regulated at the Federal and Provincial levels. The Pest Control Products Act (PCPA) of 1939 was in place until 1972 (its purpose was to ensure product efficacy and to avoid fraud in product representation) when it was amended to expand legislative authority to control handling and use of such products and inert ingredients (e.g., emulsifiers, stickers, and stabilizers for use with pesticides). Moreover, the amendment sought to strengthen federal authority to protect public from deception in pesticide merchandizing. The PCPA has since undergone further changes, and a new version of the PCPA (PCPA 2002) received Royal Assent on December 12, 2002. The PCPA is presently in the final stages of the Gazetting process and is expect to become law in June 2006. The new Act will help ensure that Canadians are better protected from health and environmental risks posed by pesticides, while ensuring a safe and abundant food supply.

Health Canada's Pest Management Regulatory Agency (PMRA), is the federal agency responsible for the regulation of pest control products in Canada. The PMRA was established in April 1995 in response to the recommendations of the Pesticide Registrations Review Team, who suggested transferring the administration of the PCPA from the Minister of Agriculture and Agri-Food to the Minister of Health**.** The goal of the PMRA is to protect human health and the environment while supporting the competitiveness of agriculture, forestry, other resource sectors, and manufacturing.

The provinces and territories may regulate the sale, use, storage, transportation and disposal of registered pesticides in their jurisdictions as long as the measures they adopt are consistent with any conditions, directions and limitations imposed under the PCPA or other federal legislation. For example, a province or territory may prohibit the use of a registered pesticide in its jurisdiction, or it may add more restrictive conditions on the use of a product than those established under the PCPA. It may not, however, authorize the use of a product that has not been approved under the PCPA and may not relieve the user of the obligation to comply with the conditions, directions and limitations imposed under the PCPA. Provinces and territories administer a pesticides management program that includes education and training programs, the licensing and certification of applicators, vendors and growers, and the issuing of permits for certain pesticide uses. It should also be noted that federal lands in provinces are outside the jurisdiction of that province, but it is the policy of the federal government that all of its activities, including pesticide management, be compatible with standards set by other levels of government.

The base and DND have their own pesticide use and application policies. In 2000 a Sustainable Development Strategy (SDS) for National Defence (e.g., Environmentally Sustainable Defence Activities) committed DND to develop and implement Integrated Pest Management (IPM) plans at all Bases/Wings, and in 2001, the Director General Environment (DGE) issued functional direction providing guidance on a national IPM. In accordance with the DND-SDS, CFB Gagetown produced a five-year IPM plan for the period of 2003-2008. Further, the base retained Independent monitors from 1993 to 2004 to oversee application by contracted professional applicators, and environmental assessments and questionnaires were often filled out (from 1987-2004) to asses application effects, while independent monitors were used to document applications.

Further, the federal and provincial governments have committees to advise DND on their application decisions. For example, the Federal Interdepartmental Committee on Pesticides (FICP), the DND Pest

Management Advisory Committee (PMAC), the Environmental Protection Service (EPS) and Pesticides Advisory Committee (PAC) of the Atlantic Region, and the Federal/Provincial/Territorial Committee (F/P/T Committee) have all been involved in pesticide decision making.

Regarding the practice of herbicide use from 1956 to 2004 at CFB Gagetown, a number of general conclusions can be drawn:

- It should be noted that the annual herbicide files that were supplied to Jacques Whitford were, more often than not, incomplete, and information frequently had to be pieced together from several different documents within the same file or from different files, and in some cases, the documents contained in any given file contradicted one another. Furthermore, the details found in the applicator and monitor records were often sparse, and in more recent years, when applications were closely monitored, inconsistencies were still observed.
- Disposal methods were documented in some cases, and appear to have changed (i.e., improved) over the years. In later years, barrels and containers were recycled or returned to the manufacturer, whereas in earlier years barrels were disposed of in dumps or landfills, and may have still contained product at their time of burial.
- In 1984, 666 drums were excavated from a Shirley Road Dump on the RTA. There were 145 crushed drums, 398 empty (331 originally contained Tordon 101), and 112 drums containing liquid, 61 of which contained 2, 4-D and picloram, the AIs in Tordon 101.
- Many different herbicide products were applied between 1956 and 2004. Some were used over the course of many years (e.g., Tordon 101 or 10K were used from 1965 until 2003) and some were used only once (e.g., Krovar was used in 1994).
- It appears that Agent Orange, Agent Purple, and Agent White were only applied on the USDoA test plots. Agent Orange was applied in the 1966 and 1967 trials; Agent Purple was only applied in 1966; and Agent White, was only applied in 1967.
- In 1956, 1957, 1963 and 1964, a 50:50 mix of 2,4-D and 2,4,5-T was applied to various areas throughout the RTA, however, the chemical form of these AIs was not given (e.g., n-butyl ester) in any report documenting these applications.
- Over the 48 years period there were 11 recorded incidents, of which 3 resulted in off site damage, and incidents ranged from inconsequential spills of product (less than 1L) to more serious claims of crop damage and the potential use by applicators of unregistered herbicide products.
- In the cases where information regarding product application rates could be determined, it appears that the actual application rates of products fall within the recommended application rates suggested by the manufacturer. Often, actual application rates were lower than the recommended rates.
- Herbicide applications in the RTA were regulated by the policies and science of the day as implemented by the Federal and Provincial governments and by DND (base and NDHQ).
- Herbicides used in the RTA for vegetation control were commonly used around Canada during the past fifty years.

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ACRONYMS AND ABBREVIATIONS

2,4-D	2,4-dichlorophenoxyacetic acid
2,4,5-T	2,4,5-trichlorophenoxy acetic acid
AI	Active ingredient
AR-PAC	Atlantic Region Pesticide Advisory Committee
BCEO	Base Construction Engineering Officer
BEnvO	Base Environmental Officer
CEAA	Canadian Environmental Assessment Act
CETO	Construction Engineering Technical Orders
CFB	Canadian Forces Base
CFMO	Canadian Forces Medical Order
CFS	Canadian Forestry Service
CLS	Chief of Land Staff, Army
DAOD	Defence Administrative Orders and Directives
DCC	Defence Construction Canada
DND	Department of National Defence
EA	Environmental Assessment
EC	Environment Canada
EPI	US EPA Estimation Programs Interface Suite™
EPS	Environmental Protection Services
EXTOXNET	EXtension TOXicology NETwork
FICP	Federal Interdepartmental Committee on Pesticides
F/P/T	Federal/Provincial/Territorial Committee
IPM	Integrated Pest Management
PCP	Pest Control Products Registration Number
MMG	Medium machine gun
MSDS	Material Safety Data Sheets
NDHQ	National Defence Headquarters
PCPA	Pest Control Product Act
PMRA	Pest Management Regulatory Agency
RTA	Range and Training Area
SDS	Sustainable Development Strategy
USDoA	US Department of the Army
US EPA	United States Environmental Protection Agency
UXO	Unexploded explosive ordnance

1.0 INTRODUCTION

Jacques Whitford Limited (Jacques Whitford) was retained by the Department of National Defence (DND), through Defence Construction Canada (DCC) (project number HQ 06220, contract number 31077) to complete work on Task 2A: The History and Science of Herbicide Use at (CFB) Gagetown from 1952 to Present. This task is part of the overall commitment made by the Federal Government of Canada to identify and report on the historical use of herbicides applied in the Range Training Area (RTA) at CFB Gagetown, through a fact-finding initiative. The historical period covered in this task is from 1952 to 2005; however, herbicide application records indicated application was initiated in 1956 and extended up to 2004.

Canadian Forces Bases (CFB) Gagetown, located adjacent to the town of Oromocto, New Brunswick, houses an 110,000-hectare range and training area (RTA) where live-fire military training occurs. Post World War II and during the beginning of the Cold War, a need was identified for a large Atlantic situated army training area where brigade and division-sized armoured, infantry, and artillery units could exercise. The land for CFB Gagetown was expropriated beginning in the 1940s and remains the largest land expropriation in the history of the province of New Brunswick. At the time of its opening in 1956, it remained the largest military training facility in Canada until the opening of CFB Suffield in Alberta in 1971.

Between 1953 and 1956 approximately 16,000 hectares of mostly forested area was mechanically cleared for training purposes, with an additional 2,500 hectares of land cleared between 1963 and 1967. During this time approximately 1,000 hectares of land was also cleared along the road allowances on the base (Walter, 1985). These areas were mechanically cleared in order to facilitate the type of military training that has occurred, and continues to this day at CFB Gagetown. The base currently houses 3,000 military personnel, with many more military staff coming to CFB Gagetown each year for training purposes. Given that small arms, grenade, mortar, rocket launcher, anti-tank, field firing, artillery and air defence ranges as well as tracked and wheeled vehicle driving areas are located on the base there is a need to reduce brush and control vegetation in these training areas. For the most part the military requirement is to ensure good line of sight for training, with a requirement that vegetation be kept below 1 m in height. It would also make tracked and wheeled vehicle training very difficult, if not impossible, to carry out if secondary forest growth was not kept in check in training areas around the base.

In addition, live fire training exercises are also carried out in the Range Training Area (RTA), which occasionally results in brush fires. In order to reduce the threat or magnitude of these fires, there is a need to ensure that the RTA has an effective brush and vegetation control program. This has traditionally been done through a combination of mechanical (e.g., cutting, crushing, or burning) and chemical control methods (i.e., spraying herbicides through ground or aerial applications with helicopters or fixed-wing aircraft) to manage vegetation growth in the RTA. In order to control grass, controlled burning is generally considered the most appropriate method, because it has the least amount of environmental impact and is relatively inexpensive. However, grass burning does place personnel in areas potentially containing unexploded explosive ordnance (UXO). Therefore, the application of herbicides in the RTA over the past fifty years has generally been the most cost effective

means of reducing secondary growth vegetation on a larger scale and promotes personnel safety by removing the risks associated with encountering UXO.

The primary objective of this work was to create a database that contains information related to the application of herbicides at CFB Gagetown. In addition, a chemical property look up table is provided in Appendix A and this report is provides context to the information housed in the database.

1.1 Scope of Work

The scope and objectives of this task were three-fold:

- The first task was to create a database populated with information related to the yearly herbicide application (e.g., products applied, areas and rates of application, weather conditions, applicator, etc.) at the RTA. It is the intention of DND that the database be used in other studies designed to assess the possibility of toxicological, epidemiological, or ecological impacts resulting from the use of herbicides in the RTA. This task required the greatest amount of effort for the project (60% of budget allocated), requiring thousands of records to be reviewed, prioritized and entered as appropriate into the database.
- The second task was to create a look-up table containing data on the physical and chemical properties of all active ingredients (AIs) (not including toxicological properties), and their potential manufacturing impurities, that were applied on the RTA. This task was budgeted as 10% of the overall project effort.
- The final task was to write a report to provide context for the database by reviewing the history and science of herbicide use at CFB Gagetown, as well as factual information on the management practices of the base and of National Defence Headquarters (NDHQ), of the production, sale, and use of these herbicides in Canada, and a review of the lifecycle management of the used herbicides at CFB Gagetown. This task was budgeted as 20% of the overall effort for the project. The report is not meant to be read in isolation of either the look-up tables or the database.

The interim report and database for Task 2A was provided to an independent Peer Review Panel selected by the Department of National Defence on April 10, 2006, and consisted of Dr. Leonard Ritter (University of Guelp), Dr. D. George Dixon (University of Waterloo) and Mr. Christopher Riley (RPC). A consolidated set of Peer Review comments was provided to Jacques Whitford on May 4, 2006, by the Chair of the committed Dr. Leonard Ritter. The Peer Review comments are found in Appendix F of the Final Report, along with a table of Jacques Whitford's response to comments. The Peer Review comments have been taken into consideration in the finalizing of the report and database for Task 2A.

1.2 Report Structure

This report is presented in 10 Sections. Section 1 describes the Scope of Work and terminology related to pesticides in which readers should be familiar. Section 2 provides information on how data was collected for this Task. Section 3 presents the general framework for how data was complied and historically validated for use in the database and report. Section 4 provides and overview of the development of the science of pesticide use. A discussion of the history of policy and regulation of herbicides in Canada at the federal, provincial/territorial, departmental (DND) and base level is found in Section 5. Section 65 discusses the life cycle management of herbicides at CFB Gagetown including a list of products, AIs, and manufacturing impurities applied from 1956 to 2004, including those used on test plots. Further, herbicide application methods, planning and contracting procedures, monitoring and environmental assessments, handling, storage and disposal of herbicides and any application incidents

are described. Section 7 describes the physical and chemical properties look-up table. Section 8 provides a description of the Microsoft Access 2000 database. Section 9 details the reporting and database challenges and limitations. Section 10 provides final conclusions regarding the use of herbicides at CFB Gagetown. Section 11 lists the references cited in this report, and further supporting information is provided in appendices at the end of the report.

2.0 DATA COLLECTION FOR TASK 2A

The initial step in the scope of work was to review documents and historical information that may contain information for use in the database, look-up table and report. Jacques Whitford was provided with hard copies of historical documents, sorted by year, relating to herbicide spray events at CFB Gagetown, and electronic versions of these documents, saved in yearly folders. Overall, hundreds of documents and records are were provided by DND and are contained on six CDs in Appendix E. These electronic files often contained additional information not found in the hard copies (e.g., documents from the Province of New Brunswick). Jacques Whitford was also provided with miscellaneous documents from NDHQ.

The information provided by DND was complied from records held at CFB Gagetown, the DND archives, and records held at NDHQ. It is believed that an exhaustive effort was undertaken by the department to retrieve all pertinent documentation related to herbicide use at CFB Gagetown. All of these files contained numerous documents which contained a variety of information, including, but not limited to:

- Summary documents of applications
- DND Specifications
- Permits issued by the Province of New Brunswick
- Request for Proposals
- Final reports provided by the Contractor responsible for the application of herbicides
- Independent Monitor's reports
- Reports from the Atlantic Region Pesticide Advisory Committee (AR-PAC), Environmental Protection Services (EPS), and Environment Canada (EC)
- Contractual Documents from Defence Construction Canada (DCC)
- Interdepartmental memorandums
- Brief summaries provided by the Contractor responsible for the application of herbicides
- DND Final and Interim Certificates of Completion
- Product information specific to the herbicides used, provided by the manufacturer
- Material Safety Data Sheets (MSDS) for individual herbicides and product labels
- Maps
- Handwritten notes, drawings, and contract diaries

It should be noted that the annual files were more often than not, incomplete, and in some cases the documents contained in any given file contradicted one another.

Jacques Whitford also sought out other information sources for the completion of Task 2A. The Pest Management Regulatory Agency (PMRA) of Health Canada was a source of information for all three components of this Task. Jason Flint, Head, Office of Policy and Strategic Advice, and Karen Lloyd, Director, Environmental Assessment, along with their respective staff supplied data required for the

look-up table and for the report, and the PMRA ELSE label site (available online at http://eddenet.pmra-arla.gc.ca/4.0/4.0.asp) was utilized to obtain information required for the database. Other reliable scientific internet sites (e.g., National Institute of Health, United States Environmental Protection Agency (US EPA), EXtension TOXicology NETwork (EXTOXNET)) and primary scientific literature were used as additional sources of information.

Jacques Whitford searched for information relevant to the project that was available at the National Archives of Canada. The process of obtaining documents related to Task 2A at the National Archives is extremely slow, and Jacques Whitford has not yet been able to obtain all requested documentation. Since the submission of the Interim Report, Jacques Whitford has received some of the documents from the National Archives, but is still awaiting a limited number of documents contained in record group (RG) 24 (National Defence). A list of files already reviewed, and of those still pending, is presented in Appendix D.

Finally, Jacques Whitford conducted formal (and informal) discussions with:

- Robert Chrétien, the DND Technical Authority for this Task
- Jason Flint, Head, Office of Policy and Strategic Advice, PMRA
- Karen Lloyd, Director, Environmental Assessment, PMRA,
- Sheldon Downe, Land Forces Atlantic Area Environmental Officer
- Sebastian Fournier, Acting Senior Environmental Advisor – Land Force Command
- Tom McLaughlan, Base Environment Office – CFB Gagetown

to provide additional context for this report.

The Peer Reviewers had suggested that interviews be conducted with historical herbicide applicators, manufactures of herbicides, amongst others. These were deemed to be outside of the scope of the current project and the timelines did not permit such interviews. These interviews would not have provided written factual accounts of the yearly herbicide application in the RTA, which were contained in the DND records. It is believed that the written documentation reviewed, as well as interviews conducted with the aforementioned people provide the context required for the project.

3.0 DATA COMPILATION AND HISTORICAL VALIDATION

Numerous documents were searched to obtain information about yearly herbicide application events. Given that each document had varying degrees of detail and direct significance to the event, each information source used in the database was assigned a numeric value as a measure of its validity (e.g., a level of confidence for each citation). Table 1 describes the types of references that were cited, the level of validity assigned to each document type, and an explanation of the assigned validation level. Files were ranked from 1 to 6, with 1 being most valid and 6 being least valid. The least valid files should not be discounted as unimportant, but are generally the ones that were least closely related to an application event, and their information is only possibly correct. For example, files given a score of 1 are first hand accounts of applications whereas files given a score of 6 may have been written months before the application period. All efforts were made to obtain information from documents within yearly files with high rankings. If these were not available, information was obtained from files with the next highest score.

Table 1: Numeric Validation of Cited Sources

Validity Level	Data Source	Comment
1	• Final reports provided by the Contractor • Scientific Internet sources	• Detailed final reports provided by the contractor were the preferred document type. These are first hand, detailed documents related to actual applications. • Reliable internet sources from academic and government sites (e.g., Extoxnet, ChemID plus, PMRA label site).
2	• Independent monitor's reports • DND, DCC, EC, AR-PAC memorandums regarding post-application events, progress claim	• Independent monitor's reports provide a summary, in varying levels of detail, of application events. These are given a lower rating than Final reports because they are not produced by the actual applicator and are second hand accountings of application events. • Memorandums reporting completed work and certificates of completion. Presumably accurate because they are post-application documents, but are given a lower score than a final report because they are second hand accountings.
3	• Brief summaries provided by the Contractor • Permits issued by the province of NB • Minutes of pre-job meetings	• Earlier contractor reports contain short descriptions and limited information regarding applications, and are given lower rating than final reports. • Pesticide application permits may have been given, but often it is unclear whether or not the product the permit was given for was actually used. • Minutes of meetings with DCC, DND, and contractor. Often contains information about the contractor, pilot, and government contact but is given a lower score than an applicator's or monitor's report because it is a pre-application source.

Validity Level	Data Source	Comment
4	• 1981 Memorandum Document (7600-2 (CE))	• A summary table and accompanying text version, prepared by DND in 1981 summarizes the herbicide applications at CFB Gagetown between 1956 and 1975. It is given a lower score because there is no way to check its accuracy as references are not provided.
	• Yearly Summary Table (1956-1968)	• Summary table supplied by NDHQ. Again, there is no way to check the accuracy as references are not provided.
	• 1996 Pesticide Report Summary	• Summary of data between 1986 and 1993, actual usage from 1994 and 1995, and 1996 prediction. Again, there is no way to check the accuracy as references are not provided.
	• Comparison between Second Growth Control Summaries (1970-1975)	• Information Chart/Summary Sheet, Brush Control, Various Training Areas, C.F.B. Gagetown (3 September 2004), is a summary of the herbicide applications at CFB Gagetown between 1965 and 1975. There is no noted author and there is no way to check the accuracy as references are not provided.
	• DCC tender documents	• Amendments, etc.
	• Quantities Adjustment Sheet	• By DCC
5	• DND Specifications	• DND Specifications were used when there was no documentation written after the spraying program. These constitute planning documents only. Furthermore, the DND specifications often provide a number of options that are considered acceptable, and cannot give any indication of which was actually sprayed in which area.
	• Notes/letters from chemical companies	• Information related to proper nozzles, applications, etc., but there is no way to know whether or not these were followed
6	• Other miscellaneous files	• Hand written notes, contract diaries, Recommendation for Release of Defects Warranty, etc. These file may have contained useful information but are given the lowest score because, for example, their source could not always be verified and they were found as loose sheets in a file without authors or dates (unable to determine if they from were pre or post application).

As mentioned above, given that each yearly application file contained numerous records, all efforts were made to obtain information from documents within yearly files with the highest validity level score. Other documents in the files may have provided corroborating or contradictory information, but were deemed of lesser validity based on their “first-handedness” to the application event. Therefore, it was felt that a single validity level was more relevant than using a matrix based score that would include additional lines of evidence.

As stated in Section 8.0 of the report, the information reported in the database is therefore reliable and can be used for subsequent tasks in the fact-finding initiative. In addition, users of the database will be able to use the reference Section of the database and the accompanying CDs of referenced documents to assure themselves of the reliability of the information contained in the database.

4.0 DEVELOPMENT OF THE SCIENCE OF PESTICIDE USE

4.1 Pesticide Terminology

The term “pesticide” is the umbrella term for chemicals used to control pests (“pest”; an unwanted organism, “icide”; to kill), whereas the term “herbicide” is the specific name for compounds used for the control of plants. Commercial formulations of herbicide products (referred to herein simply as herbicides) are given a trade or commercial name by the companies that manufacture them, and each individual herbicide formulation may contain one or more AI’s, the compounds that have herbicidal properties, and other ingredients such as carriers (which act as a vehicle for more effective transmission), dilutants, and adjuvants (which may improve the effectiveness of the AI by modifying the characteristics of the formulation). For example, the herbicide Dycleer is manufactured by Syngenta Crop Protection Canada Inc., and contains the AIs dicamba and 2,4-dichlorophenoxyacetic acid (2,4-D), along with proprietary carriers and adjuvants. In some cases, manufacturing impurities (also referred to as contaminants) are found in herbicides as a result of the production of the AIs. For example, hexachlorobenzene is a manufacturing impurity associated with the production of the AI picloram.

4.2 History of the Science of Pesticide Use

Pests are commonly referred to as any injurious or troublesome insect, fungus, bacterial organism, virus, weed, or rodent and pest control products (i.e., pesticides) are devices, organisms, substances, etc, used to directly or indirectly control, prevent or destroy pests (PCPA 2002). Human beings have been battling with pests since humans and pests have coexisted, specifically because pests are vectors for disease and compete with us for food and fodder.

Over time, humans have used various methods of pest control and prior to the Twentieth Century pests were controlled through human and animal labour and natural chemicals and “home-made” recipes of ingredients. Early Greeks and Romans are known to have used mechanical methods (e.g., human labour) for pest control, especially during periods of locust plagues, and according to documents of the day, locusts were collected by law three times a year, and in some regions people were required to take a specific quantity of locusts to their local magistrates (Beavis 1988). In fact, early golf course superintendents in Scotland employed weed pickers to remove unwanted plants from golf courses and utilized grazing cattle, sheep and rabbits to maintain a well clipped and healthy turf (Beard 1989).

The first chemical pesticides were generally made of elements that could readily be found around human establishments, or came from the animals and plants used by peoples of the time. For example, before 1000 BC, sulphur was used in China as a fumigant (Ecobichon 1996). Ancient Romans and Greeks also used sulphur as a pesticide. Sulphur was mixed with oil and used it as an insect repellent; it was boiled along with bitumen and olive oil leaves as a fumigant; and burned in order to kill insect pests (Berenbaum 2000). Sulphur was also used as a fungicide in the 1800s in Europe to control powdery mildew on fruit (Ecobichon 1996). Early cultures also relied upon plants and animals for herbicidal properties and a wide variety of plants were used. In the 1700s people from Japan are noted to have used a mix of rendered whale oil and vinegar to prevent larval growth on rice patties. Tobacco leaves, flowers from chrysanthemums, and the seed of the Strychnine Tree (*Strychnos nux-*

vomixa) were often rendered and used for their insecticidal and rodenticidal properties (Ecobichon 1996). In fact, the Romans and Greeks recommended putting dead insect larvae onto non-infested areas in order to ward off further potential infestations, indicating that they held a primitive knowledge of pheromones biology (Beavis 1988).

In the late 1800s, compounds containing heavy metals gained momentum as effective pesticides, but their use as pesticide components was known in early China (e.g., arsenic was used for its insecticidal properties) (Ecobichon 1996). For example, arsenic trioxide was used as a herbicide, Bordeaux mixture, containing copper sulphate, was used to control vine downy mildew, and Paris Green (a component of paint that consists of a mixture of copper and arsenic acid) was originally used to discourage thieves of grape foliage in France (Berenbaum 2000), was used to control the Colorado Potato Beetle (Ecobichon 1996), and copper sulfate was used to control weeds in wheat fields (Berenbaum 2000). By the 1900s, lead arsenate and calcium arsenate tended to replace Paris Green and became the predominant insecticides of the day.

Between the early 1920s and early 1940s, research in modern organic synthetic pesticides grew rapidly as a result of increased research into the use of chemicals for medical and military use. Technology of the time also improved, and in the 1920s, airplanes were first used to disperse pesticide products (Crop Life 2000). During this time, herbicide use increased, notably with the discovery of 2,4-dichlorophenoxyacetic acid likely because it was the first successful selective herbicide developed (2,4-D Industry Task Force 2005). It is generally accepted that four independent researchers from the United Kingdom and the United States discovered phenoxy herbicides in the early 1940s. The discovery of 2,4,5-trichlorophenoxy acetic acid followed in 1944 and dichloroprop (2,4DP) in 1945 (Agranova 2001). After World War Two, there was a boom in the pesticide industry for agrochemicals, and numerous pesticides for use in agricultural situations were introduced (Ecobichon 1996). Of particular note was the introduction of diuron based herbicides in the 1950s, picloram based herbicides in the 1960s, and glyphosate based products in the 1970s (Agranova 2001).

As of 1999, there were approximately 600 different AIs and 6,000 formulated products registered for use in Canada (WWF 1999). From the Atlantic Region of Canada specifically, approximately 160 different AIs were used yearly for pest control in early the 2000s (Environment Canada 2004).

5.0 HISTORY OF POLICY AND REGULATION OF HERBICIDES IN CANADA

Herbicide regulation and policies surrounding herbicide application can be found at all levels of the Canadian government and within DND itself. Briefly, today pesticides are regulated at the federal level through the Pest Control Product Act (PCPA), and Health Canada's Pest Management Regulatory Agency (PMRA) is the federal agency responsible for the regulation of pest control products in Canada. The provinces and territories regulate the sale, use, storage, transportation and disposal of registered pesticides in their jurisdictions, and also administer pesticide management programs that include education and training, licensing and certification of applicators. The provinces are also responsible for issuing permits for certain pesticide uses. DND and CFB Gagetown have their own application directives and policies issued by the Director General Environment (DGE) (see Section 4.5). Further, the federal and provincial governments have committees to advise DND on their application decisions.

5.1 Regulation of Pesticides at the Federal Level in Canada

Federal intervention to control pesticide products dates to the 1920s and 1930s with the Agricultural Economic Poisons Act of 1927. This act's principle "raison d'être" was to ensure the appropriate labelling requirements under which pesticides could be imported, manufactured, or sold in Canada (Castrilli and Vigod, 1987). In 1939 this Act was superseded by the Pest Control Products Act (PCPA), the purpose of which was to ensure product efficacy and to avoid fraud in product representation (Castrilli and Vigod, 1987).

Following the 1962 publication of the Rachel Carson's book "Silent Spring" (Carson, 1962), which was an indictment of synthetic pesticide misuse and a major trigger for environmental movement in North America (Hughes, 2001), the federal government sought to amend the PCPA in 1969 in order to expand legislative authority to control handling and use pesticides and inert ingredients (e.g., emulsifiers, stickers, and stabilizers for use with pesticides). Moreover, the amendment sought to strengthen federal authority to protect public from deception in pesticide merchandizing (Castrilli and Vigod, 1987). The modified act eventually came into force in 1972, but since that time, though having undergone some revision, is the same act in place today.

The need to update the Act has been recognized and advocated for years (Caccia 2000). In 1987, the Law Reform Commission of Canada published a paper on federal pesticide law and policy and contained close to 25 recommendations for change (Castrilli and Vigod 1987). In 1989, the Honourable Don Mazankowski, Minister of Agriculture, created a multidisciplinary task force called the Pesticide Registration Review Team to review the way in which pesticides were regulated in Canada. The team, after almost two years of negotiations and public consultations, recommended major reform of legislation, process, and accountability for pesticides and published their recommendations in what is known as the 'Blue Book' (Caccia 2000). This report recommended a complete overhaul of the pesticide regulatory system, notably, through the creation of the PMRA and the transfer of legislative authority from the Minister of Agriculture to the Minister of Health (see below).

In 1993, as part of the Liberal Party of Canada's campaign promises, the Right Honourable Jean Chrétien (then Leader of the Official Opposition), pledged to act on the Review Team's recommendations, and in 1994, the newly-elected Liberal government outlined how it would implement the Pesticide Registration Review Team's recommendations in a document entitled Government Proposal for the Pest Management Regulatory System, also known as the Purple Book (Caccia 2000).

In 2000, a report titled "Pesticides, Making the Right Choice for the Protection of Health and the Environment" was tabled as a Report of the Standing Committee on Environment and Sustainable Development (SCESD, 2000). This report outlined the need for new pesticide legislation in Canada, as the current legislation was deemed to be outdated and had a number of faults. This report also identified that there is no current registry of production or sale of herbicides by product in Canada, which appears to be still true today, where there is no central registry of herbicide sale, production or use in Canada could be located by the researchers.

A new version of the PCPA (PCPA 2002) received Royal Assent on December 12, 2002. The PCPA is presently in the final stages of the Gazetting process and is expect to become law in June 2006 (personal communication, Office of Policy and Strategic Advice, PMRA). This new Act will help ensure that Canadians are better protected from health and environmental risks posed by pesticides, while ensuring a safe and abundant food supply. The 2002 PCPA modernizes and strengthens pesticide regulation and makes the registration system more transparent. Further, the new PCPA regulates the

use of substances that claim to have pest control uses and regulates other substances, such as formulants, adjuvants, and manufacturing impurities contained in products (Health Canada, 2001). The passage of this legislation is the culmination of an extensive, multi-year review of pesticides regulation in Canada and represents an overhaul of existing pesticides legislation (PMRA, 2002).

5.2 The Pest Management Regulatory Agency

Health Canada's PMRA, is the federal agency responsible for the regulation of pest control products in Canada. PMRA was established in April 1995 in response to the recommendations of the Pesticide Registrations Review Team. The Multi-stakeholder Review Team was charged with studying and making recommendations to improve the federal pesticide regulatory system. With the transfer of administration of the PCPA from the Minister of Agriculture and Agri-Food to the Minister of Health, the PMRA was established to consolidate the resources and responsibilities for pest management regulation (Health Canada, 2001).

The goal of the PMRA is to protect human health and the environment while supporting the competitiveness of agriculture, forestry, other resource sectors (Health Canada, 2001). The Agency is also dedicated to integrating the principles of sustainability into Canada's pest management regulatory regime.

5.2.1 PMRA Regulation of Pesticides

Regulation of pesticides involves a screening process, a review process, and a final decision. Before making a registration decision regarding a new pest control product, the PMRA conducts an assessment of the risks and values of the product specific to its proposed use (Health Canada, 2001). The value assessment may consider whether the use of the product contributes to pest management and whether the application rates are the lowest possible to effectively control the target pest. The risk assessment considers the inherent toxicity, persistence and bioaccumulative nature of the product, while addressing such key concerns as the degree to which humans and the target and non-target environment may be exposed, and the possible health hazards associated with the product. Because pesticides are introduced into the environment at quantifiable rates, the potential short-term impacts of environmental exposures can be closely estimated. For long-term exposure, the PMRA relies on persistence and bioaccumulation data as qualitative indicators, as well as available monitoring data (Health Canada, 2001). For registered products, ongoing surveillance, advances in analytical methods and improved evaluation provide a means to uncover environmental or health concerns for the re-registration process.

Pest control products will be registered if data requirements for assessing value and safety have been adequately addressed, if the evaluation indicates that the product has merit and value, and if the human health and environmental risks associated with its proposed use are acceptable. The PMRA manages the risks associated with pesticide use in several ways and these include (Health Canada, 2001):

- Setting conditions of registration
- Monitoring compliance with conditions of registration
- Developing label improvement programs that support best-management practices

- Supporting the development of sustainable pest management strategies that provide a context for registration decisions

Non-compliance with conditions of registration is a violation of the PCPA and may lead to suspension, cancellation, use restrictions, or the phasing out of a pest control product. Pesticides are carefully regulated in Canada through a program of pre-market scientific assessment, enforcement, education, and information dissemination. These activities are shared among federal, provincial/territorial and municipal governments, and are governed by various acts, regulations, guidelines, directives and bylaws.

5.3 Federal Monitoring and Discussion Groups for Pesticide Use in Canada

The federal government also has advisory committees to discuss and monitor pesticide use in Canada. The following is a brief overview of the role these committees have or continue to play in pesticide management and policy in Canada.

Federal Interdepartmental Committee on Pesticides (FICP): In September of 1962 an interdepartmental ad hoc committee was formed to discuss the possibility of preparing a reference paper on pesticide use in Canada. Once completed, the paper was presented to the House of Commons Special Committee on Food and Drugs who advised that a permanent committee on pesticide use be established. On July 9, 1964, the Federal Interdepartmental Committee on Pesticide (FICP) was officially formed. The FICP was purely an advisory and consultative committee, and had no executive or operational roles, and held no mandatory powers. As the name implies, the FICP had representatives from various federal departments such Agriculture, Fisheries, Forestry, National Defence, National Health and Welfare, Northern Affairs and National Recourses, and the National Research Council. The FICP would meet twice yearly to discuss issues related to the pesticide situation in Canada at the federal, provincial and municipal level, with industrial, civil and military facets (Anonymous, 1979).

The FICP was dissolved on January 14, 1987 (Olson, 1987) and was replaced by the Pesticide Directorate of the Food Production and Inspection Branch of Agriculture Canada (note found in 1150-110/f15 box 13 rg 24 23738), which was, as mentioned above replaced by the PMRA in 1995.

Environmental Protection Services (EPS) and Pesticides Advisory Committee (PAC): The Environmental Protection Services, Atlantic, is the coordinating agency for the Atlantic Region Pesticides Advisory Committee (AR-PAC), and is responsible for distributing the FICP summary of proposed federal programs for the region to the AR-PAC members for review. The ARPAC is comprised of representatives from a number of federal departments. As of 1978, the EPS has conducted inspections of federal government sponsored pesticide applications. It also appears that the Base Construction Engineering Officer (BCEO) for CFB Gagetown has generally sent notification to the EPS-Atlantic Region identifying the potential herbicidal products to be used in that year's spray program. This appears to have been an effective means to ensure that the minimum amount of herbicide was used to effectively treat areas (Wood, 2002).

Federal/Provincial/Territorial Committee (F/P/T Committee): The Federal/Provincial/Territorial Committee (F/P/T Committee) brings together federal and provincial/territorial pesticide officials to exchange information and expertise. The role of the F/P/T Committee is to provide advice and direction to governments on programs, policies and issues relating to pesticides and actively pursues solutions to shared issues of concern through the activities of its working groups (Health Canada, 2003).

5.4 Regulation of Pesticides at the Provincial/Territorial Level in Canada

Only pesticides that are registered for use under the PCPA may be imported, sold, or used in Canada. The provinces and territories may regulate the sale, use, storage, transportation and disposal of registered pesticides in their jurisdictions as long as the measures they adopt are consistent with any conditions, directions and limitations imposed under the PCPA or other federal legislation. For example, a province or territory may prohibit the use of a registered pesticide in its jurisdiction, or it may add more restrictive conditions on the use of a product than those established under the PCPA. Federal lands in provinces are outside the jurisdiction of that province, but it is the policy of the federal government that all of its activities, including pesticide management, be compatible with standards set by other levels of government (Environment Canada 1994). A province or territory may not, however, authorize the use of a product that has not been approved under the PCPA.

Provinces and territories administer a pesticides management program that includes education and training programs, the licensing and certification of applicators, vendors and growers, and the issuing of permits for certain pesticide uses. Other important roles, carried out in cooperation with PMRA regional offices, are those of enforcement and compliance monitoring, and response to spills or accidents (Health Canada, 2003).

5.4.1 New Brunswick Regulation and Management of Pesticides

Although CFB Gagetown is situated on Crown land, there has always been cooperation with the Government of New Brunswick to ensure that herbicide applications within the RTA meet provincial standards and regulation.

New Brunswick further regulates pesticide use in the province under the Pesticides Control Act (1973), which is administered by the Environment Department. The intention of the act is to ensure that pesticides are used, stored and disposed of in a manner that ensures minimal impact on non-target species, human health or the environment.

There are four measures in the act that directly apply to the application of herbicides at CFB Gagetown (New Brunswick, 2006).

1. Pesticides Vendor's Licence: Companies selling or distributing non-domestic pesticides must be licensed, and renew this license on a yearly basis. This licensing requirement spells out requirements for storage and employee training.
2. Pesticide Operator's License: Operators offering pesticide application services must be licensed by the provincial government and meet proper storage and insurance requirements.
3. Pesticide Use Permits: When DND either ground or aerially applies herbicides at the RTA they must obtain a permit authorizing the application. The permit outlines operation conditions, outlines type of application, herbicides authorized for use, requirements for certification, setbacks from homes, water bodies, and other sensitive environmental areas, maximum wind speeds, reporting and public notification.
4. Pesiticide Applicator Certification: This certificate is proof that individuals applying herbicides have received the necessary education and training to carry out applications in a safe and responsible manner.

DND follows the provincial standards and regulations for herbicide application within the RTA at CFB Gagetown.

5.5 Department of National Defence Policies on Herbicide Use

DND regulates its pesticide practices through several internal directives, policies and documents. The main Environmental Directives are as follows, obtained from an internal DND document named "Compliance Framework for Pesticides", created and supplied by Rob Cretien, the DND Technical Authority for this Task:

- Defence Administrative Orders and Directives (DAOD) 4003-0 1999-03-31 (Environmental Protection and Stewardship): The intent of this policy is to ensure that DND employees and Canadian Forces members respect the environment, exercise environmental stewardship, and protect public and non-public properties and assets held in trust;
- Canadian Forces Administrative Order (CFMO) 34-46 Pest Control 2/79: Prescribes responsibility and procedure for pest control in DND;
- Canadian Forces Medical Order (CFMO) 36-03 Pest Control 4/78: Prescribes methods, materials and equipment for the use of pesticides on DND units;
- National Defence General Safety Standards C-02-040-009/AG-001, 1999-01-01: Contains major occupational health and safety regulatory instruments approved for application throughout DND and CF. Chapter 5, Pesticides. Chapter 20, Occupational Health Evaluations;
- Integrated Pest Management Directive 4003-XX (Draft): In December 2000 the Sustainable Development Strategy (SDS) for National Defence (e.g., Environmentally Sustainable Defence Activities) committed DND to develop and implement Integrated Pest Management (IPM) plans at all Bases/Wings by 31 March 2004. On May 29, 2001, the Director General Environment issued functional direction providing guidance on a national IPM as identified in "Actions Supporting Common Steps" for this target. A recommended format for IPM plans and procedures was also provided.

Moreover, DND also adheres to federal polices and codes of practice such as, the Treasury Board Manual, Occupational Safety and Health Volume (Chapter 2-15, Pesticides) that prescribes guidelines for use of pesticides on federal properties and requires that departments practice IPM to reduce pesticide use. It also requires that a record of pesticide use be maintained for 30 years; and the Environment Canada Code of Good Practice for the Handling, Storage, Use, and Disposal of Pesticides at Federal Facilities in Canada that provides recommendations and supporting information on measures that should be taken to minimize environmental impacts associated with pest management programs and covers practices for the selection, transportation, storage, handling, application, and disposal of pesticides, as well as emergency planning procedures.

DND, through NDHQ publishes the Canadian Forces Pest Control Manual, which is intended as a reference manual for pesticide applicators employed or associated with the department. Comprised of seven Sections, the Manual covers major pest management activities carried out at Canadian Forces facilities in Canada, and to a lesser extent abroad. There have been four editions of the hard copy manual, which were superseded by a CD version. The information contained on the CDs is expected to be available on the internet in the future. Briefly, the 4th edition of the manual (1981) outlines the following with respect to pesticides and their uses:

- Equipment and methods for pesticide use (e.g., mist blowers, pistol sprayers, fumigate, air spraying, etc.).
- Types of pesticide, formulations, and dilutions (e.g., differences among herbicides, insecticides, rodenticides, etc.).
- Specific chemical recommendations for pests (e.g., location of use, pesticides that can be used, form of pesticide, concentrations, etc.).
- Hazards and precautions (e.g., toxicity, emergency action plans, etc.).

In addition, DND published a series of Brush Control Guide Specifications (Construction Engineering Technical Orders (CETO), until the mid-90s, outlining the scope of work, materials to be used, the method of work, as well as provisions for re-treatment, cleanup, and mitigation of pollution.

DND has its own advisory committee, the Pest Management Advisory Committee (PMAC), which has been meeting and advising DND on military pest management and related entomological and medical issues since 1950. The Committee has had several names, and has been known as the Entomological Research Panel, the Advisory Committee on Entomological Research and the Advisory Committee on Pest Control. The DND PMAC is presently administered by DGE (personal communication, Robert Chrétien, DND Technical Authority for this Task).

Members of the PMAC include representatives from DGE and Director General Health Services, and volunteers selected from amongst the finest Canadian entomologists and Pest Control field experts from Canadian universities, different levels of government, and private industry. Other governmental departments are invited to share their expertise with PMAC when deemed necessary. PMAC also has the participation of the United States Armed Forces Pest Management Board which allows for the bilateral exchange of information, scientific research, and services. PMAC meets once a year and working group meetings are arranged by DGE as required to expedite the business of the Committee.

In 1990 PMAC attempted to fill in for the disbanded FICP by reviewing base pesticide use forecast reports, but this practice stopped in 1994 (personal communication, Robert Chrétien, DND Technical Authority for this Task).

Land Force Command (LFC), which is the operational command for CFB Gagetown, has a Environmental Management System (EMS) (2005) that contains a Guidance Sheet for Pesticides. This is a brief overarching EMS policy for use of pesticides at bases under the control of LFC. The LFC has mandated that pest management plans must include Integrated Pest Management (IPM) principles and practices in order to reduce the use of borad spectrum pesticides. Through personal communication with Sebastien Fournier (A/DLE3) of Land Force Command (May 17, 2006), LFC does not directly oversee or monitor herbicide application at the base level. It is the responsibility of the base to follow DND guidance and documentation and obtaining necessary permits to undertake their individual vegetation management programs.

5.6 CFB Gagetown Policies on Herbicide Use

In accordance with the DND-SDS of 2000, CFB Gagetown produced a five-year IPM plan for the period of 2003-2008. Through communication with the Base Environmental Officer (BEnvO), Tom McLaughlan, this IPM is strictly designed to direct pest management on base administrative areas, and not in the RTA.

Historically, it appears that areas were identified in the RTA for vegetation control at least one year prior to the requirement and "Project Justification" forms were completed to secure funding for the program. Once funding was secured it was either under the purview of Base Contruction Engineers or Defence Construction Canada (DCC) to produce project specifications and secure the contractor to complete the work.

The contracting and planning processes of the 1960s were not always as well documented as in the 1990s, but it does appear that fewer steps were involved in the process. Specifications for the spraying areas and suggested chemicals to be used were written by DND and then a request for contract to DCC was placed. DCC then put together a set of tender documents to allow bidders to bid for the application project. Once the contract was awarded, the applicator had a pre-job meeting with all involved parities to make sure all points of the project were understood. Soon after this the actual spray events took place.

The following information was retrieved through personal communication with Sheldon Downe (Land Forces Atlantic Area Environment Officer) about the current process in place for the vegetation management program in the RTA (May 17, 2006):

- Areas requiring herbicide application are identified by the base G3 Operations and Training Officer at least one year prior to the requirement. This is done in accordance to operational training requirements in areas of the RTA.
- G3 provides this information to the Base Construction Engineering unit that is then responsible for ensuring that DCC and the Environmental Officer are aware of the requirement.
- DCC is responsible for producing project specifications, tender documents, hiring contractor, hiring an independent monitor, ensuring appropriate provincial licensing requirements have been fulfilled and oversight of the herbicide application and receipt of reports.
- Base Environment office is responsible for ensuring that the requirements of the Environmental Assessment are completed. They ensure that areas to be sprayed and types of herbicides to be applied would not pose an undue threat to human or ecological health.

At this point the base is in the planning stages of producing a Integrated Vegetation Management Plan (IVMP) specifically for the RTA. It is the intention of the base to have this completed by the fall of 2006 (personal communication, Sheldon Downe). In addition, the base has newly formed a Vegetation Management Committee to oversee the implementation of the IVMP and to raise and address any issues that arise from the herbicide application program in the RTA. The creation of an IVMP should help in clarifying roles and responsibilities at the base level for the yearly herbicide application program within the RTA.

Figure 1 graphically depicts the relationship amongst all federal and provincial agencies, advisory committees, and private contractors dealing with the application of herbicides at the base. As noted in the above mentioned text, many of these groups have evolved or been disbanded over time.

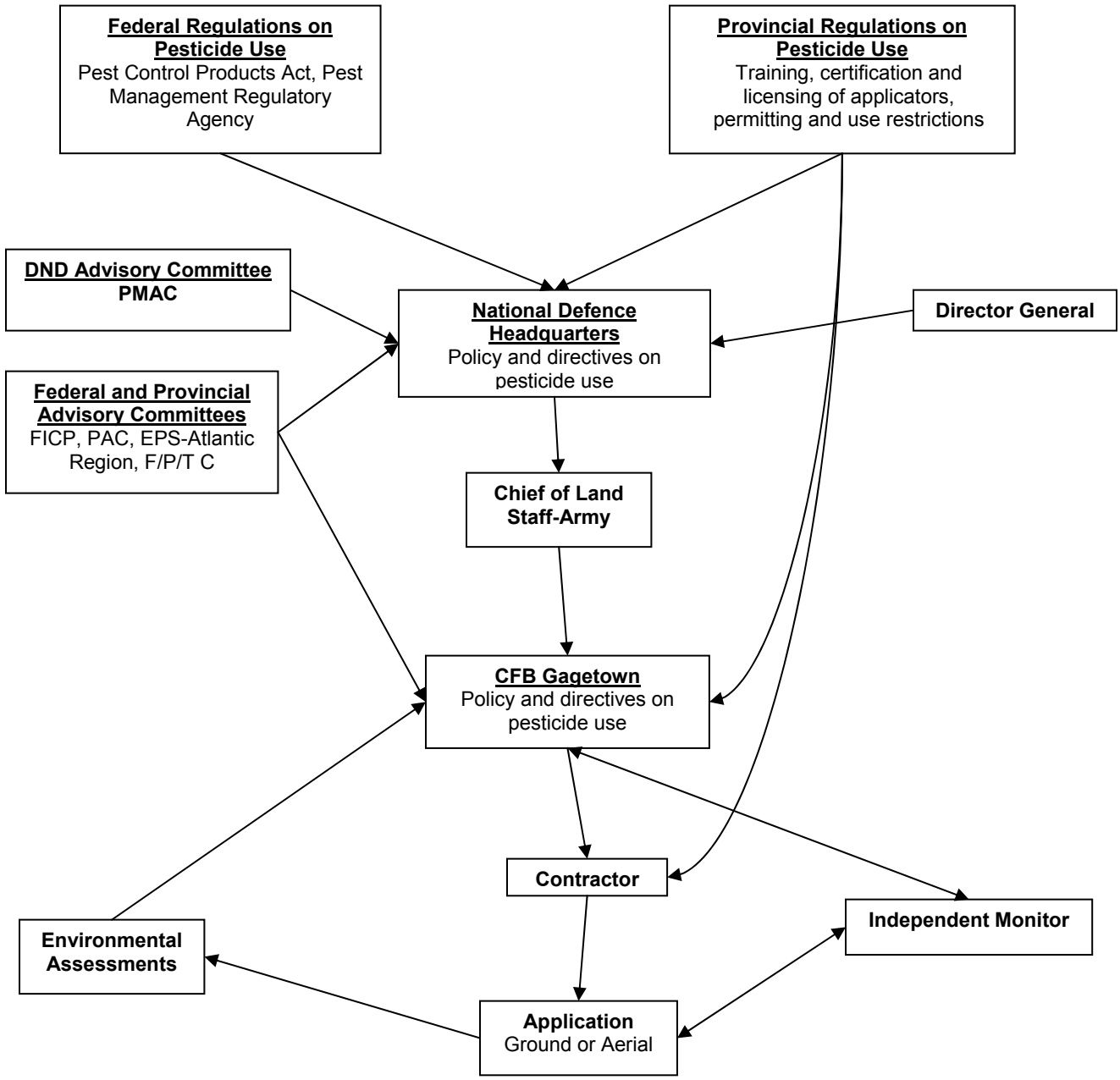


Figure 1. Overview of the groups involved in the decision making process for herbicide application at CFB Gagetown

6.0 LIFE CYCLE MANAGEMENT OF HERBICIDES AT CFB GAGETOWN

6.1 Overview of the Geology and Ecology at CFB Gagetown

Details regarding the geographical and ecological characteristics of CFB Gagetown have been previously reported (Jacques Whitford 2005) and the following text is a summary of those findings.

The northern half of CFB Gagetown lies entirely within the Grand Lake Basin subdivision of the New Brunswick Lowlands and the Saint John River, which is the division's principal drainage system, indirectly bounds the northern and eastern areas of CFB Gagetown. The St. Croix Highlands are hilly and mountainous with elevations exceeding 400 m. The southern portion of CFB Gagetown lies entirely within the Nerepis Highlands division of the St. Croix Highlands, and are generally lie between 90 to 200 m. The lowest elevations on CFB Gagetown are found in the Nerepis River watershed,

The bedrock geology in the CFB Gagetown area varies substantially from north to south. The depth to the bedrock varies from 1 to 22 m with a mean value of 4.7 m. These reported bedrock depths may not apply in the areas of thick alluvial deposits bordering river banks located within CFB Gagetown. In general, the northern half of the military complex is mainly sedimentary rocks, including red to grey sandstone, conglomerate, and siltstone of the Pennsylvanian Cumberland Group. The central portion of CFB Gagetown is also underlain by sedimentary rocks, as well as shale, minor limestone, volcanic rocks, and silicic volcanic flows, tuffs, and related intrusive igneous rocks of the Pennsylvanian and Mississippian eras. The bedrock beneath the southern portion of CFB Gagetown is underlain by a basement sedimentary bedrock complex of Silurian-Devonian age, comprised mainly of slate, siltstone, sandstone, conglomerate, limestone, and manganiferous chert and argillite, and minor volcanic rocks.

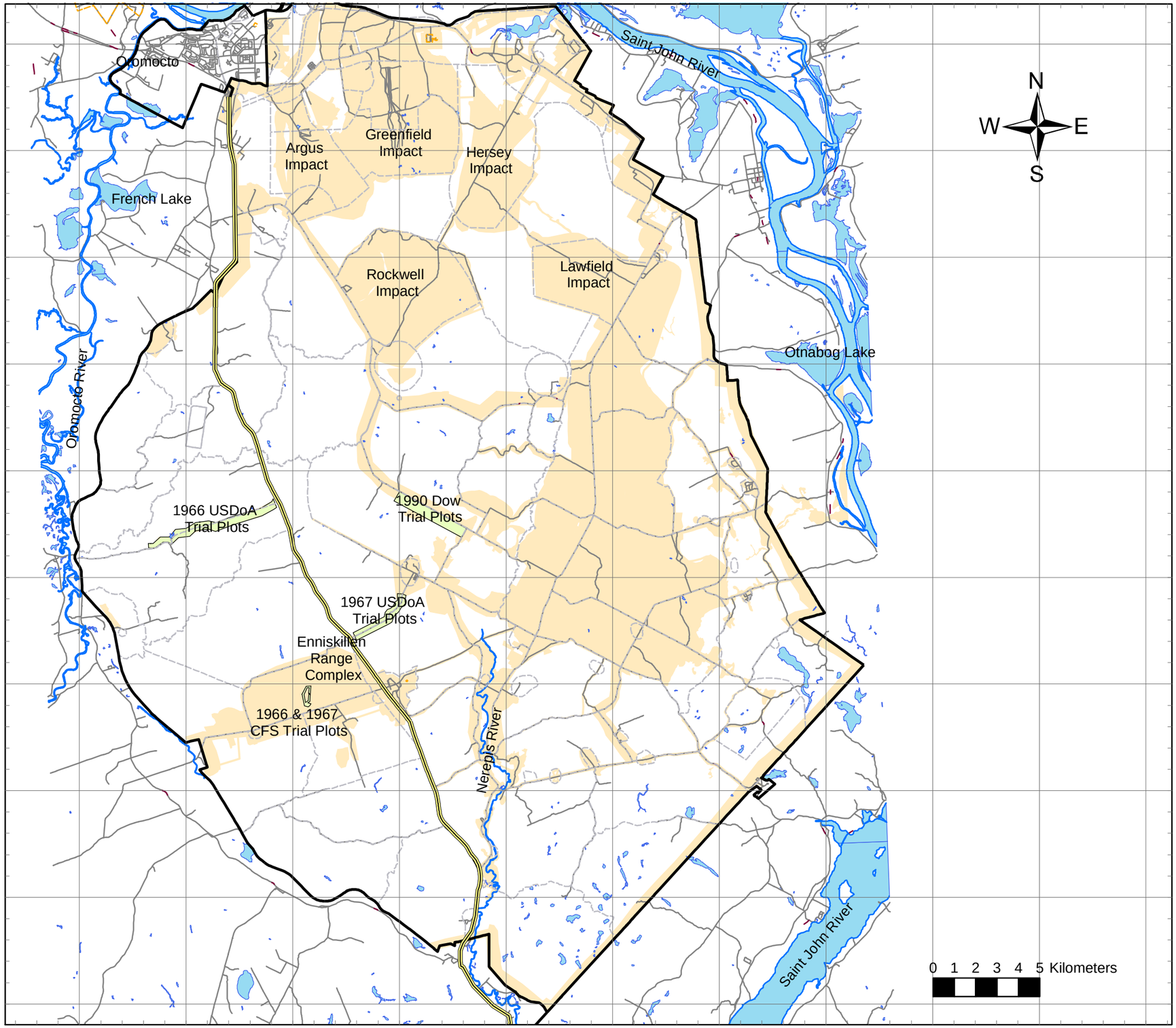
Wildlife found at CFB Gagetown are typical of the species found in New Brunswick. Carnivores such as ermine, weasel, and lynx are likely to inhabit CFB Gagetown, restricted only by the availability of appropriate food species or dens. Habitat on the base is suitable for Canada lynx, and possibly the Eastern cougar, but it is not thought to represent a critical habitat for either species. Several potential moose and deer wintering areas, based on tree species, canopy cover, and proximity to water, have been identified at CFB Gagetown. Shrews and moles, bats, the majority of rodents (e.g., voles, mice) and to a certain extent the snowshoe hare, are likely to be widely distributed around CFB Gagetown. Beaver and muskrat are restricted to the wetland and aquatic environments of CFB Gagetown.

The RTA is vegetated by mixed forest stands containing coniferous stands (over 60% softwood), deciduous stands (60% hardwood), grasslands (areas with interspersed trees), brushland/scrub, cleared forest, and wetlands. Extensive grasslands occur over much of the cleared areas within Impact Areas and the Lawfield Corridor. Grassland and brushland areas cover the shores of the lower reaches of the Nerepis River. Coniferous tree species on CFB Gagetown generally consist of, in order of relative abundance, white spruce, balsam fir, tamarack, white pine, ground hemlock, black spruce, red pine, white cedar, and hemlock. Deciduous tree species generally consist of, in order of relative abundance, speckled alder, trembling aspen, hazelnut, red maple, yellow, white, and grey birch, beech, northern red oak, American elm, striped maple, sugar maple, mountain maple, and large-toothed aspen.

As previously stated in the introduction of the report. The annual herbicide application program within the RTA is required to ensure that secondary growth of trees and brush are kept at a minimum and to ensure that the training area is in acceptable condition for military exercises and training. Chemical application of herbicides throughout the RTA has been the most effective means of achieving this objective.

6.2 Herbicides Used at CFB Gagetown

Annual herbicide applications took place throughout the RTA between May and August, starting in 1956 and ending in 2004. No herbicide applications were conducted before 1956, in 1959, 1962, or from 1997-1999. In 1966, 1967, and 1990, CFB Gagetown was host to three herbicide trials designed to test the efficacy of different products and mixtures of AIs (see Section 5.4). Map 1 shows the areas of the RTA where applications took place from 1956-2004, including the test plots. Many inconsistencies were noted in the labelling of areas of CFB Gagetown during the document review of the herbicide application files. Many of the inconsistencies are due to changes in the description of areas from 1956 to 2004, and to the changing use patterns on CFB Gagetown. This issue was rectified in the database when records are reported. Although many areas were only sprayed occasionally, others were repeatedly sprayed. These areas of repeated spray can be identified, and the spray history verified in the database.



Legend

- CFB Gagetown Administrative Boundaries
- Highway 7
- Training Boundaries
- River/Stream
- Lake/Pond
- Area of Herbicide Application
- Herbicide Trial Plot

CFB Gagetown
Areas of Herbicide Application
DRAFT

Project 1009662.	Drawn By: JPD Reviewed By: LDK
2006-03-31	Map No.: 1

Jacques Whitford

6.3 Yearly Herbicide Use at CFB Gagetown: Products, Active Ingredients and Areas of Application

This section reports on the products, AIs and manufacturing impurities applied at CFB Gagetown. As mentioned in the previous sections, herbicide applications in the RTA were regulated by the policies and science of the day as implemented by the Federal and Provincial governments and by DND. There were in total 11 incidents reported over the fifty year history of the program, but in general it appears that herbicide application at CFB Gagetown was conducted within the legal framework of herbicide application in Canada, and employed standard technologies and practices of the day.

6.3.1 Range and Training Area

From 1956 to 2004, a total of 24 products and 14 AIs were confirmed to have been applied by DND at the RTA. It is possible that a limited number of other products may have been applied in the RTA given the level of documentation provided in the earlier years of the herbicide application program. For example, in some years, DND Specifications and applicator/monitor reports are given and it is apparent that herbicides suggested in the Specifications were not actually used by the applicator (e.g., a Specifications may suggest five possible products for use, but only three were actually used). In some years only a Specifications was available so there is no way to know if all, or none, of the suggest products were actually used. In some cases, AIs alone were applied (e.g., simply 2,4-D amine), or in a mix with other AIs (e.g., 2,4-D and 2,4,5-T), and this is noted in the following tables.

Many different herbicide products were applied between 1956 and 2004. Some were used over the course of many years (e.g., Tordon 101 or 10K were used from 1965 until 2003) and some were used only once (e.g., Krovar was only used in 1994). The physical and chemical properties of AIs and manufacturing impurities are found in Appendix A in the look-up tables, with a description provided in Section 7.0, and the chemical structures of the AIs and impurities are found in Appendix B. Yearly application details (e.g., rates of products and AIs, areas where applications occurred) are contained within the accompanying database, and a description of this database is provided in Section 8.0.

Table 2 provides information on the products, AIs, and manufacturing impurities used on the RTA at CFB Gagetown from 1956-2004. Information regarding the presence of manufacturing impurities was obtained from the PMRA and from the primary scientific literature, specifically from the World Health Organization, the US EPA, and a paper published by The International Union of Pure and Applied Chemistry (Ambrus et al. 2003). It should be noted that the Ambrus et al. (2003) paper presented information regarding the presence of manufacturing impurities based on actual measurements from commercial products and those predicted to be present based on theoretical considerations. Jacques Whitford felt that it was prudent to only report those values which were actually measured. Manufacturing impurities may be found in other AIs but their presence is protected by proprietary law in Canada under the current Pest Control Products Act. For concentrations of manufacturing impurities likely to be found in the AIs, readers should refer to Section 6.3.4 and the look-up tables in Appendix A.

Table 2: Herbicide Products, Active Ingredients, and Manufacturing Impurities used at CFB Gagetown from 1956-2004

Herbicide Product	Active Ingredient(s)	Manufacturing Impurity
Ammate	Ammonium sulfamate	
Arsenal	Imazapyr	
Diurex 80W	Diuron	3,3′,4,4′-tetrachloroazoxybenzene and 3,3′,4,4′-tetrachloroazobenzene;
Dycleer	Dicamba	Proprietary Information
Dycleer 10P	unknown	
Dycleer 24	Dicamba; 2,4-D	Proprietary Information (for Dicamba); dioxin (2,4-D)
Dycleer LH	unknown	
Garlon 4	Triclopyr	
Herbec	unknown	
Herbec 20P	Tebuthiuron	
Karmex DF	Diuron	3,3′,4,4′-tetrachloroazoxybenzene and 3,3′,4,4′-tetrachloroazobenzene
Krenite Brush Control	Fosamine ammonium	
Krovar	Bromacil; Diuron	3,3′,4,4′-tetrachloroazoxybenzene and 3,3′,4,4′-tetrachloroazobenzene (from diuron)
LV Brush Killer 700	Dichloroprop; 2, 4-D	dioxin (from 2,4-D)
Roundup	Glyphosate	
Roundup Transorb	Glyphosate	
Roundup Weathermax with Transorb 2 Technology	Glyphosate	
Silvaprop	unknown	
Spike (either 5P of 5G)	Tebuthiuron	
Spike 5P	Tebuthiuron	
Tordon 101	2,4-D and Picloram	dioxin (for 2,4-D); Hexachlorobenzene (from Picloram)
Tordon 10K	Picloram	Hexachlorobenzene
Trillion	Dicamba; Mecoprop; 2,4-D	Proprietary Information for Dicamba dioxin (for 2,4-D); 4-chloro-2-methylphenol (from Mecoprop)
Vision	Glyphosate	
AI applied singly	2,4,5-T	Dioxin
AIs applied in a mix	2,4-D with 2,4,5-T	Dioxin (from 2,4-D and 2,4,5-T)

Table 3 provides information on the products used on a yearly basis on the RTA. It is noted in the table if a mixture of AIs was applied opposed to actual commercial products. In some cases more than one product was applied, and these are separated by semicolons (;).

Table 3: Products or Mixes of AIs Applied on the RTA on a Yearly Basis

Year	Product(s) Applied
1956	Mixture of Active Ingredients (2,4-D & 2,4,5-T)
1957	Mixture of Active Ingredients (2,4-D & 2,4,5-T)
1958	Ammate; Mixture of Active Ingredients (2,4,5-T Mixture)
1959	No herbicides applied
1960	Mixture of Active Ingredients (2,4,5-T Mixture)
1961	Mixture of Active Ingredients (2,4,5-T Mixture)
1962	No herbicides applied
1963	Mixture of Active Ingredients (2,4-D & 2,4,5-T)
1964	Mixture of Active Ingredients (2,4-D & 2,4,5-T)
1965	Tordon 101
1966	Tordon 101
1967	Tordon 101
1968	Tordon 101
1969	2-4-D Amine; Tordon 101
1970	Tordon 101
1971	Tordon 101
1972	Tordon 10K; Tordon 101
1973	Tordon 101
1974	Tordon 10K; Tordon 101
1975	Tordon 10K
1976	Tordon 10K
1977	Tordon 10K; Tordon 101; Spike 5P; One unknown product
1978	Tordon 10K; Dycleer 24; Herbec; Spike 5P
1979	Tordon 10K; Spike
1980	Dycleer 10P; Tordon 10K
1981	Tordon 10K; Herbec 20P
1982	Tordon 10K
1983	Dycleer 10P; Herbec 20P; Dycleer 24
1984	Dycleer LH; Silvaprop
1985	Tordon 101; Dycleer LH; Silvaprop
1986	Tordon 101; Trillion
1987	Tordon 101
1988	Dycleer; LV Brush Killer 700
1989	Dycleer; Roundup; Vision; Tordon 101; Dycleer + 2;4-D; Krenite Brush Control
1990	Roundup; Tordon 101; Krenite Brush Control
1991	Tordon 101; Roundup; Garlon 4; Krenite Brush Control
1992	Garlon 4

Year	Product(s) Applied
1993	Tordon 101; Garlon 4
1994	Krovar; Dycleer + 2;4-D; Dycleer 24
1995	Garlon 4
1996	Roundup; Garlon 4
1997	No herbicides applied
1998	No herbicides applied
1999	No herbicides applied
2000	Garlon 4; Karmex DF; Arsenal; Dycleer; 2;4-D
2001	Roundup Transorb; Karmex DF; Arsenal
2002	Roundup Transorb; Karmex DF; Arsenal
2003	Roundup Transorb
2004	Roundup Transorb; Roundup Weathermax with Transorb 2 Technology; Diurex 80W

Based on the compiled herbicide application information, it is evident that although numerous herbicides were applied between 1956 and 2004, a number of products and AIs have reoccurred over the years. For example, the products Tordon 101 and 10K were used from 1965-1993. Tordon 101 is a broad spectrum herbicide which delivers control of spruce, woody species, and broadleaf weeds (Dow Agrosciences, 2006). Its use was not restricted to CFB Gagetown, but was, and is (though no longer used after 1993 on the RTA, Tordon 101 is still registered for use today in Canada) commonly applied in sectors where vegetation needs to be controlled around railways, powerlines and roadways (Dow Agrosciences, 2006). Another example where a herbicide appears to have been favoured is with the use of the AI 2,4-D. 2,4-D was used from 1956 until 2000 and was found in a range of products. This is not surprising since 2,4-D is the third most widely used herbicide in the United States and Canada, and the most widely used worldwide (2,4-D Industry Task Force, 2005). Aside from its use on the RTA, 2,4-D is used for controlling weeds in agricultural areas, rights-of-way, roadsides, forestry, and lawns and turfgrass (2,4-D Industry Task Force, 2005).

After a spray drift incident in 1964 that involved damage to several market gardens and compensation to owners, DND switched from the use of 2,4-D and 2,4,5-T mixture to Tordon 101 applied with helicopters and was used almost exclusively until 1975. From 1975 to 1983 to Tordon 10K pellets were the preferred herbicide applied. Between 1983 and 2000 a variety of herbicides were used, while post 2001 most herbicide applications have employed a form of Roundup.

6.3.2 Test Plots

In 1966, 1967, and 1990, CFB Gagetown was host to three herbicide trials designed to test the efficacy of commercially available and military products, and mixtures of AIs. Over the course of these trials, 15 additional products (13 AIs), not used by DND in yearly chemical control, were applied in specific sections of the RTA. From these products, other manufacturing impurities have been documented, and again, information regarding this impurities was obtained from the PMRA and from Ambrus et al. (2003). Again, specific details for all trials are available in the accompanying database and concentrations of manufacturing impurities likely to be found in the AIs can be found in Section 6.3.4 and the look-up table.

6.3.2.1 1966-1967 Canadian Forestry Service (CFS) Tests

In 1966 and 1967, the Forestry Branch of the Canadian Forestry Service (CFS) Department of Fisheries and Forestry, Maritimes Region, in cooperation with DND, conducted tests to determine the effectiveness of different herbicides to control second-growth stands of conifers and hardwoods in the Medium Machine Gun Field Firing Area, north of Enniskillen road (CFS, 1969). In 1966, three concentrations of each of three herbicides were applied on test plots (20x400ft) within one of four blocks of land, and in 1967 these trails were repeated and three new herbicides were also applied. The following table (Table 4) outlines the commercially available and test products that were used (CFS, 1969), their AIs, and any manufacturing impurities.

Table 4: Herbicide Products, Active Ingredients, and Manufacturing Impurities from 1966-1967 CFS Tests

Herbicide Product	Active Ingredient(s)	Manufacturing Impurity
1966		
Tordon	2,4-D and Picloram	dioxin (from 2,4-D); Hexachlorobenzene (from Picloram)
D/T	mix of 2,4-D; 2,4,5-T	Dioxin (from 2,4-D and 2,4,5-T)
D/TP	mix of 2,4-D; 2,4,5-TP (fenoprop)	Dioxin (from 2,4-D and 2,4,5-TP)
1967		
Dacamine	2,4-D; 2,4,5-T	Dioxin (from 2,4-D and 2,4,5-TP)
D/T + TCA	mix of 2,4-D; 2,4,5-T + sodium trichloroacetate	Dioxin (from 2,4-D and 2,4,5-T)
TDB	2,4-D; 2,4,5-T; trichlorobenzoic acid	Dioxin (from 2,4-D and 2,4,5-T)

6.3.2.2 1966-1967 United States Department of the Army (USDoA) Tests

In 1966 the United States Department of the Army (USDoA) tested the efficacy of nine herbicides in 116-200x600ft plots (USDoA, 1968a,b). Herbicides were applied with a US Army helicopter equipped with a Helicopter Insecticidal Dispersal Apparatus Liquid (HIDAL) system. Commercially available and military products, and AIs alone, were used in various concentrations, application rates, and mixes. Table 5 outlines the commercially available and military products that were used, their AIs, and any manufacturing impurities.

Table 5: Herbicide Products, Active Ingredients, and Manufacturing Impurities From 1966 USDoA Trials

Herbicide Product	Active Ingredient(s)	Manufacturing Impurity
Agent Orange	50% 2,4-D and 50% 2,4,5-T present as n-butyl ester	Dioxin (from 2,4-D and 2,4,5-T)
Modified Agent Orange	70% 2,4-D and 30 % 2,4,5-T present as n-butyl ester	Dioxin (from 2,4-D and 2,4,5-T)
Agent Purple	50% 2,4-D present as n-butyl ester, 30% 2,4,5-T present as n-butyl ester, and 20% 2,4,5-T present as isobutyl ester	Dioxin (from 2,4-D and 2,4,5-T)
AI applied singly	Diquat	free 2,2′-bipyridyl
Tordon 22K	Picloram present as potassium salt	Hexachlorobenzene
Tordon 101	80% 2,4-D, 20% Picloram	Dioxin (from 2,4-D); Hexachlorobenzene (from Picloram)
M-2993	20% picloram present as isooctyl ester, 80% 2,4,5-T present as propylene glycol butyl ester	Hexachlorobenzene
Phytar 160	Sodium cacodylate and Cacodylic acid	Arsenic (part of AI)
Phytar 560G	Sodium cacodylate and Cacodylic acid	Arsenic (part of AI)

In 1967, the USDoA tested the efficacy of fifteen commercially available and military products, and AIs alone (AIs applied by themselves and not as a product or necessarily in a mix), in various concentrations, application rates, and mixes (USDoA, 1968a,b). The following table (Table 6) outlines the commercially available and military products that were used, their AIs, and any manufacturing impurities.

Table 6: Herbicide Products, Active Ingredients, and Manufacturing Impurities From 1967 USDoA Trials

Herbicide Product	Active Ingredient(s)	Manufacturing Impurity
Agent Orange	50% 2,4-D and 50% 2,4,5-T present as n-butyl ester	Dioxin (from 2,4-D and 2,4,5-T)
Agent White	80% 2,4-D, 20% Picloram	Dioxin (from 2,4-D); Hexachlorobenzene (from Picloram)
AI applied singly	2,4-D	Dioxin (from 2,4-D)
AI applied singly	Picloram ester present as isooctyl ester	Hexachlorobenzene
AIs applied as mix	Picloram and Dalapon	Hexachlorobenzene
AIs applied as mix	Hexachloroacetone and 2,4,5-T	Dioxin (from 2,4,5-T)
AI applied singly	Dinitro (dinoseb)	
AI applied singly	Paraquat dichloride	free 4,4′-bipyridyl;
AI applied singly	Diquat dibromide	free 2,2′-bipyridyl
Timbertox #10	Pentachlorophenol	dioxin and hexachlorobenzene
Tordon 22K	Picloram present as potassium salt	Hexachlorobenzene
Tordon 22K plus Diquat	Mix of Picloram present as potassium salt and Diquat	Hexachlorobenzene (for Picloram); free 2,2′-bipyridyl (from Diquat)
Tordon 22K plus Paraquat	Mix of Picloram present as potassium salt and Paraquat	Hexachlorobenzene (for Picloram); free 4,4′-bipyridyl; (from Paraquat)
Trysben 200	Trichlorobenzoic acid	
Phytar 560G	Sodium cacodylate and Cacodylic acid	Arsenic (as part of AI)

6.3.2.3 1990 Dow Chemical of Canada Tests

In 1990, Dow Chemical of Canada conducted an evaluation of aerial application methods at CFB Gagetown in Area 45 (Drummond Road near McCutcheon Road) with three different products. Table 7 outlines the commercially available products that were used, their AIs, and any manufacturing impurities. Details regarding the mixes and application rates are not known because a very limited set of reports, with very few details, were available.

Table 7: Herbicide Products, Active Ingredients, and Manufacturing Impurities From 1990 Dow Chemical Trials

Herbicide Product	Active Ingredient(s)	Manufacturing Impurity
Garlon 4	Triclopyr	
Tordon 101	2,4-D and Picloram	Dioxin (from 2,4-D); Hexachlorobenzene (from Picloram)
Vision	Glyphosate	

6.3.3 Non-AI components in Products

As mention in the Introduction, formulations of herbicide products are a mixture of AIs and other ingredients such as carriers (which act as a vehicle for more effective transmission), dilutants, and adjuvants (which may improve the effectiveness of the active ingredient by modifying the characteristics of the formulation). Water, mineral oil, and diesel oil were common carriers and dilutants used by applicators working throughout the RTA. In some cases thickeners were added (e.g., Norbak) to the product to make droplets fall faster in order to lower the potential for spray drift. Of the products used, Jacques Whitford was able to find information related to adjuvants for only four products. Arsenal appears to contain nonylphenol ethoxylate; Tordon 101 and 10K contain isopropanol, polyglycol 26-2, triisopropanolamine, and an unknown proprietary surfactant; and Roundup is known to contain the surfactant polyoxyethyleneamine (POEA).

6.3.4 Concentrations of Manufacturing Impurities in Products

Including the test plots, 7 manufacturing impurities were associated with the products applied. They were free 2,2′-bipyridyl (found in diqaut), 3,3′,4,4′-tetrachloroazoxybenzene and 3,3′,4,4′-tetrachloroazobenzene (found in diuron),, 4-chloro-2-methylphenol (from mecoprop), free 4,4′-bipyridyl (from paraquat), hexachlorobenzene (from picloram) and dioxin (from 2,4-D and 2,4,5-T) (WHO 1975; US EPA 1995; Ambrus et al. 2003; PMRA). In some cases other AIs contain manufacturing impurities, but their presence and concentrations are protected by proprietary law (e.g., 2,4-D) and cannot be disclosed in this report, the PCPA does not necessitate that manufacturing impurities be public knowledge in Canada

Table 8 outlines the concentrations of manufacturing impurities found in products (AI) applied at CFB Gagetown from 1956-2004.

Table 8: Range of concentrations of known manufacturing impurities in active ingredients applied

Active Ingredient	Manufacturing Impurity	Concentration
2,4,5-T, 2,4-D	dioxin	0.1–55 mg/kg
Diquat	free 2,2′-bipyridyl	10 mg/kg
Diuron	3,3′,4,4′-tetrachloroazoxybenzene 3,3′,4,4′-tetrachloroazobenzene	1-2 mg/kg 10-20 mg/kg
Mecoprop	4-chloro-2-methylphenol	15000 mg/kg
Paraquat	free 4,4′-bipyridyl	0.2 %
Picloram	hexachlorobenzene	200 ppm (as of 1985); <100 ppm (as of 1988); last 10 years, proprietary

6.4 Use and Sales Information of Herbicides in Canada Compared to Use at CFB Gagetown

As previously stated in the report, there is no requirement or existing database containing specific information on the sale and use of herbicides in Canada. Therefore, little information could be obtained to satisfy this requirement of Task 2A, during the allotted timeframe. Jacques Whitford does not believe that this information is critical to the overall goals or requirements of this report, or most importantly the accompanying database.

In one particular article supplied to Jacques Whitford by NDHQ (Wiggle and Mao 1981, data obtained from Statistics Canada), use 2,4,5-T in Canada from 1960 to 1970 is reported. During this ten year period, almost 5 million lbs of 2,4,5-T was applied. During its time of registration, 2,4,5-T was used for industrial and commercial uses, control of weeds on rangeland and in rice fields, and for use on lawns and turf (Spectrum Laboratories). 2,4,5-T was applied at the RTA from 1956 to 1964, but Jacques Whitford was only able to locate documented actual volume information on application information from 1960 to 1964 in the historical records. During this four year period, roughly 270,000 lbs of 2,4,5-T was applied (this does not include applications on test plots). Yearly comparisons between Canadian use and use at CFB Gagetown are shown in Table 9.

Table 9: Comparison of 2,4,5-T Applications in Canada and at CFB Gagetown from 1960-1964

Year	2,4,5-T use in Canada (lbs)	2,4,5-T use in CFB Gagetown (lbs)	Use of 2,4,5-T at CFB Gagetown Compared to the Rest of Canada (%)
1960	298,000	18,016	6
1961	275,000	15,567	6
1963	351,000	114,450	33
1964	762,000	121,563	16

From these data, Jacques Whitford was able to calculate how much 2,4,5-T was used at CFB Gagetown as a percentage of the total application in Canada. It appears that between 6 and 33% of the total use of 2,4,5-T in Canada was actually used at CFB Gagetown, assuming of course, that use records from Canada are accurate and account for nation-wide use, including that used at military installations.

Canada lacks up-to-date and historically detailed pesticide use records (Brimble et al. 2005). However, pesticide sales and use data (herbicides, insecticides, fungicides, etc.) is sometimes collected by the provinces/territories, and available information has been reported in a recent Environment Canada document (Brimble et al. 2005). At the present time there is no standardized way of reporting pesticide sales and use data in Canada. Many provinces and territories don't collect use or sales data (e.g., Saskatchewan), and for those that do, the manner (e.g., year, by kg of active ingredient, chemical groups, sector of use) is different amongst provinces. In the Brimble et al. (2005) report, a compilation of the most recent records of active ingredients sold and used in eight provinces and two territories is given. Records were available from British Columbia from 2003, Alberta from 1998, Manitoba from 2003, Ontario from 2003, Quebec from 2001, New Brunswick from 2003, Nova Scotia from 2003, Prince Edward Island from 2002, Newfoundland from 2003, and the Yukon and North West Territories from 1994 and 1995, respectively. By summing these values, Brimble et al. (2005) present the total sales and use of AIs in Canada. Obviously, since these data come from only some provinces, and since they come from various years, the Canadian total can only be used as a very rough guide for what was sold or applied nationally in the late 1990s and early 2000s and should be viewed as contextual examples of what was used in Canada.

In Table 10 these values are compared to the total amount of corresponding AIs actually applied at CFB Gagetown from 1956-2004 during the annual control of vegetation on the RTA (not including what was applied in the test plots). In some cases, the supplied files that were relied upon for populating the database did not have application amounts corresponding to application events. Thus, the total amounts presented in this table should be viewed as minimums since precise and exact application data throughout the 1956-2004 period was not always available.

Although some of the masses of herbicides appear to be quite significant, the CFB Gagetown numbers are reported from 1956 to 2004, while the Canadian data only come from a one year period. Therefore, this information should be viewed with caution as it is meant only to provide context that tens to millions of kilograms of these herbicides are applied Canada each year and governed by provincial jurisdiction.

Table 10: Comparison of National Sales and Use Data to Actual Use Data from CFB Gagetown From 1956-2004 on the RTA

Active Ingredient	Amount of AI Used in Canada Based on a Single Yearly Sales/Use Record from 10 Provinces/Territories (kg)	Total Amount of AI Used On RTA of CFB Gagetown from 1956-2004 Combined (kg)
Glyphosate	4,608,768	12,037
2,4-D	1,490,553	266,864
Dicamba	356,131	7658
Mecoprop	251,507	50
Dichlorprop	112,378	6582
Triclopyr	41,713	3811
Picloram	16,036	81,813
Diuron	10,998	1302
Imazapyr	215	35
Tebuthiuron	97	1338

6.5 Herbicide Application Methods

Herbicides were applied at the RTA using aerial and ground based application methods. They were applied either in liquid or pellet form (straight product), or in a solution of product mixed with water or a variety of different oils and fuels (e.g., mineral and diesel oil).

6.5.1 Aerial Application

Helicopters applications appeared to be the preferred method for spraying from 1965 to 2004, whereas fixed wing aircraft were used predominantly from 1956 to 1964. The switch to helicopters from fixed winged aircraft was a result of a spray drift incident reported to have occurred in 1964. Helicopters provide a lower risk of spray drift incidents occurring as they are able to fly closer to the ground above the application area.

Helicopters and planes can be used to spray a large area of land quickly and evenly, and ensure that applicators avoid UXO during the procedure. The following text, taken and paraphrased from a document written by the National Task Force on Pesticide Education, Training and Certification (Aerial Module: Basic Knowledge Requirements for Pesticide Education in Canada. H50-4/3-1995E, 1995) outlines some of the key issues surrounding handling (e.g. mixing and loading) and application processes for the aerial application of pesticides today.

In relation to mixing and loading of pesticides, the course manual suggests that applicators consider three main points; 1) carefully select and keep organized the mixing area, 2) ensure the use of a suitable mixing system for safe pesticide mixing, and 3) make sure there is a properly trained ground crew (i.e., ensure the crew can provide safe handling of materials, can rapidly load pesticides onto the aircraft, and can prepare proper loads for the aircraft type).

Safety while mixing and loading is an obvious concern and the course suggests that the main components required for aircraft loading are:

- a clean water tank with backflow prevention
- a pesticide concentrate tank
- a mixing tank

- suitable pumps
- accurately calibrated meters to measure transfer from tank to tank

When and where possible, a closed transfer system should be used so pesticides can be removed from their original containers, the containers rinsed, and the mix transferred to the aircraft without any exposure to individuals.

In relation to applications, it is suggested that pilots and crew use approved safety harnesses and crash helmets, be aware of the proper functioning of their aircraft, and remain aware during all operations. Details relating to stall avoidance, adequate buffer zones, height, speed flight paths are also discussed.

6.5.2 Ground Applications

Applicators also applied herbicides on the ground from trucks capable of carrying a large tank or by walking through the bush with a backpack hand sprayer. Ground applications were generally used to cover the outer edge of vegetated locations and roadways and in order to reduce spray drift, minimize runoff, and to ensure that herbicides did not come into contact with water sources. Different types of hand sprayers and wands were used to disperse the herbicide.

For ground based applications, herbicides were generally applied using boom sprayers, hand-held sprayers, and backpack sprayers. Boom sprayers have multiple nozzles spaced over the length of the boom and tractor mounted booms sprayers are generally used to broadcast liquid pesticides over large areas. Field sprayers may have tank sizes ranging from 500 to 4000 litres and boom widths ranging from 6 to 36 metres (PMRA 2006). Handwand sprayers are light weight and hand operated and as their name implies, they are long metal extensions that ends in an adjustable nozzle with a hose attaching the wand to a portable or stationary tank (PMRA 2006).

The most commonly used handwands are compressed-air sprayers and are used in a variety of settings for “spot treatments”. Backpack sprayers have a spray tank that fits comfortably on the back of the applicator like a knapsack (PMRA 2006). The applicator pumps the sprayer handle to build up pressure in the tank and applies the product through a small hose / single nozzle assembly. Some backpack sprayers are battery or gas powered. The usual tank capacity is about 15 litres so that the tank weight is not excessive to the handler. The backpack sprayer is ideal for covering smaller, more specific areas (e.g., spot applications). In some cases granular products were applied on the RTA and granular spreaders were used to broadcast pesticide granules over an entire field surface. Application equipment may use gravity or a positive metering mechanism to regulate the flow of granules. Small, hand-operated granule dispersal equipment (e.g., push rotary spreaders) may be used to treat smaller areas (PMRA 2006).

Before applications actually began, the contractor gained permission to store containers of herbicides in unused buildings on the base. It is believed that this is where applicators kept their trailer and spray equipment. In the case of ground applications, products were kept right on the application vehicle. Mixing and loading was conducted at several sites (e.g., Troop shelters and Airstrips) close to the site being sprayed each year depending on the amount of area to be treated. The contractor mixed large batches of mix at the mixing and loading site to allow quick reloading of aerial and ground equipment. For example, the aerial contractor in 2000 mixed 280 L Garlon 4 and 1960 L water for a total mix of 2240 L. The contractor then transferred the spray mix to the helicopter in 227.3 L loads. Sometimes surfactants, thickeners, or other additives were added to the mix to ensure that proper application rates

and efficacy. Products were applied at different rates using a variety of spray systems with varying amount of nozzles on different types of booms (e.g., Simplex Spray System with 34 T-jet 6508 and 6510 type nozzles on a 9.75 m toe mounted boom spraying at a swath width of 25 m).

Application events may have been suspended if rain was forecast within 8 hours of the spray period, if wind speeds were outside of the allowed range (e.g., outside of 3 - 10 km/h, but this may have changed yearly), if ambient temperatures were too high (e.g., greater than 25° Celsius), or if the relative humidity was too low (e.g., lower than 50%).

6.6 Monitoring and Environmental Assessments

6.6.1 Independent Monitors

Monitor reports appeared in the files from 1993, 1995, and from 2000 through 2004. Independent monitors supervised the application of herbicides at CFB Gagetown and prepared their own final report regarding the spray events and these were submitted to DND. A review of files provided to Jacques Whitford by DND indicated that the independent monitor and contractor worked closely to ensure the proper application of products. The amount of detail contained in the monitor's reports increase from the first year they were written until the last year of application. For example, the most detailed monitor's reports (e.g., 2004) contained the following information within a 50 page detailed document:

- Dates of application
- Names of contracted applicators
- Areas of application (by name of area, hectares covered)
- Products used and mixes applied
- Weather information
- Spray equipment (e.g., vehicle type (helicopter vs. plane), nozzle types, etc.)
- Detailed synopsis of application events
- Detailed recommendations
- DND's expectations of the monitor
- Copies of application permits issued to the contractor
- Applicator's notes

The monitor's reports from 1993 contained the following information within a three page, nonspecific document:

- Dates of application
- Names of contracted applicators
- Total areas treated (hectares only, and not named areas)
- Total products used
- Minor recommendations

6.6.2 Environmental Assessments

The supplied files also identified several Environmental Assessments (EAs) that were conducted with respect to herbicide use at the Base. EAs were completed in 1990, 1992, and 2000 through 2004, and their appearance coincides with the coming into force of the Canadian Environmental Assessment Act (CEAA). Prior to these EAs, environmental questionnaires were completed by DND staff in 1987, 1988, and 1989 and dealt with anticipated environmental impacts.

In 1993 the consulting firm Washburn & Gillis Associates LTD conducted an environmental evaluation of the military training activities in the CFB Gagetown training area (1993), and in 1985 the Department of Forest Resources at the University of New Brunswick (UNB) produced a report presenting information on management strategies to control secondary growth (mechanical and chemical) at CFB Gagetown.

The following text summarizes the findings and conclusions of the EA from 1990:

Anticipated environmental impacts were assessed by DowElanco Canada through a very brief EA (DowElanco, 1990). The following items were mitigated by design: emission, air contaminants, toxic or hazardous chemicals, by-products, radiation, residuals, or water products which might require mitigating measures; application activities near a water course, flood marsh, and/or sanctuary. Additional comments included that herbicide application would be carried out in accordance with known standards and procedures. Licensed applicators would be used and all provincial and federal permitting would be obtained by DowElanco Canada Inc.

The following text summarizes the findings and conclusions of the EA from 1992:

DND (1992) produced a very detailed “Project Register and Screening Decision Summary”. The general format of the document involved stating potential impacts and verifying if each impact was manageable or insignificant. Brief statements then followed stating why an impact was either manageable or insignificant. For example, a potential impact of this project (application during the 1992 period) was that pest control involving pesticide use will result in leachates contaminating aquifers for drilled wells (underground aquifers). The conclusion of the EA was that this impact would likely be insignificant because pest control does not involve a large volume with respect to the aquifers for drilled wells.

The following text summarizes the findings and conclusions of the EA from 1993:

In 1993, Washburn & Gillis Associates (1994) produced a comprehensive environmental assessment on the “Military Training Activities” at CFB Gagetown. Multiple conclusions and recommendations were addressed and were as follows:

- Groundwater resources of the Training Area are poorly defined and it is recommended that hydrological investigations be taken to better define these areas;
- The Training Area contains numerous documented heritage resources. Currently DND has a substantial database on these resources, measures should be identified to preserve and enhance information on these resources. In addition, a prehistoric burial ground has been

identified near the Enniskillen range. Field investigations are suggested to verify this potential resource;

- No endangered flora (as stated by the Endangered Species Act) were identified inhabiting the Training Area. However, several areas were identified that could support potential habitat for rare flora; surveys are needed to verify rare flora habitat;
- No endangered fauna (as per the Endangered Species Act) were identified in the Training Area; however potential areas containing critical deer wintering habitat have been identified. Washburn & Gillis (1994) recommend that an aerial deer wintering area survey be conducted to verify these potential critical habitat locations;
- Wetlands in the Training Area provide suitable staging grounds for waterfowls; surveys are recommended to verify this potential usage;
- Broods of the common loon were identified on Swan Creek Lake and several other lakes in the Nerepis Hills region. Broods of Common loon are vulnerable to disturbance especially during breeding season; therefore, the sensitivity of these birds should be considered when scheduling and conducting training activities in these areas during breeding season;
- Assessments of fish habitat identified several structures in the Training Area which could obstruct passage of fish, these include: a fishway on Queens Brook; an improperly laid culvert on Pender Brook; and a blocked culvert on Brown Brook. Remedial action is recommended to prevent continued obstruction to these passages. In addition, regular reconnaissance of all stream crossings and fish passage structures should be conducted to prevent obstruction;
- All major drainages in the Training Area provide habitat for salmonids (i.e., Atlantic salmon and Brook Trout); brook trout is ubiquitous in the Training Area. The Nerepis River watershed appears to be a major spawning area of salmon. Washburn & Gillis (1994) recommend that instream training activities be scheduled and conducted such that sensitive migrations, spawning and incubation periods of salmonids are not affected;
- The Training Area has been classified into three categories in terms of appropriateness for conducting military exercises. The categories are identified as sensitive (no use), fragile (restricted use) and durable (sustainable use). Sensitive areas should be considered out-of-bounds at all times. Areas identified as “fragile” may have seasonal sensitivities associated with them and thus should be given appropriate consideration when scheduling training activities;
- Washburn & Gillis (1994) have proposed a comprehensive monitoring program for compliance monitoring, baseline monitoring, and environmental effects monitoring. It is suggested that the proposed monitoring program be implemented to assure protection of the environment; and
- Exercise-level waste audits should be implemented. During the study, the disposal of defense stores and wet (i.e., perishable) wastes was observed at the Base dry dump following large training exercises.
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Finally, the following text outlines the EAs conducted in 2000, 2001, and 2002:

DND Environmental Assessment Forms were completed in 2000, 2001 and 2002 for an assortment of areas the Training Area. Various valued ecosystem components (VECs) were identified and the affect of ground and aerial application of herbicides were assessed on each. Soil, atmosphere, surface water, ground water and aquatic habitats could be affected by the application and migration into these areas through spills of product, direct movement of water after application and/or leaching from soils. If not applied during ideal conditions the product can volatilize and become airborne, impacting other areas. To avoid affecting these VECs label guidelines, New Brunswick permit conditions, and application guidelines will be strictly followed. An independent monitor will be hired to be on-site to verify all appropriate guidelines and conditions are being followed by the contractor during application and mixing of herbicides.

It was also cited that the health of those involved in application may be affected (i.e., applicators and those directly involved with project). In addition, subsequent users of the areas sprayed, particularly soldiers, could be affected. To avoid affects on health, all applicators and personnel involved should follow label instructions on handling and human safety. New Brunswick permits will also be strictly followed. Spray area will be signed both before and after application, no access to these sites will be allowed until the sites are deemed safe for re-entry as per label and permit conditions.

The conclusion of these assessments was that project work could proceed with minimal impacts provided the conditions identified within the assessment were strictly followed; therefore, the determination of the environmental assessment was that “effects not likely significant” and that application “may proceed”.

6.7 Handling, Storage, and Disposal of Herbicides

Very little information, if any, is available on the way herbicides were handled and stored at CFB Gagetown. As described above, before applications actually began, the contractor was given permission to store containers of herbicides and spray equipment on the base. Disposal methods were documented in some cases, and appear to have improved over the years.

Prior to the early 1970s DND Specifications simply state that waste chemicals and herbicide containers should be buried, or otherwise completely disposed of by applicators. The location of such disposal sites could not be determined from the reviewed documentation. In the early 1970s and 1980s, empty containers (not necessarily rinsed and possibly still containing product) were buried at the Shirley Road Dump site. However, it was not always clear in the supplied documentation whether all herbicide barrels and waste were placed in this dump. For example, in the minutes of a pre-job meeting from 1982 it states that “all empty containers will be burned and that….Capt. Lewis will arrange for a pit to be dug for this purpose”. It is unclear whether or not this location would have been in the Shirley Road Dump, or elsewhere.

In 1984, 666 drums were excavated from a Shirley Road Dump on the RTA. There were 145 crushed drums, 398 empty (331 originally contained Tordon 101), and 112 drums containing liquid, 61 of which contained 2, 4-D and picloram, the AIs in Tordon 101. Because of the sufficiently high levels of 2, 4-D and picloram, the remaining liquid residue was apparently disposed of at a special facility in central Canada or in the United States. The empty drums were disposed of at the base landfill. Soil from the area where most of the drums containing residue were discovered, and groundwater from wells drilled in the vicinity of the excavations, were tested for levels of 2,4-D, 2,4,5-T, dioxins, and dichloro-diphenyl-trichloroethane (DDT). The laboratory tests found only traces of 2,4-D, dioxin and DDT, all of which

were considered typical of background limits, and in groundwater, 2,4-D, 2,4,5-T and DDT were found in levels all below the maximum acceptable concentrations for drinking water. From personal communication with Sheldon Downe, the groundwater monitoring program for the Shirley Road Dump was ceased in the late 1990s, after a letter of notification was sent to Environment Canada, stating that all chemical parameters were meeting applicable environmental quality guidelines.

In the late 1980s, empty containers were triple rinsed, punctured, crushed and disposed of through a scrap dealer and in the 1990s up until 2004, empty, non-refillable, small plastic containers (10L) previously containing herbicides were jet or triple rinsed, punctured, and taken to a designated collection/recycle site. These sites were either in Cookshire, Quebec, where they were given to United Agri Products for recycling, or they were recycled at a site in New Brunswick or Nova Scotia. Larger barrels (115L) containing products from Monsanto and Dow Chemical were returned to their respective manufacturers. Records containing this information do not, however, document where containers were rinsed.

6.8 Incidents

Over the course of the spray application period from 1956 to 2004, there were a number of minor and major application incidents.

- In **2002** there was a report of an alleged spraying of a vehicle on Wednesday August 28 in the Enniskillen area. According to the applicator's and monitor's report a blue extend cab truck entered the spray block at 0952 hrs, and the pilot of the helicopter had to divert his flight path in a west-wardly direction to avoid flying directly over the truck. At the time, the helicopter's tanks were empty of herbicide. The on-site monitor reported that the helicopter was free of leaky nozzles so there was no probability that the truck was sprayed with any residual product. On September 3, the Pesticide Unit received a call from the individual driving the truck who was concerned about the aerial spraying, and a follow-up investigation was conducted including reports from the on-site monitor and pilot. The Pesticide Unit concluded that considerable effort was made to keep all individuals aware of pending applications, and no further investigation was considered. It was concluded that the accusation was at best, an inaccurate assessment of the actual occurrence or, at worst, a malicious and fraudulent act.
- In **2001** and **2002** there was the potential use of an unregistered product on the RTA. It is stated in the Monitor's report that the product Arsenal was applied during the ground application program. This statement is accompanied with reference to an EPA Registration Number (241-346), but not the Canadian Pest Control Products Act Number (PCP: 23713). On the front page of the Ground Applicator's report, the PCP number is given, but attached to this report is the US label for Arsenal which states that the product was made by the American Cyanamid Company. The Canadian label (available from the PMRA) states that Arsenal is made by BASF Canada. To further complicate matters, the active ingredient in the US formulation is imazapyr, present as an isopropylamine salt at 28.7%, but the Canadian formulation has imazapyr present as a nicotinic salt at roughly 24.0%. On the cover of the US label is stamped "specimen". This may indicate that the US label was included in the report only as an example, but this does not explain why the EPA Registration Number is used in the Monitor's report. Jacques Whitford could not verify if this was a simple case of using the wrong reference or an actual case of applying an unregistered product.
- In **2000** the pilot of the helicopter and on-site monitor learned that a concern had been raised by civilian construction personnel that the helicopter was operating in their vicinity. It was decided that the monitor would contact the construction group to inform them of helicopter movements and progress.

- In **1995** there was a small (less than 1L) spill of Garlon 4 (480 g/L triclopyr) at the mixing and loading site at Day Hill on July 2. The spill was absorbed immediately by peat moss, and the contaminated material was widely broadcast on the spray site as per New Brunswick Department of Environment direction.
- In **1993** there was a spill (less than 5L) of tank mix (73 % Water; 27 % Tordon 101 (240 g/L 2, 4-D and 65 g/L picloram). The spill was immediately covered with peat. Contaminated soil and peat was placed in a plastic garbage bag and subsequently widely dispersed by hand on the site. The bag was then rinsed and discarded.
- In **1988** there was a report of crop damage at eight commercial growers and numerous home owners adjacent to the training area at CFB Gagetown. Immediate field investigation by provincial authorities and Environment Canada personnel confirmed the crop damage. Samples may have been analyzed for phenoxy herbicides, but at the time of this report, no data is available on the outcome of the sampling. A total of 65 claims were paid out by DND for a total of $358,131.37 in compensation after this drift incident.
- In **1986** there was an unauthorized aerial application of Tordon 101 (240 g/L 2,4-D and 65 g/L picloram) in 200 ha within the Rockwell Impact area (bounded by Rockwell stream, McCain's stream, Drummond Road, and the road at gate 7B). This application was not approved and was contrary to the application permit.
- In **1985** approximately 15L of Tordon 101 (240 g/L 2,4-D and 65 g/L picloram) was spilled at the loading site near the corner of Shirley Road and Greenfield Road. Apparently the contractor immediately cleaned up the spill.
- In **1978** it appears that an unregistered product may have been applied on the RTA. The product in question is called Herbec, and there is no reference in the applicator's report, or in any of the other supplied files, to a PCP number or to the AIs. The product Herbec 20P (Dow Agrosciences), containing the AI tebuthiuron, was first registered for use in Canada (PCP#15478) in 1979, but there is no record of Herbec's registration in Canada.
- In **1972** it appears that herbicide drift from aerial applications caused severe damage to crops at a market garden located adjacent to the spray area on the RTA. The claim was for $1000. In an inter-office memo dated January 17, 1973, it is stated that it can be reasonably assumed that the damage was a consequence of spraying carried out at CFB Gagetown.
- In **1964** a spray application accident occurred during the application of 2,4-D and 2,4,5-T by fixed wing aircraft in the upper portion of CFB Gagetown. During spraying a temperature inversion and elevated soil temperatures resulted in the herbicide application being suspended above the target species. Several hours later there was an increase in wind speed that caused the herbicide application to drift to the Upper Gagetown and Sheffield area. Several market gardens in the area were damaged and the Crown paid approximately $250,000 in reparations to several owners. This resulted in DND modifying its spray program in 1965 to reduce this spray drift potential by switching to the use of Tordon 101 and a drift control agent, applied by helicopter.

7.0 PHYSICAL AND CHEMICAL PROPERTIES OF HERBICIDES USED AT CFB GAGETOWN-LOOK-UP TABLE

In Appendix A, the physical and chemical properties of the AIs found in the products applied at the RTA are presented. A list of the properties for which information was obtained is shown in Table 11.

Table 11: Properties for which Data Could Be Obtained For Look-up Table

Type of Compound	Molecular Formula	Henry's Law Constant
Chemical Form	Molecular Weight	Soil absorption coefficients
Accepted Name	Solubility	Manufacturing Impurity
CAS Number	Log Kow (Log P)	Level of Manufacturing Impurity
CAS Systematic Name	Dissociation Constant (pKa)	Bioconcentration factors
Soil Degradation	Water Degradation	Vapour Pressure
Hydrolysis rate	Photolysis rate	

Data for the look-up table was obtained from numerous sources. Jacques Whitford utilized information held by the PMRA "Environmental Assessment Division Fate and Effects Database" (extracted February 28, 2006) as the primary source of information where available, the National Institute of Health, United States Environmental Protection Agency (US EPA), Cornell University's Pesticide Active Ingredient Information Database, and from the Pesticide Information Profiles (PIP) provided by the Extension Toxicology Network (EXTOXNET), a joint effort of the University of California, Davis, Oregon State University, Michigan State University, Cornell University, and the University of Idaho.

In some cases, no information was available for a particular property, and in these cases, Jacques Whitford relied upon a program created by the US EPA. The Estimation Programs Interface Suite™ (EPI) is a Windows® based suite of physical/chemical property and environmental fate estimation models that can be used to estimate values based on the structure of the chemical. When values were obtained using the EPI they were clearly marked in the look-up table. In some cases information for these headings is protected by proprietary law, and this is noted in the look-up table. In Appendix B, the chemical formula of each AI is presented.

In the Statement of Work it was requested that information regarding percent initial dislodgeable foliar residue and foliar dissipation rates be presented in the look-up table, but information could not be found by Jacques Whitford for these items, nor was this information held by PMRA.

8.0 DESCRIPTION OF DATABASE

A user-friendly database (Microsoft Access 2000) was constructed as a part of the Statement of Work for this project. Every effort was made by Jacques Whitford to populate all database fields that were requested by DND, however, some information for fields could not be obtained (Appendix C).

The database contains a comprehensive overview of pesticide use at CFB Gagetown from 1956 to 2004 (including all test plots) and is separated into various components presented in a single user-friendly form (Figure 2): a multi-field search, text-based search, and a reference search. In addition, for convenience, the user will find access to a legend explaining each database field, a legend explaining the numerical assessment of the data sources used, a yearly and cumulative (1956-2004) table presenting the amounts of AIs used, and instructions on how to use the database. Regarding the table outlining cumulative amounts of AIs applied, in some cases yearly amounts could not be obtained, so the total amounts presented in the table should be viewed as minimums. In these cases, values are marked with "*".

The multi-field search allows a user to search the database by selecting any combination of fields to create a dynamic database query. Relevant fields have been grouped together for ease-of-use. A user can select all fields in all groups by selecting "display all data" or a user can select individual fields in each grouping to make a query of the database. In addition, the user may select all the fields in a specific group by selecting "all" checkbox next to the grouping. Once fields are selected by the user and the submit button is pressed, the search engine will run a query of the database and present the results in a table. The multi-field search applies to both the yearly spray events at CFB Gagetown from 1956 to 2004 and all the test plots during the same time period. The test plot data is country-specific and can only be queried one country at a time (i.e., Canada or the USA).

The text search allows the user to be more specific in their query of the database. A user can query the database by location, herbicide product, or active ingredient or any combination of the three. The more specific the user is in the query, the more filtered the results will be. For example, a user can type "Rockwell" in the location field and all results in the database containing the term "Rockwell" will be displayed. To filter these results further, the user could also specify herbicide product and/or active ingredient. The location query is not limited to knowledge of specific areas of CFB Gagetown. For example, a user could type "impact" and all areas with the word "impact" in its location description will be displayed. All herbicides used are displayed in a drop-down menu for the user to select. If the user would also like to limit the query by AI, depending on what the user selected for herbicide, only the relevant active ingredients for that herbicide will be displayed in the drop-down menu. All search results will display, along with the fields selected, year of application, total area treated, amount of AI in each herbicide, herbicide manufacturer, pesticide control number, recommended herbicide mix application rate, and all relevant references. The text search can query the yearly pesticide control data from 1956 to 2004 or the test plot data, which can be queried one country at a time (i.e., Canada or the USA).

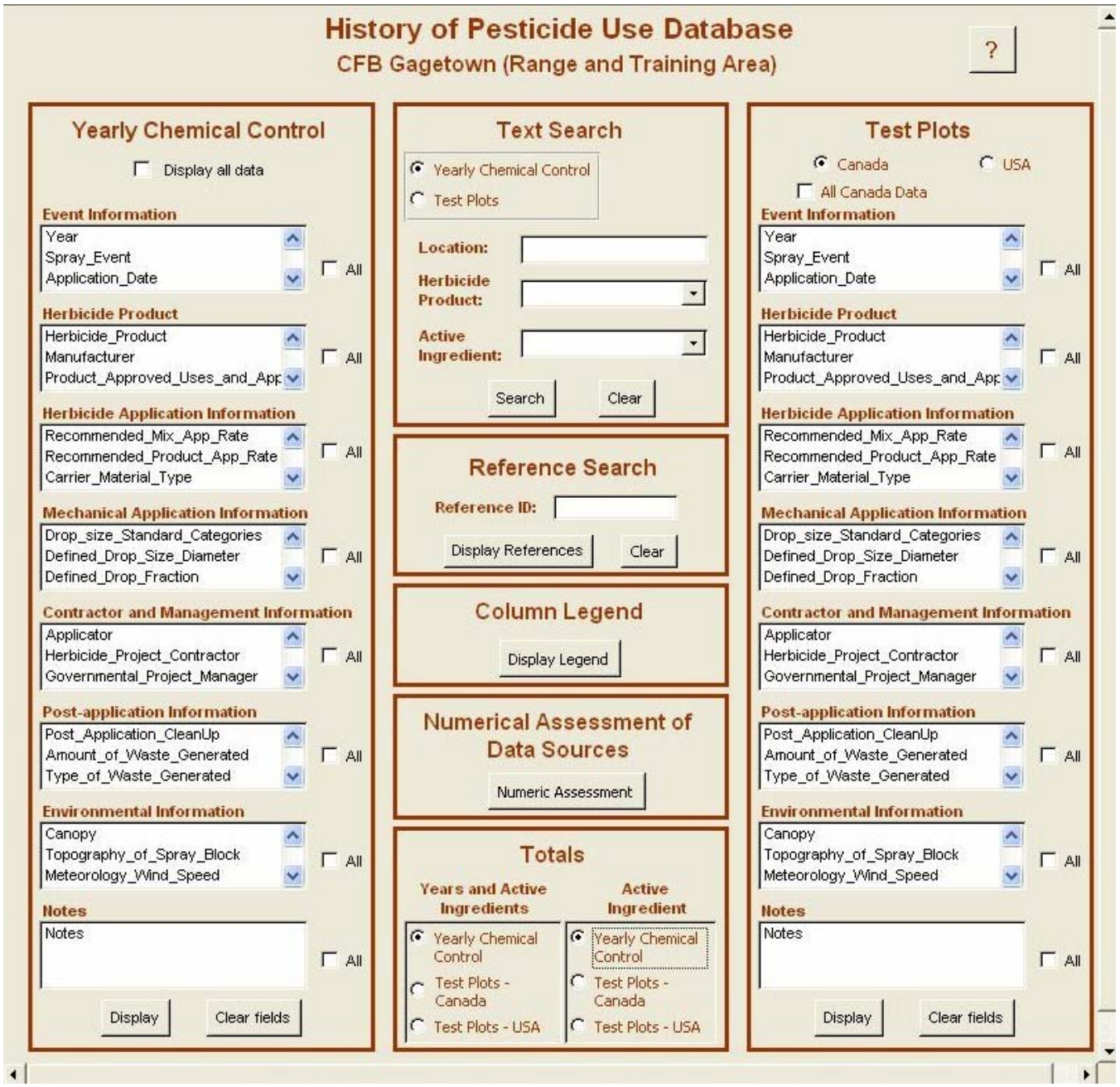

Figure 2: Screenshot of Main Database Window

The reference search allows the user to query the database for specific or all references. A user can, for example, search for a specific reference that has been displayed in one of the queries it has run. Reference searches can be specific to one particular reference (e.g., 1976-2) or general to one year (e.g., 1976); the latter will display all references specific to the year entered. References are displayed by year, ID, reference type, score, author and title of reference. Each reference is scored based on the validity of the information it has cited (see Table 1 of this report).

9.0 REPORTING AND DATABASE CHALLENGES

The following is a discussion of the limitations, data gaps, and inconsistencies encountered while extracting information for the database and report. Overall, it is important for the reader to understand that this process was constrained to a six (6) week window. The priority for data review and collection was primarily focused on collecting, reviewing and entering information on CFB Gagetown yearly herbicide application documentation into the database for future use. Although it is possible that additional information on the history and production of herbicides across Canada is available, it was not readily accessible within the allotted time frame. Jacques Whitford believes that all documentation relevant to CFB Gagetown herbicide application provided or retrieved was thoroughly reviewed in preparation of the database, look-up table and this report.

9.1.1 Data Collection from Yearly Application Record Files

As discussed previously, the annual chemical vegetation management files were more often than not, incomplete. Information frequently had to be pieced together from several different documents within the same file, and, in some cases, the documents contained in any given file contradicted one another and were missing vital details required to document applications.

- Final reports written by applicators and monitors were sometimes very brief and included very little information about actual application rates with no indication of application details such as products used or where the areas of application were within the RTA. For example, records often contained verbal descriptions of the regions and were limited to, for example, “Area 3”. These areas tended to change location from year to year. Also, the files may have indicated that spraying took place in, for example, 31 hectares of “Area X”, when, in fact, “Area X” encompasses 150 hectares, making it impossible to determine exactly where in “Area X” applications occurred.
- The calculation of actual application rates and amounts applied was often hampered by inconsistencies and omissions in relation to units of product applied (e.g., in some cases units were not given, and sometimes the total mix of application was given as “number of loads”, but without a description of what a load actually was) and information regarding tank mixes and ratios of products mixed were missing.
- In relation to products applied, yearly files were often missing Material Safety Data Sheets and label sheets. In some cases product PCP numbers were not given which made it difficult, if not impossible, to determine what product was actually applied, and as a consequence information about AIs and potential manufacturing impurities could not be obtained. Moreover, applicator records were often hand written (which at times were illegible) using short forms and trade slang.
- Often there were discrepancies between and within the monitor’s and applicator’s reports. For example, Jacques Whitford found cases where the total amount of product applied, according to the monitor, was different than the total amount applied according to the applicator. In some cases, the applicator’s report contained information that contradicted the applicator’s logs. In other cases, Jacques Whitford found discrepancies between data within a report. For example, there were cases where the actual application rate (as described by applicator and monitor) multiplied by the actual number of sprayed hectares (as described by applicator and monitor), did not equal the amount of product that was used.
- In some instances the only information regarding herbicide applications were from DND specifications. Jacques Whitford garnered as much information as possible from these types of

documents, however, in years where both specifications and a final contractor's report or monitor's report were present, it became clear that occasionally last minute changes to areas to be sprayed and products to be used (as outlined in the specification) were made, indicating that the specifications were not necessarily a reliable source of information.

- Documents contained in yearly files were often in the wrong files. For example, a lengthy document from 1983 contained one page of information from 1986.
- In some cases data contained within the 1981 Memorandum Document (7600-2 (CE)) summarizing herbicide applications at CFB Gagetown between 1956 and 1975 conflicted with data contained in the Yearly Summary Table of herbicide applications from 1956-1968. As there was little supporting documentation for herbicide application for any of those years, it was difficult to determine which document was more accurate.

Overall, Jacques Whitford believes these challenges were overcome and information provided within the database can be relied on based on the assigned validity level scores.

9.1.2 Policy and Regulation of Herbicides in Canada

Although a comprehensive overview of historical and current day policy and regulation of herbicides in Canada was provided. As previously stated, Jacques Whitford experienced difficulty in obtaining information on sale, production or use volumes of herbicides across Canada and in particular for New Brunswick. This is in most part due to the fact that there is no comprehensive database or records available for this information currently in Canada. This information does not materially impact the findings of herbicide application in the RTA at CFB Gagetown.

9.1.3 Data Collection from National Archives

Little to any useful information pertinent to the objectives of Task 2A was retrieved from the National Archives. It is believed that all relevant documents to herbicide application at CFB Gagetown were already held by DND and that no further information is held at the National Archives, specific to the application of herbicides historically at the RTA.

The process of obtaining documents related to Task 2A at the National Archives is extremely slow, and Jacques Whitford has not yet been able to obtain all requested documentation. Since the submission of the Interim Report, Jacques Whitford has received some of the documents from the National Archives, but is still awaiting a limited number of documents contained in record group (RG) 24 (National Defence). A list of files already reviewed, and of those still pending, is presented in Appendix D.

Based on our experience and review of obtained archival material from the National Archives, Jacques Whitford does not believe that the limited information not retrieved will provide any substantial information that would alter the context of this report or the accompanying database.

10.0 SUMMARY REGARDING HERBICIDE USE AT CFB GAGETOWN

Regarding the practice of herbicide use from 1956 to 2004 at CFB Gagetown, a number of general conclusions can be drawn:

- It should be noted that the annual herbicide files that were supplied to Jacques Whitford were, more often than not, incomplete, and information frequently had to be pieced together from several different documents within the same file or from different files, and in some cases, the documents contained in any given file contradicted one another. Furthermore, the details found in the applicator and monitor records were often sparse, and in more recent years, when applications were closely monitored, inconsistencies were still observed.
- Disposal methods were documented in some cases, and appear to have changed (i.e., improved) over the years. In later years, barrels and containers were recycled or returned to the manufacturer, whereas in earlier years barrels were disposed of in dumps or landfills, and may have still contained product at their time of burial.
- In 1984, 666 drums were excavated from a Shirley Road Dump on the RTA. There were 145 crushed drums, 398 empty (331 originally contained Tordon 101), and 112 drums containing liquid, 61 of which contained 2, 4-D and picloram, the AIs in Tordon 101.
- Many different herbicide products were applied between 1956 and 2004. Some were used over the course of many years (e.g., Tordon 101 or 10K were used from 1965 until 2003) and some were used only once (e.g., Krovar was used in 1994).
- It appears that Agent Orange, Agent Purple, and Agent White were only applied on the USDoA test plots. Agent Orange was applied in the 1966 and 1967 trials; Agent Purple was only applied in 1966; and Agent White, was only applied in 1967.
- In 1956, 1957, 1963 and 1964, a 50:50 mix of 2,4-D and 2,4,5-T was applied to various areas throughout the RTA, however, the chemical form of these AIs was not given (e.g., n-butyl ester) in any report documenting these applications.
- Over the 48 years period there were 11 recorded incidents, of which 3 resulted in off site damage, and incidents ranged from inconsequential spills of product (less than 1L) to more serious claims of crop damage and the potential use by applicators of unregistered herbicide products.
- In the cases where information regarding product application rates could be determined, it appears that the actual application rates of products fall within the recommended application rates suggested by the manufacturer. Often, actual application rates were lower than the recommended rates.
- Herbicide applications in the RTA were regulated by and followed the policies and science of the day as implemented by the Federal and Provincial governments and by DND (base and NDHQ).
- Herbicides used in the RTA for vegetation control were commonly used around Canada during the past fifty years.

CLOSURE

Some of the information presented in this report was provided through existing documents and interviews. Although attempts were made, whenever possible, to obtain a minimum of two confirmatory sources of information, Jacques Whitford in certain instances has been required to assume that the information provided is accurate.

The information and conclusions contained in this report are based upon work undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices current at the time the work was performed. The conclusions and recommendations presented represent the best judgement of Jacques Whitford based on the data obtained during the project. Due to the nature of assessment and the data available, Jacques Whitford cannot warrant against undiscovered environmental liabilities. Conclusions and recommendations presented in this report should not be construed as legal advice.

Should additional information become available which differs significantly from our understanding of conditions presented in this report, we request that this information be brought to our attention so that we may reassess the conclusions provided herein.

Jacques Whitford trusts that this interim report meets the requirements of the statement of work for Task 2A: The History and Science of Herbicide Use at Canadian Forces Bases (CFB) Gagetown from 1952 to Present. If you have any questions regarding this report, please contact us at your earliest convenience.

Yours truly,

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LDK/llm

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APPENDIX A

Physical and Chemical Properties Look-up Table

Table A-1. Physical and Chemical Properties of Active Ingredients and Contaminants associated with CFB Gagetown Herbicide Application Program 1956–2004.

Chemical Form [3]	Accepted Name [1, 2, 3]	CAS No [1, 3]	CAS Systematic Name [1, 2]	Molecular Formula [1]	Molecular Weight [1]	Solubility (mg/L) [1, 3, 4]	Log Kow (Log P) [1-4, 11]	Dissociation constant (pKa) [1, 4]	Vapour Pressure (mm Hg) [1, 4]	Henry's Law Constant (atm-m3/mole) [1, 4]	Soil adsorption coefficient (Koc)	Photolysis Rate (in soil) [3]	Soil Biotransformation [3]	Photolysis Rate (in water) [3]	Hydrolysis rate [3]	Water Biotransformation [3]	Bioconcentration factors	Contaminant	Contaminant Level
2,4,5-T (present as acid)	2,4,5-T	93-76-5	(2,4,5-trichlorophenoxy)acetic acid	C8-H5-Cl3-O3	255.48	278 (25°C)	3.31	2.833	6.08E-12 (20°C)	8.68E-09 (25°C)	48.63 [11]						3.162 [11]	Dioxin [5, 14]	0.1-55 ppm [5, 14]
2,4-D (present as amine salts (dimethylamine salt, diethanolamine salt, or other amine salts))	2,4-D	94-75-7	(2,4-dichlorophenoxy)acetic acid	C8-H6-Cl2-O3	221.04	677 (25°C)	2.81	2.73	8.25E-05 (20°C)	3.54-08 (25°C)	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	3.162 [11]	Dioxin [14]	Proprietary Information [3]
2,4-D (present as low volatile esters)	2,4-D	25168-26-7	(2,4-dichlorophenoxy)acetic acid	C16-H22-Cl2-O3	334.26	0.0324 (25°C)	6.73		7.06E-06 (25°C)	9.56E-05 (25°C)	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	30570 [11]	Dioxin [14]	Proprietary Information [3]
2,4-D (present as sodium salt)	2,4-D	2702-72-9	(2,4-dichlorophenoxy)acetic acid	C8-H6-Cl2-O3.Na	243.02	3.35E+05 (20°C)	-1.19		4.36E-11 (25°C)	9.25E-09 (25°C) [11]	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	3.162 [11]	Dioxin [14]	Proprietary Information [3]
2,4-DP (present as mixed butyl esters or as isooctyl esters)	2,4-DP (dichlorprop)	53404-31-2	2-(2,4-Dichlorophenoxy)propionic acid butoxyethyl ester	C15-H20-Cl2-O4	235.07	1.049 (25°C) [11]	Proprietary Information [3]		4.05E-06 (25°C) [11]	1.703E-06 (25°C) [11]	1000		Half-life = 10 days				3.162 [11]		
Ammonium sulfamate	ammonium sulfamate	7773-06-0	monoammonium sulfamate	H3-N-O3-S.H3-N	114.12	1.00E+06 (25°C) [11]	-4.34 [11]		1.51E-05 (25°C) [11]	1.929E-22 (25°C) [11]	6.124 [11]						3.162 [11]		
Bromacil (present in free form, as dimethylamine salt, or as lithium salt)	bromacil	314-40-9	5-bromo-6-methyl-3-(1-methylpropyl)-2,4(1H,3H)-pyrimidinedione	C9-H13-Br-N2-O2	261.12	815 (25°C)	1.53 (pH 5) 1.88 (pH 7) 1.63 (pH 9)	9.3	3.07E-07 (20°C)	1.29E-10 (25°C)	2.3 - 33 [3]	Stable	Half-life = 198 - 275 days in silty clay loam, silty sandy loams	Stable to a half-life of 7 days	Stable at pH 5, pH 7 and pH 9		2.1-8.3 [7]		
Cacodylic acid	dimethylarsinic acid	75-60-5	dimethylarsinic acid	C2-H7-As-O2	138.00	2.00E+06 (25°C)	0.36	1.57	1.00E-07 (25°C)	1.80E-14 (25°C)	48.64 [11]						3.162 [11]		
Dalapon (present as sodium salt or as a mixture of the sodium and magnesium salts) [13]	dalapon	75-99-0	2,2-dichloropropanoic acid	C3-H4-Cl2-O2	142.97	5.02E+05 (25°C)	0.78	1.79	0.19 (25°C)	6.43E-08 (25°C)	2.738 [11]						1.0-3.0 [13]		
Dicamba (present as acid, as diethanolamine salt, as dimethylamine salt, or as butoxyethyl ester, or as sodium salt)	dicamba	1918-00-9	3,6-dichloro-2-methoxybenzoic acid	C8-H6-Cl2-O3	221.04	8310 (25°C)	Proprietary Information [3]	1.97	3.38E-05 (20°C)	2.18E-09 (25°C)	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	3.162 [11]	Proprietary Information [3]	Proprietary Information [3]
Dinoseb (in free form, as alkanolamine salts, or as mixed amine salts)	dinoseb	88-85-7	2-(1-methylpropyl)-4,6-dinitrophenol	C10-H12-N2-O5	240.21	52 (25°C)	2.29-3.69	4.62	7.44E-05 (25°C) [11]	4.56E-07 (25°C)	120 [3]	Half-life = 14 hours in sandy loam	Half-life = 30 days	Half-life = 16 days	Stable at pH 5, pH 7 and pH 9		68 [8]		
Dioxin (Manufacturing Impurity)	TCDD (tetrachlorodibenzodioxin) Most common and abundant congener reported as contaminant.	1746-01-6	2,3,7,8-tetrachlorodibenzo-para-dioxin	C12-H4-Cl4-O2	321.97	0.0002 (25°C)	6.8		1.5E-09 (25°C)	5.00E-05 (25°C)	146300 [11]						34360 [11]		
Diquat	diquat dibromide	85-00-7	1,1'-ethylene-2,2'-dipyridinium dibromide	C12-H12-N2.2Br	344.05	7.08E+05 (20°C)	-4.6		1.81E-06 (25°C)	1.42E-13 (25°C)	100000 [3]	Stable	Half-life = 1000 days in sandy loam	Half-life = 74 days	Stable at pH 5, pH 7 and pH 9		0.7-2.5 [9]	free 2,2'-bipyridyl [14]	10 mg/kg [*,14]
Diuron	diuron	330-54-1	N'-(3,4-dichlorophenyl)-N,N-dimethylurea	C9-H10-Cl2-N2-O	233.10	42 (25°C)	2.68		6.90E-08 (25°C)	5.04E-10 (25°C)	468 [3]	Half-life = 172 days	Half-life = 372 - 1000 days	Half-life = 43 days	Stable at pH 5, pH 7 and pH 9	Half-life = 33 days	23.1 [11]	3,3',4,4'-tetrachloroazoxybenzene; 3,3',4,4'-tetrachloroazobenzene [14] 3,3',4,4'-tetrachloroazobenzene [8]	1,2 mg/kg; 10, 20 mg/kg [*,14] 9-1400 ug/g [8]
Fenoprop (present as acid, as salts (triethanolamine, sodium), or as esters (butoxyethyl, iso-octyl, propylene glycol butyl ether))	2,4,5-TP (fenoprop)	93-72-1	2-(2,4,5-T) Trichlorophenoxy propionic acid	C9-H7-Cl3-O3	269.51	71 (25°C)	3.8	2.84	9.97E-06 (20°C)	9.06E-09 (25°C)	2600 [8]						3.162 [11]	Dioxin [8]	
Fosamine ammonium	fosamine ammonium	25954-13-6	Ammonium ethyl carbamoylphosphonate	C3-H8-N-O4-P.H3-N H4-N.C3-H7-N-O4-P	170.10	1.00E+06 (25°C)	-2.92	9.25	3.98E-06 (20°C)	8.37E-23 (25°C)	8.087 [3]	Stable	Half-life = 0.5 - 8 days in sandy and silty loams	Stable	Stable at pH 5, pH 7 and pH 9		3.162 [11]		
Glyphosate (present as isopropylamine salt)	glyphosate	38641-94-0	Glyphosate mono(isopropylamine) salt	C6-H17-N2-O5-P	228.18	1.20E+04 (25°C)	-2.77		6.06E-11 (25°C) [11]	1.82E-17 (25°C) [11]	884 - 60000 [11]	DT50 = 101 days	DT50 = 150 days	DT50 = 69 days	Half-life = 35 days	DT50 = 14.4 days	0.04-0.05 (based on application of Roundup) [10]		
Glyphosate (present as potassium salt)	glyphosate	70901-12-1	N-(phosphonomethyl)glycine	C3-H8-N-O5-P	169.07	1.20E+04 (25°C)	-2.77					DT50 = 101 days	DT50 = 150 days	DT50 = 77 days	Half-life = 36 days	DT50 = 14.4 days	0.04-0.05 (based on application of Roundup) [10]		
Hexachloroacetone	hexachloroacetone	116-16-5	1,1,1,3,3,3-hexachloro-2-propanone	C3-Cl6-O	264.75	150 (25°C)	2.48-3.69		0.123 (25°C)	9.47E-08 (25°C)	1886 [8]						16.09 [11]		
Hexachlorobenzene (Manufacturing Impurity)	hexachlorobenzene	118-74-1	Hexachlorobenzene	C6-Cl6	284.78	0.0062 (25°C)	5.73		1.80E-05 (25°C)	1.70E-03 (25°C)	3380 [11]						5153 [11]		

Table A-1. Physical and Chemical Properties of Active Ingredients and Contaminants associated with CFB Gagetown Herbicide Application Program 1956–2004.

Chemical Form [3]	Accepted Name [1,2,3]	CAS No [1,3]	CAS Systematic Name [1,2]	Molecular Formula [1]	Molecular Weight [1]	Solubility (mg/L) [1,3,4]	Log Kow (Log P) [1-4,11]	Dissociation constant (pKa) [1,4]	Vapour Pressure (mm Hg) [1,4]	Henry's Law Constant (atm-m3/mole) [1,4]	Soil adsorption coefficient (Koc)	Photolysis Rate (in soil) [3]	Soil Biotransformation [3]	Photolysis Rate (in water) [3]	Hydrolysis rate [3]	Water Biotransformation [3]	Bioconcentration factors	Contaminant	Contaminant Level
Imazapyr	imazapyr	81334-34-1	2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-3-pyridinecarboxylic acid	C13-H15-N3-O3	261.28	1.13E+04 (20°C)	Proprietary Information [3]	1.81	1.79E-11 (25°C)	7.08E-17 (25oC)	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	3.162 [11]		
Mecoprop (present as amine salt)	mecoprop	1929-86-8	(2R)-2-(4-chloro-2-methylphenoxy)propanoic acid	C10-H11-Cl-O3	252.74	7.95E+05 (25°C)	Proprietary Information [3]		5.21E-011 (25°C) [11]	1.36E-16 (25°C) [11]	Proprietary Information [3]	Proprietary Information [3]	DT50 = 4 - 40 days in sand, sandy loam, loam, silty loam, and clam loams	Proprietary Information [3]	Proprietary Information [3]	Proprietary Information [3]	3.162 [11]	4-chloro-2-methylphenol [14]	15 g/kg *,[14]
Paraquat	paraquat dichloride	4685-14-7	1,1'-Dimethyl-4,4'-bipyridinium dichloride	C12-H14-N2.2Cl	257.16	7.00E+05 (20°C)	-4.5		1.01E-07 (25°C) [11]	1.00E-09 (25°C)	15473 [3]	Stable	DT50 = 1000 days	Stable	Stable at pH 5, pH 7 and pH 9		3.162 [11]	free 4,4'-bipyridyl [14]	0.2 % *,[14]
Pentachlorophenol	pentachlorophenol	87-86-5	Pentachlorophenol	C6-H-Cl5-O	266.34	14 (25°C)	5.86	4.7	1.10E-04 (25°C)	2.45E-08 (25°C)	1250,1800 [3]	Hallf-life = 14 days in sandy clay loam	Hallf-life = 85 hours	DT90 = 10 hours	Half-life = 328 hours		50-5370 [8]	Dioxin, HCB [14]	Proprietary Information[3]
Picloram (present as acid, isooctyl esters, potassium salt or present as amine salts)	picloram	1918-02-1; 2545-60-6; 26952-20-5	4-amino-3,5,6-trichloro-2-pyridinecarboxylic acid	C6-H3-Cl3-N2-O2	241.46	430 (25°C)	0.3	2.3	7.21E-11 (20°C)	5.33E-14 (25°C)	16 [3]	Stable	Hallf-life = 513 days	Half-life = 26 days @ 25 °C	Stable at pH 5, pH 7 and pH 9		3.162 [11]	HCB [6]	200 ppm (1985) [6]; <100 ppm (1988) [6], last 10 years proprietary [3]
Sodium cacodylate	sodium cacodylate / cacodylic acid	124-65-2	sodium cacodylate	C2-H7-As-O2.Na	159.98	2.00E+06 (25°C)	-2.18	6.29	2.89E-08 (25°C)	6.08E-15 (25°C)							3.162 [11]		
Sodium trichloroacetate (present as sodium salt)	sodium trichloroacetate / TCA	76-03-9	Sodium trichloroacetate	C2-H-Cl3-O2.Na	185.37	1.00E+06 (25°C)	1.33	0.512	2.60E-08 (25°C)	1.35E-05 (25°C)	2.738 [11]						1-1.7 [8]		
Tebuthiuron	tebuthiuron	34014-18-1	N-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-N,N'-dimethylurea	C9-H16-N4-O-S	228.32	2500 (25°C)	1.79	1.2 [8]	2.00E-06 (25°C)	1.20E-10 (25°C)	23 [8]				Extremely Slow or t1/2 > 1 Year [11]		4.768 [11]		
Trichlorobenzoic acid (technical: present as dimethylamine salt or as sodium salt)	trichlorobenzoic acid	50-31-7	2,3,6-Trichlorobenzoic acid	C7-H3-Cl3-O2	225.46	7700 (22°C)	-2.37	1.5	5.50E-04 (25°C)	2.12E-08 (25°C)	65.49 [11]						3.162 [11]		
Triclopyr	triclopyr	55335-06-3	[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid	C7-H4-Cl3-N-O3	256.47	440 (25°C)	2.7	3.97	1.26E-06 (25°C)	9.66E-10 (25°C)	Proprietary Information [3]		Half-life = 12 hours - 18 days in silty clam loam, silty loam	DT50 = 2 days	Proprietary Information [3]	Half-life = 42 - 130 days	3.162 [11]		

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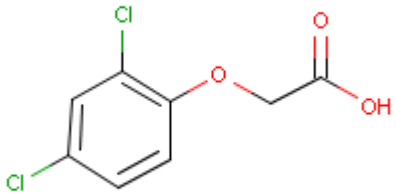
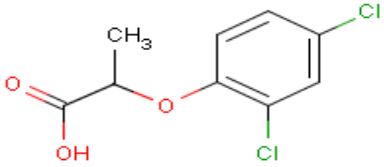
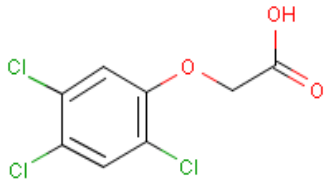
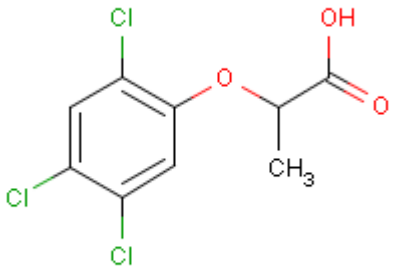
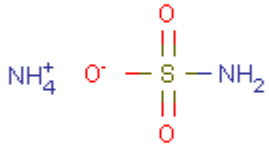
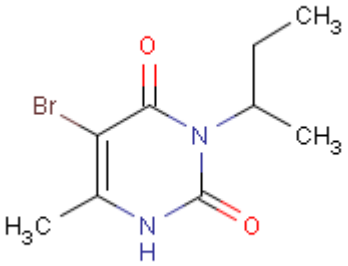
2 Compendium of Pesticide Common Names (http://www.alanwood.net/pesticides/index.html)
3 Pest Management Regulatory Agency " Environmental Assessment Division Fate and Effects Database" - extracted February 28, 2006
4 FIFRA (EPA Pesticide Active Ingredients)
5 World Health Organization (1975), Data Sheets On Pesticides No. 13, 2,4,5-T
6 US EPA Reregistration Eligibility Decision (RED) 1995 Picloram
7 US EPA Reregistration Eligibility Decision (RED) 1996 Bromacil
8 Hazardous Substances Data Bank, U.S. National Library of Medicine
9 US EPA Reregistration Eligibility Decision (RED) 1995 Diquat
10 World Health Organization (1994), International Programme On Chemical Safety, Environmental Health Criteria 159, Glyphosate
11 US EPA Estimation Programs Interface (EPI) Suite™
12 Tomlin, C.D.S., ed. 1997. The Pesticide Manual; A World Compendium. 11th edition. The British Crop Protection Council.
13 US EPA Technical Fact sheet on: DALAPON
14 Ambrus A., Hamilton, D.J. Kuiper, H.A., Racke, K.D. 2003. Significance of Impurities in the Safety Evaluation of Crop Protection Products (IUPAC Technical Report). Pure Appl. Chem., Vol. 75, No. 7, pp. 937–973, 2003.

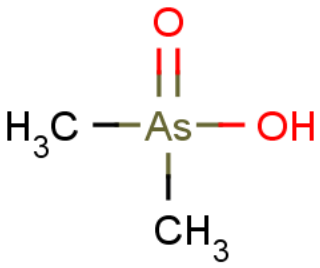
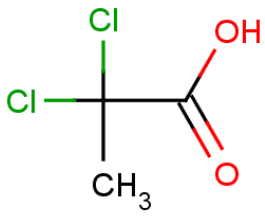
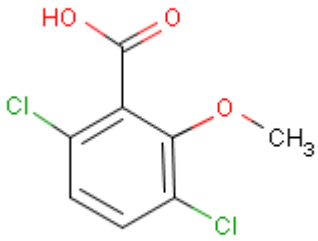
* Ranges or maximum levels of impurities actually measured in commercial samples

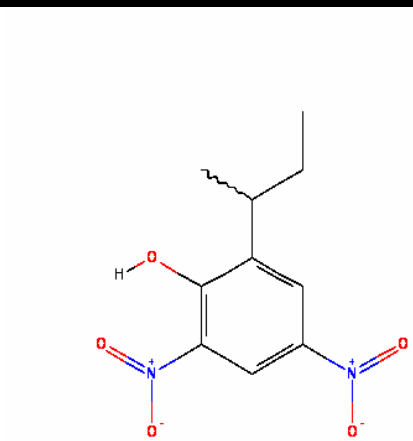
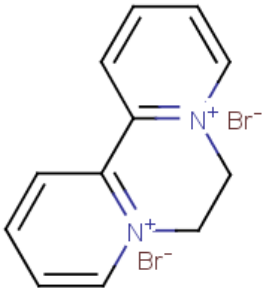
APPENDIX B

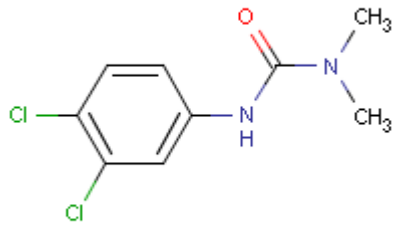
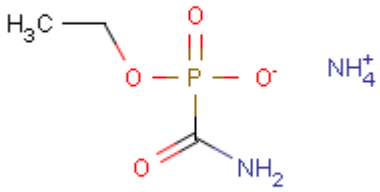
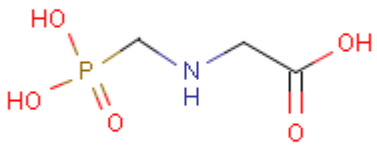
Chemical Structure of Active Ingredients and Manufacturing Impurities

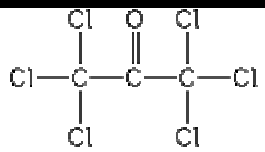
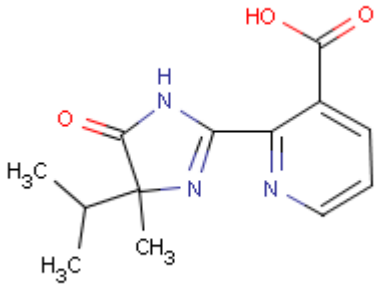
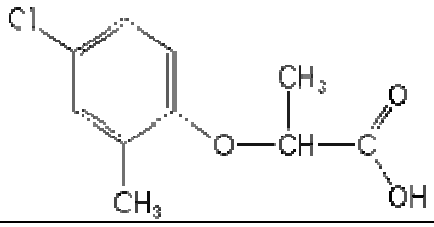
Active Ingredient	Chemical Structure
2,4-D	
2,4-DP	
2,4,5-T	

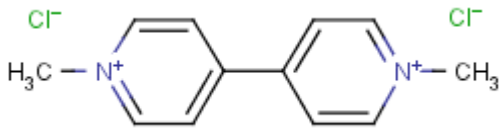
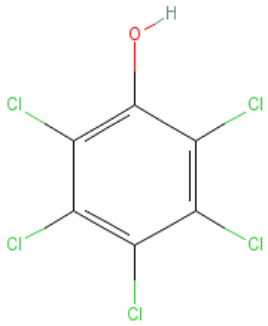
Active Ingredient	Chemical Structure
2,4,5-TP	
Ammonium sulfamate	
Bromacil	

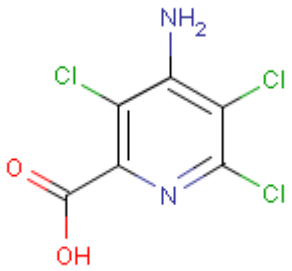
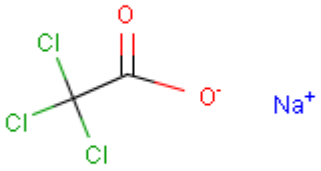
Active Ingredient	Chemical Structure
Cacodylic acid	
Dalapon	
Dicamba	

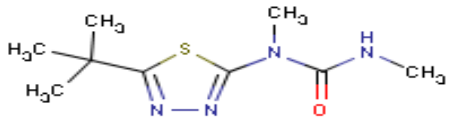
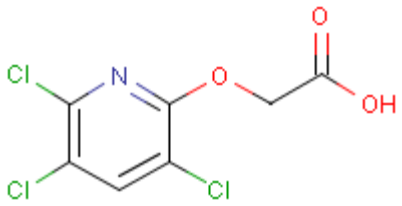
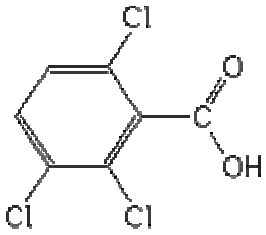
Active Ingredient	Chemical Structure
4,6-dinitro-o-sec-butylphenol (Dinitro)	
Diquat (dibromide)	

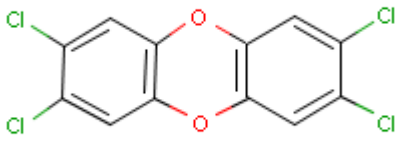
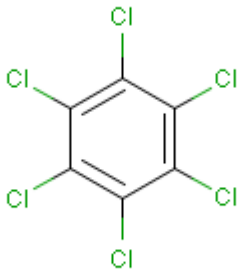
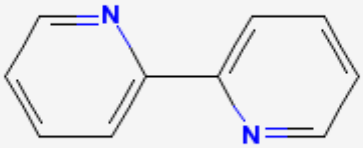
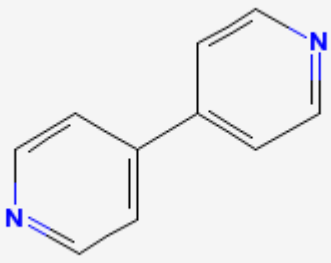
Active Ingredient	Chemical Structure
Diuron	
Fosamine ammonium	
Glyphosate	

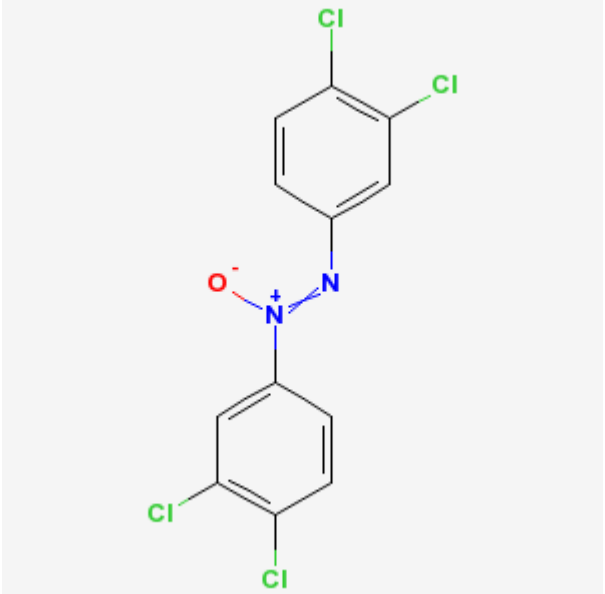
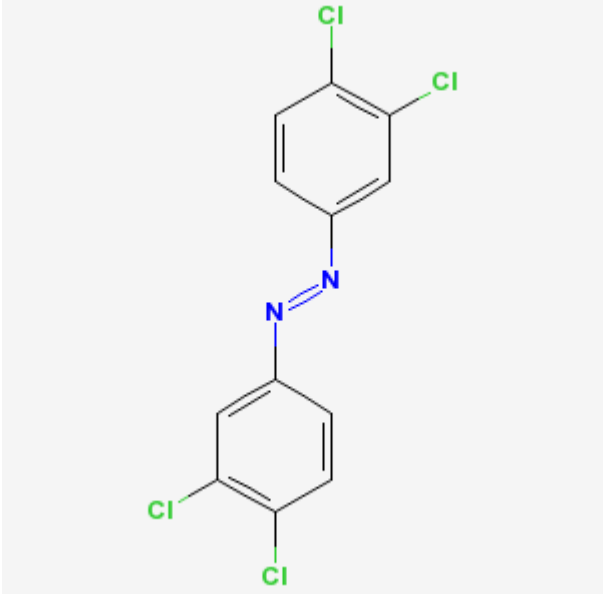
Active Ingredient	Chemical Structure
Hexachloroacetone (1,1,1,3,3,3-hexachloro-2-propanone)	
Imazapyr	
Mecoprop	

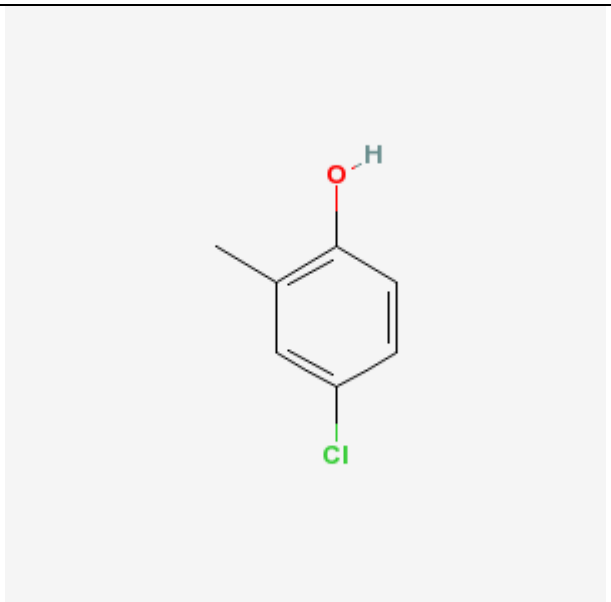
Active Ingredient	Chemical Structure
Paraquat (dibromide)	
Pentachlorophenol	

Active Ingredient	Chemical Structure
Picloram	
Sodium cacodylate	
Sodium trichloroacetate	

Active Ingredient	Chemical Structure
Tebuthiuron	
Triclopyr	
2,3,6-Trichlorobenzoic acid	

Manufacturing Impurity	Chemical Structure
2,3,7,8-tetrachlorodibenzo-para-dioxin	
Hexachlorobenzene	
2,2′-bipyridyl	
4,4′-bipyridyl	

3,3′,4,4′-tetrachloroazoxybenzene	
3,3′,4,4′-tetrachloroazobenzene	

4-chloro-2-methylphenol	

APPENDIX C

List of Fields in the Database for Which Data Could and Could Not be Obtained

Fields for Which Data Could be Found	Fields for Which Data Could Not be Found
Year	Site Land Used
Spray Event	Product Batch Number
Application Date	Canopy
Location Description	Topography of Spray Block
Application Type	Info Occupational Exposure
Herbicide Product	Info Non-Occupational Exposure
Manufacturer	Exposure Through Food
Product Approved Uses/Application Information	Drop Size Standard Categories
Active Ingredient 1	Defined Drop Fraction
Amount AI1 Product	Carrier Material Specific Gravity Carrier
Suspected Contaminant AI1	Carrier Material Specific Gravity Non-Volatile
Active Ingredient 2	Carrier Material Evaporated Rate
Amount AI2 Product	Carrier Material Non-Volatile Rate
Suspected Contaminant AI2	Carrier Material Active Rate
Active Ingredient 3	Carrier Material Spray Volume Rate
Amount AI3 Product	Stability
Suspected Contaminant AI3	Aircraft Type Semispan
AI1 Chemical Name	Aircraft Weight
AI2 Chemical Name	Propeller Speed
AI3 Chemical Name	Propeller Radius
Pest Control Product Number	Propeller Efficiency
Recommended Mix Application Rate	Biplane Separation
Recommended Product Application Rate	Platform Area
Carrier Material Type	Aircraft Engines
Tank Mix	Aircraft Engine Position
Total Area Treated	Wing Vertical
Total Mix Applied	Aircraft Drag Coefficient
Total Product Applied	Vortex Decay Rate
Actual Product Application Rate	Boom Height Above Ground
Total Active Ingredient 1 Applied	Flight Lines
Total Active Ingredient 2 Applied	Swath Displacement
Total Active Ingredient3 Applied	Nozzles Distribution Extent
Applicator	Terrain Surface Roughness
Herbicide Project Contractor	Terrain Upslope Angle
Governmental Project Manager	Terrain Downslope Angle
Vehicle Configuration	Flux Plane Distance
Sprayer Configuration	
Mixing Loading	
Personal Protective Equipment	
Total Number of Workers per Operation	
Post Application Clean-Up	
Amount of Waste Generated	
Type of Waste Generated	
Waste Method Disposal	
Record of Incidents	
Defined Drop Size Diameter	
Meteorology Wind Speed	
Meteorology Wind Speed Height Measurement	
Meteorology Wind Direction	

Fields for Which Data Could be Found	Fields for Which Data Could Not be Found
Meteorology Wind Relative Humidity	
Meteorology Temperature	
Aircraft Speed	
Boom Position	
Boom Length	
Swath Width	
Nozzles type	
Number of Nozzles	
Nozzles Spacing	
Nozzles Placement	
Notes	

APPENDIX D

List of Files From the National Archives That Have Been Reviewed and Those Which Have Been Requested But Not Received

Listing of References Requested	Status	Reference	File Title
1	Viewed	RG24 , National Defence , Accession 1983-84/167 , Box 7796 File : C-2-6030-110/P27 , Access code: 32 Parts: 1	Canadian Forces Medical Services - Committees & Boards - Federal Interdepartmental Committee on Pesticides
2	Viewed	RG24 , National Defence , Accession 1983-84/167 , Box 7797 File : C-2-6030-110/P27 , Access code: 32 Parts: 2	Canadian Forces Medical Services - Committees & Boards - Federal Interdepartmental Committee on Pesticides
3	Viewed	RG24 , National Defence , Accession 1983-84/167 , Box 7797 File : C-2-6030-110/P27 , Access code: 32 Parts: 3	Canadian Forces Medical Services - Committees & Boards - Federal Interdepartmental Committee on Pesticides
4	Viewed	RG39 , Forestry , Volume 514 File : 435-2-2 , Access code: 90 Parts: 1	Forest Management Institute. Provision of Technical and Professional Services, Department of National Defence. Camp Gagetown, New Brunswick
5	Viewed	RG39 , Forestry , Volume 516 File : 437-13-0 , Access code: 90 Parts: 1	Forest Management Institute. Program and Miscellaneous Technical Activities. Logging, General "Quarterly Report" No. 2, Camp Gagetown, New Brunswick
6	Viewed	RG39 , Forestry , Volume 852 A File : 20-0 (C.G.) , Access code: 32 Parts: 1	Gagetown military area - General
7	Viewed	RG39 , Forestry , Volume 891 File : 42-4-0 (Gagetown) , Access code: 32	National Defence
8	Viewed	RG39 , Forestry , Volume 529 File : Report No. 11 , Access code: 9	Department of Forestry and Rural Development - Report on the Forest Survey of the Canadian Forces Base Gagetown - New Brunswick
9	Viewed	RG39 , Forestry , Series A , Accession 1995-96/336 , Box 42 File : 1200-55/N3-1 , Access code: 32 Parts: 1	CFB GAGETOWN
10	Viewed	RG39 , Forestry , Series A , Accession 1994-95/770 , Box 48 File : 1438-55/N3-1 , Access code: 32 Parts: 2	RELATIONS - DEPT OF NATIONAL DEFENCE - CFB GAGETOWN

Number of References Requested	Status	Reference	File Title
11	Viewed	RG24 , National Defence , Series G-1 , Volume 23738 File : 1150-110/F15 , Access code: 32 Parts: 1	Committees and boards (with codes) - Federal Interdepartmental Committee on Pesticides
12	Viewed	RG84 , Canadian Parks Service , Series A-5-a , Volume 2335 File : C-1165-175 , Access code: 32 Parts: 1	Committees - Federal Interdepartmental Committee on Pesticides
13	Viewed	RG108 , Environment Canada , Volume 190 File : 1165-36/F15-4 , Access code: 32 Parts: 5	Federal Interdepartmental Committee on Pesticides - Federal Government Pest Control Projects
14	Viewed	RG108 , Environment Canada , Volume 225 File : 1165-36/F15 , Access code: 32	Committees, boards, commissions - Federal Interdepartmental Committee on Pesticides
15	Pending	RG108 , Environment Canada , Volume 225 File : 1165-36/F15 , Access code: 32	Committees, boards, commissions - Federal Interdepartmental Committee on Pesticides ©
16	Viewed	RG2 , Privy Council Office , Series A-5-a , Volume 6338 , Access code: 32	Confirmation of Cabinet Committee decisions - Membership - Federal Interdepartmental Committee on Pesticides
17	Viewed	RG2 , Privy Council Office , Series A-5-a , Volume 6395 , Access code: 32	Membership of the Federal Interdepartmental Committee on Pesticides
18	Pending	RG24 , National Defence , Accession 1983-84/232 , Box 234 File : 3136-5-3154 , Access code: 32	Defence Programming - Defence Services Program - Program Change Proposal - Ranges-Brush Clearance - CFB Gagetown
19	Pending	RG24 , National Defence , Accession 1983-84/167 , Box 5711 File : 5365-G2/2 , Access code: 32 Parts: 4	"Ranges & Training Areas - Military Camp - Gagetown, NB"
20	Pending	RG24 , National Defence , Accession 1983-84/167 , Box 5746 File : 5432-G2/2 , Access code: 32	"Weed & Brush Control - Camp Gagetown, NB"

Number of References Requested	Status	Reference	File Title
21	Viewed	RG24 , National Defence , Accession 1983-84/167 , Box 5750 File : 5445-G2/2 , Access code: 32 Parts: 13	"Streets & Roads - Training Area - Gagetown, NB"
22	Viewed	RG24 , National Defence , Accession 1983-84/167 , Box 5651 File : 5205-G2/2 , Access code: 32 Parts: 10	"Fires - Army Training Area - Gagetown, NB"
23	Viewed	RG24 , National Defence , Accession 1983-84/167 , Box 5656 File : 5220-G2/2 , Access code: 32 Parts: 3	"Forestry Mangement Army Training Area - Military Camp - Gagetown, NB"
24	Pending	RG24 , National Defence , Accession 1983-84/167 , Box 5746 File : 5432-1 , Access code: 32 Parts: 3	Weed & Brush Control

APPENDIX E

CD Information of Historical Application Records from 1956 to 2004
Provided by DND

APPENDIX F

Peer Review Panel Comments and Response

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
4.	REVIEW	
1. Is the selected team of specialists that contributed and produced the report and database appropriate?	In addition to the JW report itself the peer reviewers were provided with a file detailing the professional qualifications of the multidisciplinary team assembled by JW for the task of assessing the history and science of herbicide use at Gagetown. The expertise included biologists and risk assessment specialists, engineers and database managers. The team assembled by JW were relatively junior in terms of the breadth and depth of their collective experience, especially in matters directly relevant to pesticide application, pesticide science, pesticide regulation and potential human and environmental adverse effects that might have resulted from the herbicide spray programs at CFB Gagetown; to the extent that their participation in the current Task was used to embellish the resumes of several team members, the Consultant team should not be considered as "Expert Witnesses" in these topics.	**Disagree** We take exception to the suggestion by the ad hoc review panel that CVs of several team members were "embellished". This is quite a strong accusation and the implication is that Jacques Whitford falsified CVs in order to be successful in our bid for this Government contract. The claim by the panel is not supported or substantiated by any description or reference. Jacques Whitford did include the ongoing project work for Task 2B at CFB Gagetown on all team members CVs, as each had actively participated in the initial historical review, were familiar with the material, and each were experienced with the herbicides used specifically at CFB Gagetown. There were indeed several junior members on the project team, however, the Project Manager Dr. Christopher Ollson has 10 years of experience managing complex environmental projects (including those related to pesticides), the Technical Authority Dr. Loren Knopper has a PhD in pesticide environmental toxicology, has completed a Post-doc with Dr. Pierre Mineau of the Canada Wildlife Service in pesticide ecotoxicology and is currently completing a second Post-doc with Jacques Whitford in biomarkers related to pesticide exposure. He has also published numerous peer review articles in this field. Senior Database Manager David Wilson has 16 years of professional experience, including 6 years in data management. It is these three individuals that would be called upon as Expert Witnesses, for their respective roles on the project. It should also be noted that one of the members of the peer review panel, Chrisopher Riley of RPC had contacted Jacques Whitford during the proposal phase to become part of Jacques Whitford's bid team. Unfortunately, as he did not have the appropriate, required security clearance mandated by DND he was ineligible to be part of the bid. This was the case for several other professionals Jacques Whitford approached who had 20 plus years of experience with pesticides. The RFP limits CVs to 1 page maximum. Full length CVs which would convey depth and experience of each team member could have been provided upon request.

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
	The peer reviewers have noted that while much of the scientific uncertainty that characterizes the report is a function of inadequate records related to the spray programs at the RTA, it is probable that a more experienced team might have been able to identify more reliable sources of information that may have strengthened the observations and conclusions in the report. Whilst the Peer Reviewers have been asked to present their opinions on this issue, the team provided by the consultant was approved through the contracts process of DND and as such any weaknesses in the knowledge, skills and experience of the consultant's team should have been addressed before the contract was awarded.	**Disagree** Jacques Whitford disagrees with this statement, and believes that a more "experienced team" would have been constrained by the same limitations encountered by Jacques Whitford, namely the level of detail in the yearly spray records for the base, which date back over 50 years. **Disagree** As with the statements made above, this comment veers considerably from scientific objectivity and impartiality that generally accompanies review processes. Jacques Whitford was awarded the contract based on merit of our technical proposal, the personnel proposed to work on the project, in an open competitive bid process.
2. Is the material in the report and database presented in a clear, logical and concise manner? Is the report and database comprehensive? Please explain fully	The interim review report spans the period between 1956 and the present (which in practical terms was taken to be approximately 2004). Three sources of data were available to the Consultant for assessment: (1) DND records and National Archives material; (2) consultation with individuals that were directly involved with the spray applications or their management; and (3) the primary scientific literature. The inclusion of material from DND records appears to be relatively complete. Data from the National Archives was requested by the Consultant but did not become available in the allotted time and is still pending. As to consultation, there appear to be only three individuals who were consulted during the process of the review (listed on pages 3 and 4 of the report). There is no indication whether the Consultant was provided with additional names for consultation, or developed additional contacts in the academic, NGO, public or private sectors as part of the process. There is no evidence that the Consultant undertook a comprehensive search of the scientific literature related to the types of herbicide applications carried out on the RTA, or potential adverse health or environmental effects that might have been relevant to the nature of the herbicide spray program (see section 9 below for further commentary).	**Agree** Jacques Whitford believes that interviews with people in the academic, NGO, and public or private sectors would have potentially strengthen some of the background information on historical context of pesticide use throughout Canada. However, such interviews would not have shed additional factual light on information to be presented in the database, which was the primary objective of Task 2A. Given the short timeframe and upset limit of the contract, Jacques Whitford felt these interview would be only of a secondary importance to the objectives of the project. **Agree** It is true that no exhaustive literature search was carried out in order to find information about "the types of herbicide applications carried out on the RTA" because the information required would not be found in the primary scientific literature. Types of herbicide applications carried out in the RTA (i.e., products, AIs, aerial and ground applications, etc.) are described in the application records and monitor's reports, for example, supplied in the yearly files given to Jacques Whitford by DND. It is also true that Jacques Whitford did not undertake a comprehensive search of the scientific literature related to "potential adverse health or environmental effects that

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
		might have been relevant to the nature of the herbicide spray program" because this was not within the Scope of Work.
	The peer reviewers were of the opinion that the Consultant interim report includes significant repetition which will make its use (in its present form) difficult and cumbersome. To illustrate, section 5 essentially repeats the information in section 1, and sections 5.3.1 and 5.3.4 essentially provide the same information. The entire report should be carefully edited in order to minimize repetition where it does not contribute to the overall thrust of the report. The peer reviewers were of the opinion that the logical sequence in which the information has been presented needs to be improved. Information presented in Section 4 should be presented as a time line describing the policy and regulation of herbicides beginning with 1952 and ending with the present. Similarly, the history of the development of pesticide application technology and other procedures described in Section 5 should be documented.	**Agree / Disagree** Jacques Whitford believes that reorganizing these sections would actually make the report more "cumbersome". However, this comment was taken into consideration during the final version of the report and some sections were reorganized.
	The reviewers noted that many references have been inadequately or incompletely cited, and could not be retrieved without considerable difficulty. These include, but are not restricted to, all of the US EPA RED citations, the Wigle and Mao (1981) citation and the 1975 WHO citation. JW should also note the spelling error, twice, in "Castrill and Vigod, 1987" on page 4.1/pg 8. The correct spelling appears in the biblio and should be "Castrilli"; and note as well that the tetrachlorodibenzodioxin is incorrectly identified as 2,3,4,7,8 on page 23 (third sentence).	**Disagree** Jacques Whitford disagrees, for the most part, with this claim. All cited US EPA RED documents are readily available online at www.epa.gov, and the 1975 WHO citation is available through the WHO, at the INCHEM web site (www.inchem.org) under the alphabetized Pesticide Documents section. Regarding the Wiggle and Mao document, it was supplied to Jacques Whitford by DND as an appendix in a report from DT Wiggle to Renee Forcier, Military Assistant to the Minister. This report could have been supplied to the Peer Review Team on request. We agree about the misspelling of Castrilli and the typo regarding the identification of tetrachlorodibenzodioxin; these have been changed accordingly in the final report. Web addresses have been added to report for each reference.
	Finally, the peer reviewers noted that in order to improve the overall utility of the report, the Consultant should prepare of a table that summarizes, on a year by year basis, the information that does, and does not exist in the database. Such a table will also serve as a checklist for the Consultant when trying to obtain missing information for each case and subsequent users of the database would be able to identify, at a glance, the "completeness" of the data without having to search record by record.	**Disagree** Appendix C in the Interim report highlights the fields in the database in which data could and could not be obtained, and a yearly summary of this can be generated in the database. Considering that the purpose of the written report is to add context to the database, the inclusion of a lengthy yearly summary of available fields would add very little worth.

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
3. Are the stated goals realistic? Do the report and database adequately meet the stated objectives?	The objective of the review conducted by the Consultant was to create a database of herbicide use and application at the Gagetown RTA, and to supplement this with a report on the science and history of herbicide use at the RTA. DND have indicated that it is their intent to use the report prepared by the Consultant to assist other tasks in assessing possible toxicological, epidemiological and ecological impacts that may have been associated with the use of herbicides at the RTA. There are two major impediments to meeting these objectives. These include the very limited time allocated to complete the work (of which the Consultant must have been aware and presumably accepted as a condition of the contract) to research, gather, review and report on the various aspects of the history and science of herbicide use in the RTA over a period of more than 50 years; given the quality of the report and the obvious information gaps the time provided to complete this task has clearly been inadequate. In view of the fact that the availability of records for the period of study was reported to be quite variable, and of poor quality in the early years, it seems that it may have been possible to strengthen the data base if a more realistic, and practical, timeframe had been available to complete this important piece of work. In this context potentially relevant data from the National Archives, as well as additional personal contacts may have contributed significantly to the strength and completeness of the report. The peer reviewers noted that the information on the "history and science, as well as factual information, on the management practices, production, sale and use of these herbicides, indicating levels of confidence, including the quantities associated with similar uses elsewhere in Canada" is synoptic as opposed to detailed. In this context, for example, the information on known contaminants an expected key aspect of the Consultant's report and of potential adverse effects — could be much improved with a more detailed literature search. The Peer Review Panel specifically notes that having accepted the Terms of Reference for completion of the project, which specifically included the timelines imposed by the contract, the Consultant cannot then "explain' inadequacies in the quality of their report on the basis of inadequate time, incomplete records or lack of information.	**Agree** **Agree** As stated in the Interim report, Jacques Whitford agrees that time and information gaps were obstacles encountered when conducting Task 2A. However, Jacques Whitford's effort in this Task was focused on review of the DND historical annual herbicide application records. We believe that the allotted timeline was sufficient to complete this objective and that information contained in the database is accurate and little if any improvement on the factual information of herbicide application in the RTA would have resulted from more time. The historical use of pesticides in Canada and sales records, application volumes, etc. could have been improved with a greater timeline, however, we do not feel that this materially impacted the overall objectives of Task 2A. **Agree** Jacques Whitford agrees that the written document was more of a summary rather than comprehensive document since its purpose was to add context to the database. A "key aspect" of the report was not to report on the potential adverse effects of known contaminants, as this was outside the Scope of Work for Task 2A. **Disagree** There is no "explanation" contained in the report about inadequate time. All timelines were met for Task 2A, and there were associated limitations with regard to some aspects of the project, however the fact that there are Incomplete records in some of the annual herbicide application files would not improve with an altered timeline.

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
4. Are the assumptions, strategies, physical and statistical tests, data sets, and scope of review, as well as methods of application appropriate?	There is no evidence that the Consultant undertook a comprehensive search of the scientific literature related to the types of herbicides (and associated contaminants) or applications carried out on the RTA. The report is therefore not a scientific review. As noted above, the two most important limitations to the quality and subsequent value of the Consultant report, for its intended purpose, are the very constrained timeline in which it had to be produced, and the quality of the data on which it relied. The latter may have been more comprehensively addressed had a more thorough search and assessment of the scientific literature been included by the Consultant (see section 9 below for additional commentary regarding the adequacy of the literature search and assessment). The impact of these limitations is evident in several places in the report. The peer reviewers noted that the Consultant created a quality assurance template to serve as a standard against which information quality could be assessed; it was also noted that the Consultant included all information that was available for its review, regardless of quality. Having said this, the Consultant noted that even after creating a quality assurance template to categorize the various reports that it included in its assessment (see Table 1), significant discrepancies and inconsistencies were still apparent, even when data considered of the highest quality were utilized (for example, see discussion in 4th bullet, section 8.1.1). This has invariably led to several assumptions which are fraught with uncertainty, and the conclusions derived thereof must be viewed very cautiously - especially so if assessments of adverse human health outcomes will depend on these assumptions. While the peer reviewers are of the opinion that it was not within the mandate of the Consultant to determine if the quality of the available data would be adequate to support a robust risk assessment (this would be the task of the risk assessor), the peer review panel did wonder if assumptions that are so fraught with uncertainty can be used with adequate confidence for the purpose of assessing potential human and ecological health impacts.	**Disagree** This comment is a repetition of previous comments. Jacques Whitford agrees that this interim report should not to be considered a scientific review. It is a summary of history and science of herbicides in Canada and used on the RTA at CFB Gagetown and information regarding application and types of herbicides used at CFB Gagetown were contained within applicator records, etc supplied by DND. As mentioned above, the scientific literature would not yield further information. **Disagree** Paraphrased from paragraph 9 of the Statement of Work, the purpose of this task was to create and populate a database with numerous application parameters, to create a lookup table with physical-chemical properties, and to write a supplemental report to the database. Table 1 in the report provides a Numeric Validation Score assigned to varying levels of confidence in data entered in databse. This is so that end users on subsequent tasks will be fully aware of the degree of confidence in the data provided for each record in the database. In addition, each data point is supported by a reference in the database. The intent is so that end user can review the reference and make a decision on the validity for subsequent tasks. The Jacques Whitford Project Manager is the Director of Risk Assessment for the company. As the peer review correctly points out that determining adequacy of the data for a subsequent risk assessment is outside the Scope of Work, however, my comment is that the database was designed so that risk assessors can make their own decisions on adequacy of the data. That being said, I the database is not “fraught with uncertainty”, each data point has an assigned score that can be reviewed in subsequent tasks.

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
5. Is the overall approach to the planning, data acquisition, data assessment, and data interpretation as described in the report and database technically acceptable?	The approach utilized by the Consultant relied on access to a very limited number of personnel, both within the DND and PMRA. As noted above, there is no information to indicate that the Consultant attempted to expand its contacts to include individuals that were directly involved with the spray programs or their management and may have been able to strengthen the quality of the overall data being collected. It is also likely that much of the information that was supplied to the Consultant by various current contacts has limited applicability to the assessment of herbicide application that may have occurred almost 50 years ago. The Consultant report does not indicate that a comprehensive search of the scientific literature was undertaken to address any of the uncertainty and deficiency in the data base. The peer review panel is aware that the Consultant attempted to obtain further records from the National Archives, but the information could not be retrieved within the time available to the Consultant for preparation of its report. The uncertainties inherent in various aspects of the report and the lack of detailed information will, limit the ultimate value of the Consultant report.	**Disagree** This comment is a repetition of previous comments made by the review panel and it has been address in the comments above. Interviews with staff involved in application over 50 years ago may have increased the antidotal information in the report but would not have been placed as factual, documented information within the database. It should be noted that CFB Gagetown has undertaken an independent task where former military staff or civilians were asked to come to the base and show where they believe barrels were disposed of. There has yet to be a barrel uncovered in any of the areas proposed. Information held by the National Archives contains no information on spray records at CFB Gagetown. It would be useful for historical context of the report only. Therefore, we disagree that the report's value has been ultimately limited.
6. Does the work conducted yield scientifically credible conclusions?	At the risk of repeating some previous comments, the report includes a number of areas of significant uncertainty. The real question here is whether or not the data sets on the use of herbicides at CFB Gagetown are sufficiently detailed, comprehensive and reliable to allow meaningful environmental and human health risk assessment. The peer review panel is of the view that there are too many gaps in the information and/or a lack of detailed information in the interim report to lead to credible conclusions. Taken together, the limitations noted above result in conclusions that are fraught with uncertainty. It is important to note that the Consultant was very much aware of the limitations of the data on which they relied, and these limitations and their impact to the applicability of the report, are candidly described in sections 8 and 9. This uncertainty, at least in a number of instances, does raise question regarding the validity and credibility of use of the present report for its planned purpose.	**Disagree** See previous comments on validity of data in the database and the requirements of risk assessors. Jacques Whitford wishes to emphasize that the information contained in the database is taken from the only available application records and documents in existence for CFB Gagetown. There is uncertainty in some of the data, as indicated by the numeric validity score, however, there is a tremendous amount of value that can be derived from proper use of the database by qualified professionals. The citing of uncertainties and limitations provides a factual account for users of the database. This is the professional way to present such information, to not have done so would have given user of the database false comfort and reliability. Inclusion of limitations and uncertainties in no way invalidates the usefulness of the database.

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
7. In your opinion, what are the weakest and the strongest aspects of the report and database to address the history and science of herbicide use at CFB Gagetown? Please make suggestions on how the weakest parts can be strengthened.	The weakest aspect of the report is the quality of data, especially so for the earliest period included in the present assessment. This quality of the data results in a number of assumptions for which the validity is questionable and may also limit the ultimate utility of the report for its intended purpose. The use of a "quality assurance" template by the Consultant to assess the quality and reliability of the various data included in their report is an obvious strength. The weakness of the data will be difficult to strengthen in that it is likely that these are simply the best available data. Having said this, it is possible that more reliable data (testimony) may be obtainable from a wider range of contacts with persons that were actually involved with the management and realization of the herbicide application programs (other than the very few already consulted by The Consultant) and that some of the data requested from the National Archives may also assist in reducing some of the uncertainty.	**No comment required** **Agree** It is true that further details regarding herbicide application may be available from those individuals who were actually involved with the spray program. However, if applicators and monitors did not note key details in their reports, there is little likelihood that they would remember the key detail at the present time, which in some instances could be five decades ago. Some, but still not all, of the requested information from the National Archives has been retrieved and reviewed (some information is still pending) and other than supplying further details about the FICP, no pertinent information about herbicide application on the RTA was available.
8. Are there any elements missing from the report and database which you think need to be included or which would strengthen the documents? Are you aware of any other significant data/studies that are relevant and should be included or referenced in these documents?	As noted above.	Other than suggesting a detailed literature search, the review panel does not suggest any documentation from the primary literature that would be useful for this task. Thus, their comment "As noted above" regarding this question by the client is not overly insightful regarding the final report.

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
9. Are you aware of any other significant data/studies that are relevant and should be included or referenced in these documents? Please explain fully	The US government has had a similar interest to that being expressed by the Government of Canada in the present Gagetown review. While the US government studies have been motivated by concerns of adverse effects in US veterans who may have been exposed to various herbicides utilized by the US military in several combat operations, the chemicals involved may be similar, and in some instances identical, to those that are being considered in the present context. The US National Academy of Science, Institute of Medicine, has undertaken several reviews of US veterans and Agent Orange, the most recent of which was issued by the Academy as a 2004 update (http://fermat.nap.edu/catalog/l 1242.html). The update, the sixth in the series, is some 650 pages in length and a very comprehensive synopsis of published information on all aspects of the herbicides in question. The update provides a comprehensive overview of the literature on herbicides, including at least some of the formulations discussed in the Jacques Whitford report. The update could be particularly useful for strengthening the section on manufacturing impurities in herbicides, particularly from a historical perspective. The Consultant does not seem to have been aware of the Academy review of this topic, and the work of the Academy should be considered when the report is being finalized.	**Disagree** Jacques Whitford was aware of the book written by the US National Academy of Science, Institute of Medicine, regarding US veterans and Agent Orange. The purpose of this book was to "review recently published scientific evidence regarding associations between health outcomes and exposure to TCDD and other chemical compounds in herbicides used in Vietnam" and its chapters deal with, for example, toxicology (Chapter 3), epidemiology (Chapter 4) and cancer (Chapter 6), all topics outside the Scope of Work for this Task. Furthermore, the book focuses on "…mixtures of 2,4-dichlorophenoxyacetic acid (2,4-D), 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), picloram, and cacodylic acid… 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)" (Chapter 2, pages 21-22). this document is some 650 pages in length and is a very comprehensive synopsis of published information regarding the above mentioned chemicals, but it is not a very comprehensive synopsis of published information on all aspects of the herbicides in question from CFB Gagetown. Therefore, during preparation of this Task Jacques Whitford determined that this book, although potential useful in other tasks involving heath related aspects, provided no useful information for this Task.
4. ASSESSMENT	The ad hoc review panel has concluded the draft JW report will require major revision, including considerably more follow-up with individuals and more complete information if it is to be considered acceptable.	All of the aforementioned comments were taken into consideration by Jacques Whitford in the preparation of the final report. We note that the Peer Review had no comment regarding the look-up table or specific comments on the database.
5.	GENERAL COMMENTS AND RECOMMENDATIONS	
Content	1. The consultant report needs to be strengthened for the period 1952 to 1990 if it is to provide the information that has been requested by, and will be useful to, the client in order to calculate a science-based estimate of exposure and to conduct meaningful health and environmental risk assessments.	**Disagree** All information available for this time period can be found in the database. Only information on historical best practices could be included. Again this is a repletion from above, the database is very useful for subsequent tasks, and will be aided by the numerical validity score.

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
	2. The logical sequence in which the information has been presented needs to be improved.	**Disagree** See Jacques Whitford comments above.
	3. Describe and document how the system of pesticide regulation has developed over the period of interest; giving details of the changes/improvements from 1952 to the early 90's. When describing the roles of the different organisations it would be useful to present the information should be presented in tabular form, in chronological order with specific details of the policies and regulations that were in place at different dates. A brief but detailed description of the different policies and regulations that were introduced with an analysis of the changes that were implemented, why they were implemented, and how pesticide management was improved should be included.	**Agree** Text has been added to this section in the report.
	4. The history of the development of pesticide application technology and other procedures should be documented in chronological order.	**Agree** Text has been added to this section in the report.
	5. The section on manufacturing impurities is weak and inaccurate in so far as other contaminants are known. Seek more published information and conduct interviews with synthetic chemists, pesticide chemists and toxicologists held in order to circumvent the limitations of "proprietary information". Provide documentation for all interviews.	**Disagree** Jacques Whitford is somewhat confused by this comment, as proprietary information can not be circumvented by law. As the presence of some manufacturing impurities in products is protected by proprietary law, a separate look-up table containing information on the proprietary contaminants has been provided to DND, however, this table is not available for public reviewing. In addition, Jacques Whitford requested that the PMRA send a list of known contaminants in the AIs used at CFB Gagetown and this data has been incorporated into the text and database.
	6. The Consultant should undertake a comprehensive search of the scientific literature for the required information on the science on the types of herbicide applications carried out on the Base.	**Disagree** See Jacques Whitford comments above.

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
	7. Provide more information to document the storage, handling and disposal of herbicides on the base.	Unfortunately, there is no more information available in the yearly application records supplied by DND (e.g., base records, monitor reports, applicator notes), the archive documents, or records held at NDHQ in relation to storage, handling and disposal.
	8. In order to fill obvious gaps in the report a major effort should be put into contacting and interviewing all older employees, former employees or retired employees that were directly responsible for, and involved with, the management and execution of the herbicide programs. A comprehensive list of individuals with first-hand experience of previous Gagetown spray programs and the products used should be developed and interviews held (and documented). The interviews should be documented, ideally with a standard format, and the content signed off by the interviewee and interviewer. Good documentation is essential because those interviewed may be required to give testimony at a later date. The following contacts are suggested: Pesticide applicators/contractors, Pilots, Monitors, Chemists, Pesticide manufacturers and their technical representatives (e.g DowElanco), Pesticide toxicologists, Pesticide application specialists, Vegetation management specialists, Research scientists, Regulatory personnel at the federal and provincial level, The Canadian Forest Service.	**Agree** Jacques Whitford agrees that these individuals may be able to provide some additional information. However, this effort would require substantial time and budgetary investment by the client.
	9. Describe the individual inconsistencies in the information that was obtained.	**Agree** Jacques Whitford agrees and has added some examples in the final report
	10. Incorporate information from other published sources as suggested	**Agree** See Jacques Whitford comments above.
	11. Rewrite the report, update the Appendices and Tables to take account of the findings from the extensive personal interviews and literature search that have been suggested.	**Disagree** Modifications have been made to the report. However, it was never within the scope of work to conduct the additional interviews as suggested. This is something DND may wish to consider in the future as part of the health or epidemiology tasks.
	12. The report should be carefully edited in order to minimize repetition where it does not contribute to the overall thrust of the report	**Agree/Disagree** Edits to the report have been made throughout, including additional text.

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
	13. Justify, and explain with references, the use of the words "apparently" and "appears that".	**Disagree** "Apparently" and "appears that" were used in the report when it is suggested that something was done, but there was no evidence to support the claim. For example, on page 29 it is written "Apparently the contractor cleaned up the spill". There is no corroborating evidence that this took place so the word "apparently" was used to qualify the statement. Also on page 29 it is stated that and "..it appears that an unregistered product was applied on the RTA". Again, there is no further line of evidence to corroborate this statement so it simply seems that this happened. Jacques Whitford does not feel that the use of "apparently" and "appears that" need clarification as they were used in accordance with their English language definitions.
	14. Clarify and define the practices that are referred to in the statement "The information and conclusions contained in this report are based upon work undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices...	This statement indicates that all Jacques Whitford staff involved in this task were trained professionals and the information and conclusions from the report are based on educated training.
References & record keeping	15. All factual information must be referenced thoroughly and should be given in the accepted format with the level of detail that is required for scientific publications.	**Agree** The use of references in this report follows the format of previously submitted, reviewed, and finalized reports conducted for the client in the past. However, if it seems unclear in the report where the source of information comes from, Jacques Whitford will add the required reference.
	16. The information given in (all) Tables should be accompanied by numbered references	**Disagree** Data presented from tables 1-3 comes from close to 450 different sources. Each piece of information is referenced In the database, so interested parties should refer to that as the source of cited documentation. Jacques Whitford does not believe that tables 4-6, 8 and 9 need further references as it is clear from the text where data was obtained. The information in Table 10 requires no referencing. Jacques Whitford agrees that Table 7 requires a citation as it is not explicitly clear where the information was obtained.
	17. Document the measures that were taken in order to identify the required information i.e. provide detailed information on all the organisations and individuals that were contacted in an attempt to find the information. Specify the various federal departments that sent individuals to attend the meetings of the FICP, PMAC etc. Who were	**Agree** Information about departmental attendance at the FICP has been obtained from records made available from the National Archives after the submission of the interim report and this will be incorporated into the final report. As this information was made available after the

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
	the individuals and how many former members were contacted in order to try to obtain copies of documents and minutes from important meetings? Who was responsible for record keeping? Were they contacted? Document all personal contacts and interviews that were carried out with present and former employees.	submission of the report, no individuals were contacted. Again it should be noted that this requirement of the report is very minor in overall context of database, lookup tables and report.
Database	18. The consultant should provide a table in the report that summarizes, on a year by year basis, the information that does, and does not exist in the database.	**Disagree** As mentioned above, Appendix C essentially does this, as it outlines the fields where data could and could not be found for the database. Readers interested in knowing exactly what information is available on a yearly basis should see the database.
	19. Update the database on the basis of information from personal interviews	**Disagree** Please see comments above. It is troubling to note that the peer review team only has two minor comments about the database, and has focused most of its attention on the written report (but not the attached look-up table).
6.0	SPECIFIC COMMENTS AND RECOMMENDATIONS	
Page 1 - 2	and each herbicide is a mixture of AI's,... this statement is ambiguous. The following is suggested . . .and individual herbicide formulation may contain one or more AI's	**Agree** The sentence has been changed in the final report to reflect this comment.
	For consistency the term "principal ingredient" should be replaced with the term "active ingredient"	**Agree** Has been changed in the final report.
	I am not aware of any adjuvants that 'modify the action" of the active ingredient. They may improve the effectiveness of the active ingredient by modifying the characteristics of the formulation. The statement as currently written implies a lack of knowledge and understanding by the consultant.	**Agree** Jacques Whitford agrees that adjuvants improve the effectiveness of the active ingredient by modifying the characteristics of the formulation, not the actual AI. However, this very minor typo should not be used to suggest that the consultant lacks the knowledge and understanding required for the task; it was simply an oversight in the editing process.
Page 3.	The information that is available on the PMRA website may present information only for current formulations. If possible, the consultant should verify that the formulations have not changed. This information should be available through direct contact with the PMRA or pesticide manufacturers. If specific formulations have been modified over time	**Disagree** Information of the PMRA label site is broken up by current and historical registration. Each entry is accompanied by dates of registration that were scrutinized by the Jacques Whitford team to ensure proper formulations were given for products.

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
	then the appropriate data must be presented.	
Page 4, Table 1.	But it is often unclear whether or not the product the permit was given for was actually used. The author should contact regulatory personnel and present factual information on when inspections were carried out by regulatory personnel and whether, or not, the contractor was found to be complying with the conditions of the Permit. The term often should be quantified. The availability of inspection reports should be listed.	**Disagree** This is the case for records dating back to the 1950 to 1970s. It would not be possible to contact these people and ask they to recall specific instances of herbicide application over 30 years ago.
	Trace and contact the authors of the 1981 memorandum document (7600-2(CE)); the Yearly Summary Table (1956-1968); the 1996 Pesticide Report Summary; the Comparison between Second Growth control Summaries (1970-1975) through contacts with retired employees in order to verify the sources of the information present. Contact and interview pesticide applicators in order to confirm use of DND specifications.	**Disagree** It is outside of the Scope of Work for Jacques Whitford to trace and contact the authors of reports that were supplied to us by the client.
Page 7	What snapshot in time is represented by the information in Figure 1? How does the information presented differ from year to year throughout the period?	Figure 1 is an overview of the process and incorporated all years. Details about year to year (decade to decade) changes are described in the text. Jacques Whitford will make this explicitly clear in the text leading up to Figure 1 in the final report.
Page 8	It might be useful to include copies of Federal and Provincial pesticide legislation in appendices.	**Disagree** These documents are readily available on line and in some cases are a hundred pages long.
	The Reference to the book of Rachel Carson is not necessary.	**Disagree** The sentence containing the mention of the book by Rachel Carson was taken from its accompanying reference, so if the original author felt it was required, Jacques Whitford does not believe that it should be paraphrased.
Page 9.	When a statement is made such as “very little information was found or made accessible to. ..“ then the consultant needs to document the measures that were taken in order to identify the required information i.e. provide detailed information on all the organizations and individuals	**Agree** As mentioned above, since the time of the writing of the interim report, more information was made accessible from the National Archives and this will be incorporated into the final report.

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
	that were contacted in an attempt to find the information.	
Page 11	What existed before the CF Pest Control Manual? What were the dates of the three previous editions? Describe in detail the content for herbicide applications. .how did the information improve/differ from one edition to the other? Provide references.	This information was not obtained at the time of completion of final report.
	Provide FULL references for the Brush Control Guide Specifications (and all sources of information). The specific details of the information provided in the specifications should be given with as much relevant detail as possible. The report was commissioned so that detailed information would be at the fingertips of DND. . . if the client has to go back to the original documents to get detailed information then the review is of limited value.	**Disagree** This report was meant as a summary of thousands of pages of annual spray records, legislation, scientific articles, etc.. In no way would it be possible to include all details from all sources in this review. In many instances, if not all, DND or any end user of this document should refer to the primary source of literature if a full understanding is required.
	I believe the five year IVM plan was prepared by Jim Jotcham out of Nova Scotia (company name Marbicon?). This project was done "in association with" DowElanco (Timothy McKay was the technical sales representative at the time). Jim is involved with field trials of pesticide products and Quality Management he should therefore have excellent data records possibly even dating back to the early 1990's.	**Agree** Through conversations with Sheldon Downe Atlantic Region Environment Officer, the five year Integrated Vegetation Management plan covers only base facilities and specifically not the RTA. Therefore, it is not relevant to Task 2A. As detailed in the report the base is working on a IVMP for the RTA, to be completed this fall.
	What interviews were conducted to follow up on the IVM plan that was described in the "minute sheet" (please reference. from, to, date, etc) this needs to be documented.	Stated in final report text
Page 12	Details of the IPM plan for 2003- 2008 need to be provided — although with considerable less detail than for the earlier, more relevant, period of interest. A reference for the discussions prior to herbicide applications needs to be given.	**Disagree** Again IPM plan for 2003-2008 provides little to any direct detail or relevance to the overall context of Task 2A. This plan is current practice and standard by which DND is conducting itself and is not within the scope of the assessment to comment on current management practices being employed by DND.

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
Page 13	Provide complete references for the documents confirming the herbicide programs that were carried out.	**Disagree** Jacques Whitford obtained over 450 references when populating the database with information relating to herbicide application at CFB Gagetown, and all of these references are in the database. It would be redundant to cite these in the report. CDs with all references are included in final report.
Page 15	Suggested change to wording... AI's and manufacturing impurities of herbicide formulations applied at.... The term".. .were regulated by the policies and science of the day... "is used. The details of the policies and science need to be presented in the report in comprehensive detail and in chronological order. The current report is weak in this regard, for example: a reader of the report could not easily identify the policies and science of herbicide application in 1958.. .and how this differed from say, 1964. This needs to be addressed. The following statement could be very damaging to the client. . .It is possible that other products were applied, but there was no way to confirm their use .... If this statement cannot be supported by facts it should be removed. What is the referenced source of information that is the basis for the statement? AI's alone were applied.. .please clarify whether this means that unformulated active ingredients were applied or that formulations with only one active ingredient were applied. The section on manufacturing impurities is weak. The peer reviewer was able to find several Internet sites where information, references and follow-up contacts were available. Were interviews with synthetic chemists, pesticide chemists and toxicologists held in order to circumvent the limitations of "proprietary information"? If not why not? Please provide documentation for all interviews. The PAN UK website had information for the impurities of diuron, an	**Agree** Where applicable, "herbicide formulations" will be added in the final report. **Agree** Text has been modified in the report. However, it should be noted that this was a motherhood statement and is correct. **Agree** This statement is based on the comparison of DND Specifications and applicator and monitor reports. In some years, specs and reports are given, and it is apparent that herbicides suggested in the specs were not actually used by the applicator. For example, a spec may suggest 5 possible products for use, but only 3 were actually used. In some years only a spec was found so there is no way to know if all or none of the suggest products were used. Jacques Whitford will make it explicitly clear in the final report the reason for the statement and will reword it to be clear. Yes, in some cases (e.g. 1967 USDoA test plot) only the AI was applied. Formulated products and AIs applied are outlined in the tables. **Agree** The reference by Ambrus et al. is especially useful, and Jacques Whitford was able to identify manufacturing impurities from three AIs (parquat, diquat and diuron) that were not identified by PMRA. These have been added into the database, look-up tables and report.

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
	EEC Review Report for paraquat mentioned contaminants for diquat, an EPA Reregistration Eligibility Decision provided information on the impurities of bromacil, an IUPAC Technical Report provides extensive information on many products including several of those used at Gagetown and for which the consultant found no information [Ambrus el al. (2003): SIGNIFICANCE OF IMPURITIES IN THE SAFETY EVALUATION OF CROP PROTECTION PRODUCTS (IUPAC Technical Report); Pure Appi. Chem., Vol. 75, No. 7, pp. 937—973] It is suggested that the consultant follow up on the leads provided by these sources in order to update the information fields that is given in the various tables and look-up tables and rewrite the section. I would suggest “pilcoram was a source of hexachlorobenzene”. .rather than “the” source. Are products that were used 10, 20 or more years ago still protected by proprietary law? Contact with (retired or current) representatives of the pesticide industry, pesticide toxicologists, researchers and government analytical laboratories should result in the identification of the unidentified active ingredients of products in Table 2. If the search for information is still unsuccessful the report should list the contacts from which information was sought.	**Agree** Text will be updated in final report. Products are protected by proprietary law for up to 15 years. This was not possible due to time and budgetary constraints. Would not materially impact report.
Page 17	The introduction to Table 3 gives the impression that a mixture of unformulated active ingredients were applied rather than a mixture of formulated products with different active ingredients. Is this correct?	Yes it is. In some case only AI were applied.
Page 18.	More details of the applications for the 1966-67 test plots should be given in the report (areas treated, application technology, contact details for the (former) employees that were responsible for these trials etc.) Document all personal contacts and interviews.	**Disagree** Again the primary references for these years should be refered to for these details. It was not possible to contact those suggested and given that the reports contained quite a lot of detail it may not be required. Regardless this would fall under the Scope of Work of another Task related to health.
Page 21.	Provide references for where the mixes were described. Were active ingredients really applied by themselves? Without any diluent or carrier?	The references are cited in the text before the tables. Yes, AIs were really applied by themselves. When dilutents or carriers are known, it is given in the database.

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
Page 22	Provide references for when the different carriers were used. The explanation for the use of thickeners is incorrect. No thickener was ever added to make droplets fall faster! The rate of fall is determined by the mass of the droplet, air viscosity and turbulence within the mass of air in which the droplet is falling.	**Disagree** References for the carriers used are found in the database. The description of thickeners was obtained from an OMAFRA document. Jacques Whitford should have referenced this and it will now be included in the final report. This appears to be a matter of semantics.
Page 23	Are there any more references for dioxin levels in 2,4,5-T? The report should document the individuals that were contacted in the search for more information for the period 1965 to 1970 inclusive? The pesticide industry should be able to provide this type of detailed historical information.	Presumably yes, in fact the Ambrus et al. reference suggested by the review panel does. Please see above.
Page 24	I believe that Provincial records of pesticide sales in New Brunswick date back much further than 2003. Has this been verified and documented?	As mentioned in the report, information regarding provincial use records were obtained from a recently published document from Environment Canada. It was thought to be the most up-to-date and comprehensive document on provincial and federal herbicide use. An attempt was made to gather further information from New Brunswick but at the time of the final report this information was not available.
Table 9	What is the year for the data presented in column 2?	As mentioned in the text describing the table, data presented in column 2 is not based on a particular year, but rather from a number of different years between 1990 and early 2000.
Page 25	The section on Planning and Contracting Procedures should be documented in chronological order and describe the procedures in effect for the entire period of interest. There are no references provided for the factual information on which the two examples have been prepared. The years for which pesticide operator's licenses and application permits were obtained from the provincial government should be summarized in a table. Give specific details (identify) "all involved parties" Monitors should be contacted in order to improve the amount of available information.	**Agree** In the final report planning and contracting procedures from the 1960s will precede that of the 1990s. References are in the database. They were obtained for all years as is required by law and discussed in the report. --- This would not provide any additional useful information as monitors have only recently been contracted and there reports are available on the CD.
Page 27	Full references and a summary of the findings for the Environmental	**Agree** This has been added to the final report.

REVIEW CRITERIA	PEER REVIEW COMMENT	JACQUES WHITFORD RESPONSE
	Assessments should be included in the report. More information to document the storage, handling and disposal of herbicides on the base should be sought from those that were directly involved with the management and supervision of the operations. Interviews should be documented and factual data fully referenced.	Please see above
Page 28	The acronym U.A.P. stands for United Agri Products (this should have been obvious to a team of consultants expert in pesticides and pesticide management). Please give more details to identify "the Pesticide Unit" What was the response of the monitor regarding the label of the product that was not registered for use in Canada. What do the purchase and sales records indicate? Pages 28 and 29 are lacking references for most of the factual statements that are made.	Our sentence was misunderstood. When it was written that the acronym was not defined, Jacques Whitford meant that it was not defined in the actual monitor's report. Regardless, we thank the reviewers for pointing this out, but again, take exception to the unscientific way in which the comment was presented. As mentioned above, NDHQ is looking into this claim and Jacques Whitford has not been made aware of the outcome. As mentioned above, references are provided in the database.
Page 29	The National Institute of Health pertains to which nation? Specify. Appendix B will need to be updated with the chemical structures of the contaminants that will be identified.	NIH is a US institution. Yes, Appendix B was updated.
Page 37.	The consultant should continue to gather information in order to prepare a comprehensive report that addresses the clients needs. It should not be the responsibility of others to provide additional information so that the conclusions can be reassessed by the consultant.	This is a legal statement prepared as a standard clause in our closure section. It does not specifically pertain to this report only. This is standard practice in the consulting industry.

The History and Science of Herbicide Use at CFB Gagetown from 1952 to Present

Task 2A

Department of National Defence

Review of the Interim Report Prepared by Jacques Whitford

Jacques Whitford Project No. 1009662

Consolidated Report of the Peer Review Panel for Task 2A

Leonard Ritter, Chair of the Ad Hoc Review Panel
D. George Dixon
Christopher M. Riley

May 3, 2006

1. INTRODUCTION

The Government of Canada has committed to identifying and reporting on facts surrounding the experimental use of Agent Orange and Agent Purple and other herbicides during the specific test periods in June 1966 and June 1967. The Government of Canada has also committed to identifying and reporting on facts surrounding the use of herbicides and any herbicide-related contaminants, particularly dioxins, sprayed at CFB Gagetown during the 8 to 12 weeks per year when spraying occurred each summer from 1952 to present day.

2. OBJECTIVE

The objective of the peer review of the Jacques Whitford's interim report on *The History and Science of Herbicide Use at CFB Gagetown from 1952 to Present: Task 2A* and database (History and Science) is to assess the adequacy of Jacques Whitford (the Consultant) in providing information on the types of herbicides that were used and how they were used on the CFB Gagetown ranges and training areas, including management practices; the production, sale, and use of these herbicides; and information on similar uses elsewhere in Canada.

It is important to note that the peer reviewers for Task 2A were not provided with any of the core data or information which formed the basis of the JW assessment and conclusions. The consolidated peer review of the JW report that follows is therefore based entirely on the JW assessment of any information and /or data that was included in preparation of its report.

The present peer review report represents the consolidated consensus opinion of the peer reviewers for Task 2A.

3. REVIEW CRITERIA

Peer reviewers were provided with the Terms of Reference for the peer review of the History and Science report and database and a copy of the Statement of Work for the Task.

The ad hoc peer review panel was asked to provide an overall assessment including comments on the History and Science report and database. The overall assessment is presented as one of the following:

Acceptable as is;
Acceptable with minor revision (as indicated);
Acceptable with major revision (as outlined); or
Not acceptable under any circumstance (as outlined).

In addition, peer reviewers were asked to structure their reviews in a manner that would address the following criteria:

Is the selected team of specialists that contributed and produced the report and database appropriate?

Is the material in the report and database presented in a clear, logical and concise manner? Is the report and database comprehensive? Please explain fully.

Are the stated goals realistic? Do the report and database adequately meet the stated objectives? Please explain fully

Are the assumptions, strategies, physical and statistical tests, data sets, and scope of review, as well as methods of application appropriate? Please explain fully.

Is the overall approach to the planning, data acquisition, data assessment, and data interpretation as described in the report and database technically acceptable? Please explain fully.

Does the work conducted yield scientifically credible conclusions?

In your opinion, what are the weakest and the strongest aspects of the report and database to address the history and science of herbicide use at CFB Gagetown? Please make suggestions on how the weakest parts can be strengthened.

Are there any elements missing from the report and database which you think need to be included or which would strengthen the documents? Please explain fully

Are you aware of any other significant data/studies that are relevant and should be included or referenced in these documents? Please explain fully

4. REVIEW

1. Is the selected team of specialists that contributed and produced the report and database appropriate?

In addition to the JW report itself, the peer reviewers were provided with a file detailing the professional qualifications of the multidisciplinary team assembled by JW for the task of assessing the history and science of herbicide use at Gagetown. The expertise included biologists and risk assessment specialists, engineers and database managers. The team assembled by JW were relatively junior in terms of the breadth and depth of their collective experience, especially in matters directly relevant to pesticide application, pesticide science, pesticide regulation and potential human and environmental adverse effects that might have resulted from the herbicide spray programs at CFB Gagetown; to the extent that their participation in the current Task was used to embellish the resumes of several team members, the Consultant team should not be considered as "Expert Witnesses" in these topics.

The peer reviewers have noted that while much of the scientific uncertainty that characterizes the report is a function of inadequate records related to the spray programs at the RTA, it is probable that a more experienced team might have been able to identify more reliable sources of information that may have strengthened the observations and conclusions in the report.

Whilst the Peer Reviewers have been asked to present their opinions on this issue, the team provided by the consultant was approved through the contracts process of DND and as such any weaknesses in the knowledge, skills and experience of the consultant's team should have been addressed before the contract was awarded.

2. Is the material in the report and database presented in a clear, logical and concise manner? Is the report and database comprehensive? Please explain fully

The interim review report spans the period between 1956 and the present (which in practical terms was taken to be approximately 2004). Three sources of data were available to the Consultant for assessment: (1) DND records and National Archives material; (2) consultation with individuals that were directly involved with the spray applications or their management; and (3) the primary scientific literature. The inclusion of material from DND records appears to be relatively complete. Data from the National Archives was requested by the Consultant but did not become available in the allotted time and is still pending. As to consultation, there appear to be only three individuals who were consulted during the process of the review (listed on pages 3 and 4 of the report). There is no indication whether the Consultant was provided with additional names for consultation, or developed additional contacts in the academic, NGO, public or private sectors as part of the process. There is no evidence that the Consultant undertook a comprehensive search of the scientific literature related to the types of herbicide applications carried out on the RTA, or

potential adverse health or environmental effects that might have been relevant to the nature of the herbicide spray program (see section 9 below for further commentary).

The peer reviewers were of the opinion that the Consultant interim report includes significant repetition which will make its use (in its present form) difficult and cumbersome. To illustrate, section 5 essentially repeats the information in section 1, and sections 5.3.1 and 5.3.4 essentially provide the same information. The entire report should be carefully edited in order to minimize repetition where it does not contribute to the overall thrust of the report. The peer reviewers were of the opinion that the logical sequence in which the information has been presented needs to be improved. Information presented in Section 4 should be presented as a time line describing the policy and regulation of herbicides beginning with 1952 and ending with the present. Similarly, the history of the development of pesticide application technology and other procedures described in Section 5 should be documented. The reviewers noted that many references have been inadequately or incompletely cited, and could not be retrieved without considerable difficulty. These include, but are not restricted to, all of the US EPA RED citations, the Wigle and Mao (1981) citation and the 1975 WHO citation. JW should also note the spelling error, twice, in "Castrill and Vigod, 1987" on page 4.1/pg 8. The correct spelling appears in the biblio and should be "Castrilli"; and note as well that the tetrachlorodibenzodioxin is incorrectly identified as 2,3,4,7,8 on page 23 (third sentence).

Finally, the peer reviewers noted that in order to improve the overall utility of the report, the Consultant should prepare of a table that summarizes, on a year by year basis, the information that does, and does not exist in the database. Such a table will also serve as a checklist for the Consultant when trying to obtain missing information for each case and subsequent users of the database would be able to identify, at a glance, the "completeness" of the data without having to search record by record.

3. Are the stated goals realistic? Do the report and database adequately meet the stated objectives?

The objective of the review conducted by the Consultant was to create a database of herbicide use and application at the Gagetown RTA, and to supplement this with a report on the science and history of herbicide use at the RTA. DND have indicated that it is their intent to use the report prepared by the Consultant to assist other tasks in assessing possible toxicological, epidemiological and ecological impacts that may have been associated with the use of herbicides at the RTA.

There are two major impediments to meeting these objectives. These include the very limited time allocated to complete the work (of which the Consultant must have been aware and presumably accepted as a condition of the contract) to research, gather, review and report on the various aspects of the history and science of herbicide use in the RTA over a period of more than 50 years; given the quality of the report and the obvious information gaps the time provided to complete this task has clearly been

inadequate. In view of the fact that the availability of records for the period of study was reported to be quite variable, and of poor quality in the early years, it seems that it may have been possible to strengthen the data base if a more realistic, and practical, timeframe had been available to complete this important piece of work. In this context potentially relevant data from the National Archives, as well as additional personal contacts may have contributed significantly to the strength and completeness of the report.

The peer reviewers noted that the information on the "history and science, as well as factual information, on the management practices, production, sale and use of these herbicides, indicating levels of confidence, including the quantities associated with similar uses elsewhere in Canada" is synoptic as opposed to detailed. In this context, for example, the information on known contaminants – an expected key aspect of the Consultant's report and of potential adverse effects – could be much improved with a more detailed literature search.

The Peer Review Panel specifically notes that having accepted the Terms of Reference for completion of the project, which specifically included the timelines imposed by the contract, the Consultant cannot then "explain' inadequacies in the quality of their report on the basis of inadequate time, incomplete records or lack of information.

4. Are the assumptions, strategies, physical and statistical tests, data sets, and scope of review, as well as methods of application appropriate?

There is no evidence that the Consultant undertook a comprehensive search of the scientific literature related to the types of herbicides (and associated contaminants) or applications carried out on the RTA. The report is therefore not a scientific review.

As noted above, the two most important limitations to the quality and subsequent value of the the Consultant report, for its intended purpose, are the very constrained timeline in which it had to be produced, and the quality of the data on which it relied. The latter may have been more comprehensively addressed had a more thorough search and assessment of the scientific literature been included by the Consultant (see section 9 below for additional commentary regarding the adequacy of the literature search and assessment)

The impact of these limitations is evident in several places in the report. The peer reviewers noted that the Consultant created a quality assurance template to serve as a standard against which information quality could be assessed; it was also noted that the Consultant included all information that was available for its review, regardless of quality. Having said this, the Consultant noted that even after creating a quality assurance template to categorize the various reports that it included in its assessment (see Table 1), significant discrepancies and inconsistencies were still apparent, even when data considered of the highest quality were utilized (for example, see

discussion in 4th bullet, section 8.1.1). This has invariably led to several assumptions which are fraught with uncertainty, and the conclusions derived thereof must be viewed very cautiously - especially so if assessments of adverse human health outcomes will depend on these assumptions. While the peer reviewers are of the opinion that it was not within the mandate of the Consultant to determine if the quality of the available data would be adequate to support a robust risk assessment (this would be the task of the risk assessor), the peer review panel did wonder if assumptions that are so fraught with uncertainty can be used with adequate confidence for the purpose of assessing potential human and ecological health impacts.

5. Is the overall approach to the planning, data acquisition, data assessment, and data interpretation as described in the report and database technically acceptable?

The approach utilized by the Consultant relied on access to a very limited number of personnel, both within the DND and PMRA . As noted above, there is no information to indicate that the Consultant attempted to expand its contacts to include individuals that were directly involved with the spray programs or their mangement and may have been able to strengthen the quality of the overall data being collected. It is also likely that much of the information that was supplied to the Consultant by various *current* contacts has limited applicability to the assessment of herbicide application that may have occurred almost 50 years ago. The the Consultant report does not indicate that a comprehensive search of the scientific literature was undertaken to address any of the uncertainty and deficiency in the data base. The peer review panel is aware that the Consultant attempted to obtain further records from the National Archives, but the information could not be retrieved within the time available to the Consultant for preparation of its report.

The uncertainties inherent in various aspects of the report and the lack of detailed information will, limit the ultimate value of the Consultant report.

6. Does the work conducted yield scientifically credible conclusions?

At the risk of repeating some previous comments, the report includes a number of areas of significant uncertainty. The real question here is whether or not the data sets on the use of herbicides at CFB Gagetown are sufficiently detailed, comprehensive and reliable to allow meaningful environmental and human health risk assessment. The peer review panel is of the view that there are too many gaps in the information and/or a lack of detailed information in *the interim report* to lead to credible conclusions.

Taken together, the limitations noted above result in conclusions that are fraught with uncertainty. It is important to note that the Consultant was very much aware of the limitations of the data on which they relied, and these limitations and their impact to

the applicability of the report, are candidly described in sections 8 and 9. This uncertainty, at least in a number of instances, does raise question regarding the validity and credibility of use of the present report for its planned purpose.

7. **In your opinion, what are the weakest and the strongest aspects of the report and database to address the history and science of herbicide use at CFB Gagetown? Please make suggestions on how the weakest parts can be strengthened.**

The weakest aspect of the report is the quality of data, especially so for the earliest period included in the present assessment. This quality of the data results in a number of assumptions for which the validity is questionable and may also limit the ultimate utility of the report for its intended purpose. The use of a "quality assurance" template by the Consultant to assess the quality and reliability of the various data included in their report is an obvious strength.

The weakness of the data will be difficult to strengthen in that it is likely that these are simply the best available data. Having said this, it is possible that more reliable data (testimony) may be obtainable from a wider range of contacts with persons that were actually involved with the management and realization of the herbicide application programs (other than the very few already consulted by The Consultant) and that some of the data requested from the National Archives may also assist in reducing some of the uncertainty.

8. **Are there any elements missing from the report and database which you think need to be included or which would strengthen the documents? Are you aware of any other significant data/studies that are relevant and should be included or referenced in these documents?**

As noted above.

9. **Are you aware of any other significant data/studies that are relevant and should be included or referenced in these documents? Please explain fully**

The US government has had a similar interest to that being expressed by the Government of Canada in the present Gagetown review. While the US government studies have been motivated by concerns of adverse effects in US veterans who may have been exposed to various herbicides utilized by the US military in several combat operations, the chemicals involved may be similar, and in some instances identical, to those that are being considered in the present context. The US National Academy of Science, Institute of Medicine, has undertaken several reviews of US veterans and Agent Orange, the most recent of which was issued by the Academy as a 2004 update (http://fermat.nap.edu/catalog/11242.html). The update, the sixth in the series, is some 650 pages in length and a very comprehensive synopsis of published information on all aspects of the herbicides in question. The update provides a comprehensive overview of

the literature on herbicides, including at least some of the formulations discussed in the Jacques Whitford report. The update could be particularly useful for strengthening the section on manufacturing impurities in herbicides, particularly from a historical perspective. The Consultant does not seem to have been aware of the Academy review of this topic, and the work of the Academy should be considered when the report is being finalized.

4. ASSESSMENT

The ad hoc review panel has concluded the draft JW report will require major revision, including considerably more follow-up with individuals and more complete information if it is to be considered acceptable.

5. GENERAL COMMENTS AND RECOMMENDATIONS

Content

1. The consultant report needs to be strengthened for the period 1952 to 1990 if it is to provide the information that has been requested by, and will be useful to, the client in order to calculate a science-based estimate of exposure and to conduct meaningful health and environmental risk assessments.

2. The logical sequence in which the information has been presented needs to be improved.

3. Describe and document how the system of pesticide regulation has developed over the period of interest; giving details of the changes/improvements from 1952 to the early 90's. When describing the roles of the different organisations it would be useful to present the information should be presented in tabular form, in chronological order with specific details of the policies and regulations that were in place at different dates. A brief but detailed description of the different policies and regulations that were introduced with an analysis of the changes that were implemented, why they were implemented, and how pesticide management was improved should be included.

4. The history of the development of pesticide application technology and other procedures should be documented in chronological order.

5. The section on manufacturing impurities is weak and inaccurate in so far as other contaminants *are* known. Seek more published information and conduct interviews with synthetic chemists, pesticide chemists and toxicologists held in order to circumvent the limitations of "proprietary information". Provide documentation for all interviews.

6. The Consultant should undertake a comprehensive search of the scientific literature for the required information on the science on the types of herbicide applications carried out on the Base.

7. Provide more information to document the storage, handling and disposal of herbicides on the base.

8. In order to fill obvious gaps in the report a major effort should be put into contacting and interviewing all older employees, former employees or retired employees that were directly responsible for, and involved with, the management and execution of the herbicide programs. A comprehensive list of individuals with first-hand experience of previous Gagetown spray programs and the products used should be developed and interviews held (and documented). The interviews should be documented, ideally with a standard format, and the content signed off by the interviewee and interviewer. Good documentation is essential because those interviewed may be required to give testimony at a later date. The following contacts are suggested:

    Pesticide applicators/contractors
    Pilots
    Monitors
    Chemists
    Pesticide manufacturers and their technical representatives (e.g DowElanco)
    Pesticide toxicologists
    Pesticide application specialists
    Vegetation management specialists
    Research scientists
    Regulatory personnel at the federal and provincial level
    The Canadian Forest Service

9. Describe the individual inconsistencies in the information that was obtained.

10. Incorporate information from other published sources as suggested

11. Rewrite the report, update the Appendices and Tables to take account of the findings from the extensive personal interviews and literature search that have been suggested.

12. The report should be carefully edited in order to minimize repetition where it does not contribute to the overall thrust of the report

13. Justify, and explain with references, the use of the words “apparently” and “appears that”.

14. Clarify and define the practices that are referred to in the statement “The information and conclusions contained in this report are based upon work undertaken by trained

professional and technical staff in accordance with generally accepted engineering and scientific practices…."

References & record keeping

15. All factual information must be referenced thoroughly and should be given in the accepted format with the level of detail that is required for scientific publications.

16. The information given in (all) Tables should be accompanied by numbered references

17. Document the measures that were taken in order to identify the required information i.e provide detailed information on all the organisations and individuals that were contacted in an attempt to find the information. Specify the various federal departments that sent individuals to attend the meetings of the FICP, PMAC etc. Who were the individuals and how many former members were contacted in order to try to obtain copies of documents and minutes from important meetings? Who was responsible for record keeping? Were they contacted? Document all personal contacts and interviews that were carried out with present and former employees.

Database

18. The consultant should provide a table in the report that summarizes, on a year by year basis, the information that does, and does not exist in the database.

19. Update the database on the basis of information from personal interviews

6.0 SPECIFIC COMMENTS AND RECOMMENDATIONS

Page 1 - 2

*…and each herbicide is a mixture of AI's,…*this statement is ambiguous. The following is suggested …and individual herbicide formulation may contain one or more AI's…..

For consistency the term "principal ingredient" should be replaced with the term "active ingredient"

I am not aware of any adjuvants that "modify the action" of the *active ingredient.* They may improve the effectiveness of the active ingredient by modifying the characteristics of the formulation. The statement as currently written implies a lack of knowledge and understanding by the consultant.

Page 3.

The information that is available on the PMRA website may present information only for current formulations. If possible, the consultant should verify that the formulations have not changed. This information should be available through direct contact with the PMRA or pesticide manufacturers. If specific formulations have been modified over time then the appropriate data must be presented.

Page 4, Table 1.

But it is often unclear whether or not the product the permit was given for was actually used. The author should contact regulatory personnel and present factual information on when inspections were carried out by regulatory personnel and whether, or not, the contractor was found to be complying with the conditions of the Permit. The term *often* should be quantified. The availability of inspection reports should be listed.

Trace and contact the authors of the 1981 memorandum document (7600-2(CE)); the Yearly Summary Table (1956-1968); the 1996 Pesticide Report Summary; the Comparison between Second Growth control Summaries (1970-1975) through contacts with retired employees in order to verify the sources of the information present.

Contact and interview pesticide applicators in order to confirm use of DND specifications

Page 7

What snapshot in time is represented by the information in Figure 1? How does the information presented differ from year to year throughout the period?

Page 8

It might be useful to include copies of Federal and Provincial pesticide legislation in appendices.

The Reference to the book of Rachel Carson is not necessary.

Page 9.

When a statement is made such as “very little information was found or made accessible to…” then the consultant needs to document the measures that were taken in order to identify the required information i.e provide detailed information on all the organizations and individuals that were contacted in an attempt to find the information.

Page 11

What existed before the CF Pest Control Manual? What were the dates of the three previous editions? Describe in detail the content for herbicide applications…how did the information improve/differ from one edition to the other? Provide references.

Provide FULL references for the Brush Control Guide Specifications (and all sources of information). The specific details of the information provided in the specifications should be given with as much relevant detail as possible. The report was commissioned so that detailed information would be at the fingertips of DND…if the client has to go back to the original documents to get detailed information then the review is of limited value.

I believe the five year IVM plan was prepared by Jim Jotcham out of Nova Scotia (company name Marbicon?). This project was done "in association with" DowElanco (Timothy McKay was the technical sales representative at the time). Jim is involved with field trials of pesticide products and Quality Management he should therefore have excellent data records possibly even dating back to the early 1990's.

What interviews were conducted to follow up on the IVM plan that was described in the "minute sheet" (please reference..from, to, date, etc)?….this needs to be documented.

Page 12

Details of the IPM plan for 2003- 2008 need to be provided – although with considerable less detail than for the earlier, more relevant, period of interest.

A reference for the discussions prior to herbicide applications needs to be given.

Page 13

Provide complete references for the documents confirming the herbicide programs that were carried out.

Page 15

Suggested change to wording….AI's and manufacturing impurities *of herbicide formulations* applied at.…

The term "*…were regulated by the policies and science of the day…"* is used. The details of the policies and science need to be presented in the report in comprehensive detail and in chronological order. The current report is weak in this regard, for example: a reader of the report could not easily identify the policies and science of herbicide application in 1958…and how this differed from say, 1964. This needs to be addressed.

The following statement could be very damaging to the client…*It is possible that other products were applied, but there was no way to confirm their use* …. If this statement cannot be supported by facts it should be removed. What is the referenced source of information that is the basis for the statement?

AI's alone were applied…please clarify whether this means that unformulated active ingredients were applied or that formulations with only one active ingredient were applied.

The section on manufacturing impurities is weak. The peer reviewer was able to find several Internet sites where information, references and follow-up contacts were available. Were interviews with synthetic chemists, pesticide chemists and toxicologists held in order to circumvent the limitations of "proprietary information"? If not why not? Please provide documentation for all interviews.

The PAN UK website had information for the impurities of diuron, an EEC Review Report for paraquat mentioned contaminants for diquat, an EPA Reregistration Eligibility Decision provided information on the impurities of bromacil, an IUPAC Technical Report provides extensive information on many products including several of those used at Gagetown and for which the consultant found no information [Ambrus el al. (2003): **SIGNIFICANCE OF IMPURITIES IN THE SAFETY EVALUATION OF CROP PROTECTION PRODUCTS (IUPAC Technical Report);** *Pure Appl. Chem.*, Vol. 75, No. 7, pp. 937–973] It is suggested that the consultant follow up on the leads provided by these sources in order to update the information fields that is given in the various tables and look-up tables and rewrite the section.

I would suggest "pilcoram was a source of hexachlorobenzene"..rather than "the" source.

Are products that were used 10, 20 or more years ago still protected by proprietary law?

Contact with (retired or current) representatives of the pesticide industry, pesticide toxicologists, researchers and government analytical laboratories should result in the identification of the unidentified active ingredients of products in Table 2. If the search for information is still unsuccessful the report should list the contacts from which information was sought.

Page 17

The introduction to Table 3 gives the impression that a mixture of unformulated active ingredients were applied rather than a mixture of formulated products with different active ingredients. Is this correct?

Page 18.

More details of the applications for the 1966-67 test plots should be given in the report (areas treated, application technology, contact details for the (former) employees that were responsible for these trials etc.) Document all personal contacts and interviews.

Page 21.

Provide references for where the mixes were described. Were active ingredients really applied by themselves? Without any diluent or carrier?

Page 22

Provide references for when the different carriers were used.
The explanation for the use of thickeners is incorrect. No thickener was ever added to make droplets fall faster! The rate of fall is determined by the mass of the droplet, air viscosity and turbulence within the mass of air in which the droplet is falling.

Page 23

Are there any more references for dioxin levels in 2,4,5-T?

The report should document the individuals that were contacted in the search for more information for the period 1965 to 1970 inclusive? The pesticide industry should be able to provide this type of detailed historical information.

Page 24

I believe that Provincial records of pesticide sales in New Brunswick date back much further than 2003. Has this been verified and documented?

Table 9

What is the year for the data presented in column 2?

Page 25

The section on Planning and Contracting Procedures should be documented in chronological order and describe the procedures in effect for the entire period of interest. There are no references provided for the factual information on which the two examples have been prepared.

The years for which pesticide operator's licenses and application permits were obtained from the provincial government should be summarized in a table.

Give specific details (identify) "all involved parties"

Monitors should be contacted in order to improve the amount of available information.

Page 27

Full references and a summary of the findings for the Environmental Assessments should be included in the report.

More information to document the storage, handling and disposal of herbicides on the base should be sought from those that were directly involved with the management and supervision of the operations. Interviews should be documented and factual data fully referenced.

Page 28

The acronym U.A.P. stands for United Agri Products (this should have been obvious to a team of consultants expert in pesticides and pesticide management).

Please give more details to identify "the Pesticide Unit"

What was the response of the monitor regarding the label of the product that was not registered for use in Canada. What do the purchase and sales records indicate?

Pages 28 and 29 are lacking references for most of the factual statements that are made.

Page 29

The National Institute of Health pertains to which nation? Specify.
Appendix B will need to be updated with the chemical structures of the contaminants that will be identified.

Page 37.

The consultant should continue to gather information in order to prepare a comprehensive report that addresses the clients needs. It should not be the responsibility of others to provide additional information so that the conclusions can be reassessed by the consultant.

APPENDIX G

History of Pesticide Use Database
CFB Gagetown (Range and Training Area)