CFB Gagetown Herbicide Spray Programs

1952 – 2004

Fact-Finders' Report

Dr. Dennis Furlong

August 27, 2007
Honourable Peter MacKay
Minister Department of National Defence
Ottawa, Ontario
Canada

Mr. Minister,

May I initially say thank you to the Government of Canada for the designation of "fact finder" in the very public issue of herbicide spraying and any associated human health risk currently and historically at C.F.B. Gagetown, New Brunswick.

I am submitting a review of my final report including a general resume of the events from the autumn of 2005 to the summer of 2007, a short summary of each of Task one, Task Two and Task three, also a full electronic copy and hard copy of all historical data collected and scientific studies as well as an historical epidemiological study of the endemic population health around Base Gagetown.

All data and facts collected and collated are now tabled at the Department of National Defence as requested by contract to allow the Government of Canada to prepare public policy regarding the issue. Herbicide spraying has spanned five decades and has possible public policy implications potentially reaching equally as far into the future as science advances. It took twenty-four months of expedition to complete the work of the fact finding mission.

Through you Mister Minister I relate my appreciation to the lead federal Departments of Defence, Veterans Affairs and Health Canada for their immense and credible co-operation during the process.

Finally, I would like to thank the Base Gagetown commanders and their staff for wonderful co-operation. I also would like to inform the Government of Canada that the Government of New Brunswick was equally as available to help when it was needed. Many of our veterans were also wonderfully contributory, especially Mr. Wayne Cardinal and Mr. John Chisholm who sat on my advisory panel. Their "first- hand" historical recollection of remote events was invaluable.

May I relate to you briefly some salient information;

- The degree of exposure of an individual to any chemical sprayed was indeterminable.
- Precedent has been set by the Government of Canada regarding compensation for exposure to the 'rainbow chemicals' tested by the American Army at Base Gagetown.
- Connectivity between exposure to the contaminants, dioxins and hexachlorobenzene has not been secured in the scientific world literature, only loose association as yet. Threshold dosage has not been determined either in quantity or duration that would indicate human health risk.

- The rainbow chemicals used by the American Army were federally unregistered products as opposed to the annual spray products used by the Canadian forces who used products registered for public use in Canada.
- I have not been able to determine any culpability in the spray program based on the utilization of any product with prior scientific knowledge of human health risk throughout the fifty years.
- There are over-all similar issues and implications for non-military employees of the Federal Government falling under the Department of Human Resources and Development Canada.
- There are over-all similar issues and implications for non-military and non-employees of the Government of Canada falling under the Workplace, Health, Safety and Compensation Commission of New Brunswick and possibly other provinces.
- It should be noted that other aerial sprays occurred during the years in question (for spruce budworm) confounding the issue.
- The epidemiological study done to compare the endemic population of the Base Gagetown area with the rest of New Brunswick did not show any statistically significant differences in selective cancers or disease.
- The 'Agent Orange" testing of 1966-1967 has been confused with the annual spray program at Base Gagetown consistently and persistently and continues to be confounding to the public.
- Respectfully, I think it is important to indicate that throughout my two years of work it was repeatedly apparent that a 'gap' exists between the Canadian Government and the individual veteran aggravating the circumstances. It seems that it has more to do with communication and process than with policy or decision.

Please accept my final resume of the full report completing my work.
The Government of Canada is challenged with three points in the quandary, the emotional component, the precedent set and the non-supportive science for health risk as of August 2007.
Sincerely,

Dennis J Furlong BPE., MSc., BMed.Sc., MD.

Acknowledgements

I want to acknowledge and thank all those who made the work of the Fact Finder's project possible. Mr. Ron Murray- Deputy Coordinator, Ms Patricia Rogers - Researcher and Mr. Kevin Barry administrative assistant all guided the day to day operations of the project and provided me the support I needed to address this long standing public policy issue.

In addition it would not have been possible without the guidance provided by the community advisory panel members, Dr. Christofer Balram, Dr. Barry Brown, Mr. Wayne Cardinal, Mr. John J.Chisholm, Ms. Diane Lutes, Dr. David MaGee, Ms. Barbara McGill, Dr. Michael Perley, Mrs.Gloria Sellar, Ms. Pam Sheridan, and Mr. John Tarrel. Their knowledge of the area and their unique expertise were invaluable. The veterans, especially Wayne Cardinal and John Chisholm, shared their knowledge of military life and demonstrated passion in advocating for the needs of their comrades.

The cooperation and support provided by the Base Gagetown Commander and his staff was also critical to our success.

The Management and staff of the Department of National Defense were extremely helpful in providing information and support to the project in a professional and timely fashion. The senior professionals at Health Canada and the Pesticides Management Review Agency were also equally as helpful.
The Department of Veterans Affairs Canada who worked closely with the project and facilitated information sharing and direct contact with claimants when required.
To all my sincere appreciation

Preface

"War was a major determinant in building Canadian nationhood"
(Canadian Military History: An Overview)

It is generally accepted that war was a major determinant in building Canadian nationhood. Few would argue the notion that Canada's involvement in two world wars, while having placed enormous strains on society, strengthened the Canadian state.

Canada began the First World War as a British Colony and was at war by declaration of the mother country. Peace returned with Canada as a separate signatory to the Treaty of Versailles, an independent country confident in its ability to manage its own affairs. The war marked the transition of Canada's armed forces from a colonial militia to what was probably the most powerful army corps on either side of the conflict; a force capable of planning and executing independent operations, beginning with the Easter Monday, 1917, assault on Vimy Ridge. The war overseas brought the greatest expression of Canadian nationalism in its history to that time. This came at great cost for those who lived through the First World War, referred to it as the "Great War", for the rest of their lives, even though another world war followed within a generation.

From a population of some 8 million, over 600 000 served in the Canadian Expeditionary Force. Nearly 60 000 lost their lives – eighty seven percent of which were a direct result of enemy action in France and Flanders. More than 154 000 were wounded - some more than once - and this does not include the mental and emotional casualties which were not recorded. Scarcely a community in Canada, large or small, escaped the dreadful effects of the war without casualties and broken lives.

Most general histories of Canada in the Second World War emphasize the themes of nation building and the war as a "national experience". Certainly, the war transformed Canada from a country that perceived itself as a colony into a confident and united nation.

The country wanted to forget the war and move on with nation building. Returning soldiers who did not always understand or appreciate what was happening on the home front often refused to talk about their experiences, whether of mass casualties or courageous deeds. At the same time, however, they would come to idealize the comradeship of the trenches and to support civic values.

The war would never be completely over for those who lived it. A number of veterans would be haunted by physical or psychological wounds for the rest of their lives. .

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Introduction

The people were shocked to learn that they would lose not only their land but also communities, schools, and churches. One particular newspaper compared it to the expulsion of the Acadians

On August 1, 1952, the Federal Government of Canada announced that a military base would be established in New Brunswick. The Base located in Queens and Sunbury Counties, between the Broad and River Roads, would encompass an area of approximately one thousand square miles.

The government would acquire the land through purchase and expropriation, displacing in the process an estimated seven hundred and fifty families. This announcement confirmed the rumours which had been circulating for the better part of a year. The establishment of Base Gagetown followed quickly on the heels of the Second World War and the beginning of the "cold war". Therefore, a land -mass resembling that of Eastern Europe was important to decision makers planning military training in preparation for defending Canada in the future. The land-mass in Queens and Sunbury Counties closely resembled the terrain and topography of Eastern Europe, and was therefore considered an ideal military training area. Also the potential economic benefits of such a large military establishment weighed heavily in the location selection as its presence would contribute significantly to the growth and development of the greater southern New Brunswick region.

Canadian Forces Base Gagetown (CFB Gagetown) land use totals approximately one hundred and ten thousand hectares, including 65 lakes, 365 wetlands, and 251 permanent and intermittent streams. The Range Training Area (RTA) represents approximately thirty thousand hectares of this land use. A variety of non-military land uses currently occur within the approximated eighty thousand hectares of non-RTA land, including forest management, hunting, fishing, camping, and various other recreational activities. CFB Gagetown conducts a significant amount of live-fire military training within designated RTA Impact Areas. As a result, it is absolutely critical that these impact areas are free of both softwood and hardwoods in order to provide a safe training area for the military, one with ample line-of-sight during operations and a reduced risk of forest fires resulting from live-fire exercises.

While CFB Gagetown employs a variety of vegetation control methods in the training areas, chemical vegetation control has generally been the preferred method - at least in managing secondary vegetation growth throughout the Impact Areas and firebreak roads. The reason for such vegetation control, of course, is to protect all persons who may be moving throughout these areas.

The Fact-finding Project

Fifty- three years later, on August 15, 2005, the Federal Government announced its plan to address public concerns related to the herbicide spray programs at CFB Gagetown. While quiet, years of public concern regarding the herbicide spray program, particularly the Agent Orange, Agent Purple And Agent White Testing Programs, has remained persistent. Although the Annual Spray Program never used the product referred to as Agent Orange the herbicides sprayed were persistently referred to as 'Agent Orange'. Such concerns were prompted and aggravated by reports of "secret chemical testing conducted by the Americans" and an application incident involving farms throughout the Upper Gagetown and Sheffield areas for which compensation was awarded. From this arose a general perception of an increased incidence of various types of cancer in the communities adjacent to the Base. This concern was shared by a number of former CF members and civilian employees who had worked at the Base. Following a media report stating that Veterans Affairs Canada (VAC) had made a pension settlement related to Agent Orange exposure at Base Gagetown, public concern was no longer expressed quietly.

The pension settlement awarded to Brigadier General Gordon Sellar in early 2005, and the publicity surrounding that settlement, became the lightning rod which galvanized a number of military veterans and civilians living in the area to take public action against the Government for alleged environmental and health impacts relating to the annual herbicide spray programs at Base Gagetown.
The fall-out from these events also resulted in the development of a class action suit against the Government of Canada by the Merchant Law Group of Saskatoon, Saskatchewan, as well as the creation of an advocacy group called the "Agent Orange Association of Canada." Both groups have railed against the Government regarding the effect of the spray program on behalf of all those who served at the Base from 1952 to the present.

The issue of herbicide spraying at CFB Gagetown is difficult and emotionally charged. Multidimensional in nature, it is an issue which includes elements of; public health, long term occupational health and safety, environmental impact, land use implications, as well as financial, jurisdictional, and political considerations.

In order to address the issue, the government decided to utilize a fact-finding approach which would include both qualitative and quantitative studies.
Mr. Vaughn Blaney was appointed Chief Fact-Finder and Outreach Coordinator, Mr. Ron Murray, Deputy Coordinator on August 16, 2005. In the midst of considerable media and public interest following the announcement, Blaney and Murray had first to establish a base of operation while undertaking the challenge of defining and planning an infrastructure which would support an open, transparent, and independent process that would promote citizen engagement and optimum accessibility.
Mr Blaney's failing health, two months into the process, led to my appointment as Outreach Coordinator.

> " an angry crowd accused military officials of a cover-up during a hearing into the spraying of Agent Orange and other defoliants at a New Brunswick Military base in the 1950s and 60s" CBC News June 13,2005

Access and Communication

> **Very quickly we were reminded "that every one who had an interest in our work did not live adjacent to the base".** Personal communication to Coordinator

Communication with concerned individuals and the public in general was of prime concern when we began planning the community outreach aspect of the project on August 16, 2005. We were aware that the methods through which interested and concerned individuals would have access to the work of the project and its findings would have a crucial bearing on credibility in the process.
The first steps in developing the communication system were to quickly establish and advertise a local project office and telephone number.

It is worth noting that when the project was announced, the common perception was that our work would be directed by the Commander of Base Gagetown, and the results would, therefore, be subjected to the control of the Department of National Defence. Extraordinary steps were taken to prevent that notion from becoming an actual issue. We established the project office in a location that was visible and easily accessible to the surrounding communities and not on Base Gagetown property.

The project office in Oromocto became easily accessible to individuals living in southern New Brunswick. We recognized the need to develop communication vehicles that would make the Project's information accessible for all concerned citizens – regardless of how near or far they might be situated. Further to the traditional mailing address and telephone number, we established a website, a toll free telephone number, and published a quarterly newsletter. We advertised the existence of these communication vehicles through paid advertising, public meetings, and the Project website. The newsletter was circulated throughout Canada via veterans associations, the Royal Canadian Legion and the project website.

Initially we received many complaints from those living in other parts of the country that they did not know enough about the project. Subsequently, with improved access, communications increased significantly. In the early months of the project there were 25 to 30 calls per day and an equal number of e-mails. In those early days the tone of the messages was inquisitive, accusatory - indeed often quite angry.

The Coordinator visited many individuals at their homes and met with many groups and individuals at the project Office. We were very conscious of the feelings of scepticism and frustration, and therefore made every possible effort to communicate with each and every person in a way that best suited their particular needs. It was also important to convey the message that the government was sincere in its attempt to obtain the facts around the Herbicide Spray Program and bring a sensible solution to this long-standing matter in a manner that would assist those most affected while simultaneously making sense to the tax-paying public. The Coordinator was consistent in communicating that his mandate was to gather the facts and to present them in an organized fashion to the government, which would then make the necessary policy decisions concerning pensions and/or compensation based on the current science and accurate historical information.

Two veterans Wayne Cardinal and John Chisholm, representing the Black Watch and Royal Canadian Regiment (RCR) respectively as spokespersons, were invited to establish a desk in the project Office. The value of their volunteer work to this project was immeasurable. They worked diligently, initiating nation-wide contact with their regimental associations and Royal Canadian Legion representatives, arranging and accompanying the Coordinator on a number of home and office visits, and acting as able supporters at the community public meetings. This simple but unique approach soon became known as the "*vet net*". Word got out and the tone of communication to the project office changed. This approach did not stop some from continuing to question the validity of our work but it certainly changed it significantly. In addition to their volunteer work, Mr Cardinal and Mr Chisholm were appointed to the Project Advisory Panel.

While public dialogue continued project task contracts were awarded, completed, and a press event was held, complete with material and subject matter experts available for briefing purposes. It was important to release the results of the studies to the public expeditiously as soon as the work was completed. It was also important to maintain an informed dialogue with all interested parties.

In an effort to be inclusive we established a '*Vets breakfast*' an event scheduled to run concurrently with the press briefing held prior to the actual press conference.

This breakfast, hosted by the Coordinator was attended by former CF members, retired Canadian Forestry workers and members of the Project Advisory Panel. The Coordinator used this time to review, in advance of the press conference, the study being released and to answer questions.

However, despite best efforts to communicate the results of the studies, many comments, especially from the veterans, suggested that we were not sharing enough information with them.

Although the latest communication techniques were being used and known engagement processes were being employed, the question of involvement for those living at a distance from the Base was still a source of discomfort for many. They simply did not feel able to contribute to the fact-finding process. In our first newsletter published early in 2006 we announced that we were *"currently fine- tuning a survey which will encourage enlisted people and civilian personnel, who were present at Base Gage town from 1952 to present, to share their stories and relevant information."* Privacy issues precluded this approach. Although it was not possible to conduct the survey due to privacy issues work continued with the means and resources available.

Community Outreach

Because of the public controversy surrounding the issue and the establishment of the project, Mr. Blaney initially insisted upon reaching out to the public sooner, rather than later. He wanted to engage the public quickly so as to put to rest some of the myths surrounding the whole issue of spraying herbicides at Base Gagetown.

It was believed that the best way to generate input from veterans and concerned citizens regarding their perceptions of the impact of the spray program would be through open public discussions. A total of eight public meetings were held in various communities surrounding the base. The first two meetings were conducted by Mr.Vaughn Blaney in September, 2005. Before resuming the meetings I waited until the Federal Election in 2006 was over in order to minimize any opportunity for conflict with what parliamentarians might have been saying about the issue during the campaign. I carried out the remaining six during the month of February, 2006.

Each meeting began with an overview of the process, its objectives, and an outline of the three main tasks through which information would be collected. While details differed from one meeting to the next, four key process-related themes emerged – (1) frustration, (2) relationships with the base,(3) health concerns, and (4)distrust – remaining consistent throughout. With few exceptions, those who spoke up claimed that they had worked or lived near the base and expressed a deep sense of betrayal and (a) frustration, the first theme. They had concern over what they considered wrongdoing by the Government of Canada, and the subsequent negative effects on their lives, their families' lives, and their communities. The majority were angry at the lack of response by the government which in their estimation translated into a lack of respect for their situation and a lack of willingness to consider the validity of their claims. Canadian Forces members repeatedly expressed a sense of having been betrayed by those whom they had served.

Participant quote:
"We were exposed and were never told. If we knew we could have taken precautions. We ate, worked, and slept in that environment. Now, the DVA says there is not proof my COPD can be linked to those chemicals".

Participant quote:
"I've written the minister a dozen times. I have heard from nobody"

Civilians who live or lived, near the base at one time or another were frustrated with the Government's apparent lack of recognition that they may also be suffering from the effects of the spray program. This was compounded by the fact that there appeared to be no clearly established channels of redress for civilians and members of the Canadian Forestry Service. Only members or former members of the Canadian Forces, civilian employees of DND , and contractors who worked at the Base were eligible to make claims.

Participant quote:
"If you didn't work for DND there is no venue there is no number to call, there's no voice to hear you, or ears to listen, and we are not being considered for our suffering and our losses or for our exposure and that has got to change".

We had to work diligently in order to explain that the name "Base Gagetown and Area Fact Finders Project" held a pre-determined meaning. More specifically, this name indicated that the Government wanted to hear from all persons in the area not only those who worked on the Base.

The second theme – relationship with the base – concerned individuals' involvement with the base over many years. Retired veterans spoke of specific work details that they recalled as being part of the spray program while also living, eating and sleeping out in the training area for extended periods of time.

Participant quote:
"You could hardly breathe when driving through certain parts of the area during the period of time from 1962 through 1966. Whatever they were spraying was strong".

Participant quote:
I was in Gagetown in 1959. I was with the Brigadier. I drove the Brigadier's caravan. We were told to bury everything we had. Food, new equipment, new shells, new rigs, everything…bury it, because it's all contaminated".

Many civilians talked about extensive contact with wildlife and nature throughout the base area. They recounted experiences such as picking berries and fishing in the local brooks and streams. These reflections invariably ended with recollections of the presence of brown foliage, evidence of dead birds, animals and insects – especially after periods of spraying. Listening to the participants at the public meetings leaves a clear impression that they truly believe that there is a connection between their current health problems and the spraying of herbicides at base Gagetown.

The third theme about health concerns was persistent and consistent. Those who were directly involved on the Base, and those who lived in surrounding communities were the most emotional. Many participants either had health issues of their own or had a family member who was ill, had died or knew someone in the community who was ill. In the opinion of the participants all could be traced back to the herbicide spray program. Many argued that there was no history of such diseases in their family line, therefore they had to be the result of exposure to the contaminants in the spray.

Participant quote:
"I had a heart attack in '88, I had two angina attacks, I had two angioplasties done, I had two minor heart attacks, and I just had a quadruple bypass done last August. Now when I joined the army in '52 to '55 I was healthy as could be. My wife has cancer, she had a stroke and she's had many heart problems. My son has a heart problem. My other children have serious health problems as well".

Participant quote:
"I've lived here all my life. What I want to know is what about my generation? How has it affected us? I've ate blueberries off the base all my life. I've ate trout that came from out there all my life. I've got health problems, everyone around has breathing problems".

Many participants were of the opinion that the compensation benefit process should be simple and straightforward. If an individual had a health problem, and government records indicate that this person was at the Base during periods when spraying took place, then a benefit from the government should be granted Their point was that if the American government is compensating its veterans for exposure to herbicide spray, then why would we not do the same thing? All were informed of the fact that the American government paid such benefits only to Vietnam Veterans and not to personnel who had served only in the Continental US. This fact did not meet with enthusiastic agreement. Discussion about the American based Institute of Medicine's list of diagnoses, considered to be associated with certain herbicide spray related diseases was received with equal scepticism. Anything less than a direct cause and effect link seemed not to be acceptable.

The fourth theme, a commonly held view of participants, was the notion of a faulty process. Many expressed the belief that whatever action might be taken would be simply too little, too late. While participants indicated trust in the Fact-Finder, statements very quickly singled out the Canadian Government as negligent, irresponsible, and untrustworthy. Some of the sources for this expression are as follows:

1. the negative media publicity surrounding the issue. For example: "The many dioxin-laden barrels remaining throughout the base".
2. the perceived lack of acknowledgement of a significant problem on the part of the government until recently pressured into steps toward positive action.
3. the often iterated difficulty in achieving satisfactory results and service from the Department of Veterans Affairs.

The generic "you don't qualify" letter from the Department of Veterans Affairs, or seemingly worse still, the alleged no response of any kind, became a hot button issue at the public meetings. The burden-of-proof required by those who applied for pension was perceived as unreasonable, and some participants went so far as to suggest that the government itself withheld information that could help applicants establish their own respective claims.

Participant quote:
"Veterans Affairs tell me that they cannot establish that I had time in the training area. They want to know the grid references. Do you know whether that's forty years ago, forty five years ago. I can't remember that and Ottawa will not send me the evidence".

Participant quote:
"I understand theres been 32 applications already sent to the government for compensation. I'd like to know if they are all brigadier generals? Or are they going to forget all about the people who were down in the mud, and crawling through the stuff day in and day out. Or do we even count"?

A commonly held view was that the so called "higher-ups" were being granted compensation while the ordinary rank-and-file member was being routinely refused. Some participants endorsed the fact-finding process as meaningful and fair. Unfortunately, many expressed the belief that it was in essence a governmental public relations exercise, a stalling tactic that would not serve to ameliorate the situation.

Public Meetings

Upper Gagetown

The following are some excerpts and highlights of the eight public meetings held to gather facts from participants. Their recollections, experiences, and feelings as iterated concerning the negative effects of the herbicide spray program at the Base. Coordinator Mr. Vaughn Blaney after being appointed held his first public meeting on September 21, 2005. A few short weeks into the project, individuals in the area had an opportunity to hear from the Coordinator and participate in a dialogue with him regarding their experience with herbicide spraying on the Base. This dialogue was a method by which participants were able to share their perceptions of how the Government of Canada was dealing with their problems and complaints.

At 7:00 PM on a warm September 21st evening more than one hundred people crammed into the Upper Gagetown Hall, only to be equalled in numbers by the local and national media. The Canadian Broadcasting Corporation (CBC) was on strike at the time, otherwise the meeting might well have had to be moved to a larger venue. It was by far the largest, most action-packed event held in Upper Gagetown in recent memory. Attendees travelled seventy kilometres from Saint John, forty kilometres from the City of Fredericton, and all the way from Hoyt and Enniskillen – small communities at the most western edges of the Base. There was no lack of interest as anxious anticipation filled the room when Mr. Blaney called the meeting to order. He began by thanking everyone for coming to the meeting. He stated that, while this was a local issue, national interest was high, and noted the presence of the Federal Member of Parliament, Mr. Greg Thompson, and the Provincial Member of the Legislative Assembly, Mr. Jodie Carr, as well as an unusually large contingent of national media. The Outreach Coordinator explained what was intended to be accomplished over the course of the evening, that it would include the role and mandate of the Fact-Finding Project. Mr. Blaney emphasized that the real purpose of the public meetings was to generate feedback from the citizens and to have them share their issues and concerns regarding the spray program at Base Gagetown.

The first participant to speak was Mr. John Chisholm who asked "why would it take a year to get the facts when the government already has all the facts needed"? He went on to say that "there is no mention of compensation in what was made public so far, and there definitely should be". Mr. Chisholm counselled that "the government better get used to what we are all about and that is an acknowledgement that we were sprayed with awful stuff and we want to be compensated".

Mr. Charles Bryson, a seventy-one year old veteran from Saint John, who served in the military from 1952 through 1967, including the Korean War, claimed that he had been battling the government on the issue of spraying and his poor health for the past twenty nine years. Mr. Bryson stated: "My daughter had cancer at ten, at forty-eight, and now has blood clots. I have had four heart attacks including a quadruple bypass. As well, my wife has cancer and she had a stroke. I can't seem to get anyone's attention, only a call from a New York journalist who wants to do a story on my case. What's wrong with the government"?

Darren Bromwell, a representative with the Merchant Law Group from Saskatchewan involved with the class action suit, told those in attendance that the only resolution to this disaster would come through the courts and he encouraged individuals to join the class action suit. Mr. Bromwell concluded by communicating to attendees that he would be available to help interested parties with the application process.

Mr. Ken Coates speaking on behalf of Mr. Neil Munn, who was present, said that "the message to the government was that spraying its people was an outrageous act and that the government was simply in denial. The facts should be gotten quickly and action taken at once".

Linda Warren, a local resident, explained her first-hand experience with childhood kidney disease, and also how her sister died as a result of breast cancer. "It can all be linked to spraying on the base", said Mrs. Warren. In another account, Mrs. Joyce Parent asserted that her daughter lies in the graveyard next to the hall and her death was clearly a result of the spraying of herbicides at the Base.

Another participant, Annette Currie, asked about the long term health effects of eating berries that were so plentiful on the base. She also indicated that she ate trout from brooks that were contaminated by the spray, and in her opinion it would take so long to get to the bottom of this catastrophe that all those who were affected will be dead before anything comes of this exercise. In a call for a show of hands, approximately eighty percent of those present claimed they were directly affected, in one way or another, by the spray program.

Although it was an action-packed and somewhat intimidating evening, participants were generally courteous. All the same, attendees passionately expressed their scepticism regarding the prospect of positive results stemming from the fact-finding exercise.

Oromocto Meeting

The Oromocto meeting was the eighth and last of the scheduled public meetings. The tone of the participants had changed quite a bit in comparison to the first meeting at Upper Gagetown. While the concept of the Fact-Finders' work was not always well understood or agreed upon, at least the general purpose of the project was understood. At that point, we were more at ease with our message and I was able to articulate more fully the purpose of the project and provide an account of what had been done to date and clarify dates for upcoming events. At that stage, the conduct of the meetings included information statements followed by questions to which I provided as clear and concise answers as possible at the time.

Approximately two hundred people arrived at the United Church basement hall with many questions on their minds. Since this was the last of the scheduled meetings a fairly large contingent from the Agent Orange Association was present.

One point that was made repeatedly at the meetings was how difficult it is, and was, for individuals who do not live near the base to remain informed about the process. Despite websites and modern communications techniques, it has not been easy to keep those individuals who do not live nearby up- to-date on developments and other news pertaining to the fact-finding process. This difficulty allowed for rumour and hearsay to fill the gap and, consequently, for scepticism to flourish. One of the first important pieces of information I clarified at the public meetings, while being careful to note that the definition of full and fair compensation had not yet been determined, was to explain that the new government had accepted accountability for the spray program, and that the Minister of Veterans Affairs, together with the Prime Minister, had said that "full and fair compensation would be paid to those whose health was adversely affected by the herbicide spray program". While I delivered an overview of the various tasks that were being undertaken, and was being careful not to suggest any particular outcomes. I did note that the first task of determining who was posted at the Base from 1952 to present would seem straightforward, but was in fact proving to be more difficult than originally thought. Quite plainly, the method(s) in which records were maintained during the 1950s and 1960s made for laborious retrieval of detailed information.

A point requiring clarification was the notion that the greater fact-finding exercise was only about veterans and employees of the base. It was made clear, repeatedly, that it also pertained to individuals living in communities around the Base. A recurring concern, especially at the meetings held in smaller communities was that the process pertained primarily to military personnel. Again, I reminded those in attendance at the Oromocto meeting that the project took the entire area into account in its studies and deliberations.

Another issue that we were asked to defend was the credibility and qualifications of those who would be conducting the studies.. Fortunately we were able to say that all of the studies were being carried out by well established, reputable, international firms possessing the expertise to properly carry out the necessary technical and scientific work. The allegation was often made that these firms were depending on the government for contracts, and would therefore provide results favourable to the best interest of government. Many participants who spoke at the meetings or contacted our office took the position that the government wanted to hear that everything was done to the letter and that no individual's health was adversely affected. My response was that all of the companies had international reputations to protect. Additionally,I explained that we had an advisory panel of community individuals and experts to provide advice and monitor the work of the contractors. All seemed to be comforted that this work was not being done by government employees.

Many participants continuously insisted that the government was fixated on the spray program of 1966 and 1967. They spoke passionately and gave clear voice to the fact that the entire spray program from 1956 to the present needs to be considered, and not simply 1966 and 1967. I continued to emphasize the point that the Government of Canada accepts that there was in fact a spray program and that the fact- finding is not limited to 1966 and 1967. I explained that we were considering and conducting detailed scientific studies which would include the annual spray program. All resulting information will form the basis of my report. Clearly, this report will not be limited to the testing conducted by the Americans in 1966 and 1967.

Many participants claimed that the Americans have done all the research and are paying their people based on the "presumptive" exposure clause. This continued to be a significant issue which I persistently attempted to clarify. In a room of two hundred people who really wanted to hear the side of the story that best suited their own purpose, tension could be felt – which is quite understandably human. I pointed out that the Americans have contributed considerably to the knowledge of the effects of herbicide spray on human health through the work of the *American Academy of Sciences* – an independent, publicly- funded institute. A sub-committee, called the *Institute of Medicine*, specifically addresses itself to the health related impact studies pertaining especially to the soldiers who fought in the Vietnam War. This committee concluded that it is impossible to establish a direct link between exposure to the chemicals sprayed and adverse health effects. The Institute of Medicine, however, does claim that there is an *association* with eleven categories of diseases. The American Government has utilized a *presumptive exposure clause* ,to establish compensation claims, because it was not possible to determine exactly where soldiers were geographically located during spray periods in Vietnam. While they acknowledge that their soldiers were present in Vietnam, the precise location within the country, at any given time, could not be ascertained. Knowing that a huge volume of chemical spray was used to defoliate the leaf canopy in Vietnam, the American Government presumed that everyone was effected in one way or another and so decided to compensate everyone who was there participating in the war at that time. This same *presumptive exposure clause*, however, was not applied to the Continental USA. I pointed out that we have a very different situation at Base Gagetown, therefore the presumptive exposure clause may not be able to be applied in the same manner.

A number of participants wanted to know whether we had conducted adequate testing of the soil and water to definitively conclude safety in exposure to and ingestion of the water and berries. The answer again is that we employed the services of the best scientists to provide us with advice in these areas and that their findings will be taken seriously. Furthermore, their work will be double peer reviewed in order to make certain that the science was carried out correctly.

The meeting concluded with Mrs. Gloria Sellar, widow of Gordon Sellar, informing participants that her remarks were directed particularly to the retired military folk in attendance, and that she was working hard on their behalf and intends to continue. She explained that since she had been appointed to the Project Advisory Panel, she will carry their message into all meetings in the future. Mrs. Sellar emphasized that she was speaking on behalf of the "women and children who have suffered so much as a result of the spray program".

Overview of 1966 – 1967 Testing

1966 and 1967 testing of Agent Orange, Agent Purple and Agent White

For three days in June 1966 and four days in June 1967, testing of various defoliants and desiccants, including the defoliants known as Agent Orange, Agent Purple and Agent White took place at Base Gagetown. Agent Orange was applied in the 1966-1967 trials; Agent Purple was only applied in 1966; and Agent White was only applied in 1967. The purpose of these tests was to find more effective ways to deal with vegetation in the training area. The tests were conducted by the Base and the US Department of the Army (USDoA).

The testing took place in an area of 83 acres in a remote and heavily forested part of the Base. Eighty three acres is equivalent to 0.03% of the total two hundred and seventy one thousand eight hundred and sixteen (271 816) acres which comprise Base Gagetown. I have been informed by the Base that the specific areas used by the Americans for testing in 1966 and 1967 have not been used since for formal training by the Base.

1966 Testing
The first tests were conducted from June 14 to 16 in 1966. The site was located in the western portion of the Base between the Broad Road and Blissville Road. It was approximately 4 miles long and about 1200 feet wide. A total of116 plots, each 200 x 600 feet with a 100 foot buffer strip between plots. A total of nine herbicide products were tested in 1966.The test plots were 4.5 kilometers from the nearest populated area.

1967 Testing
The second set of tests was conducted from June 21 to 24 1967. The test area was located along the Ripon Road east of the Broad Road. Fifty plots, each 200 x 600 feet with a 200 foot buffer between adjacent plots, were laid out on each side of the Ripon Road. A total of fifteen herbicides were tested in 1967. The test plots were 8.5 kilometers from the nearest populated area.

The location of the two test sites took into consideration their proximity to local populations, croplands and accessibility. The testing, according to the records, was conducted in an area of the Base that was difficult to access, under strictly controlled conditions, ensuring minimal spray drift.. Helicopters were used and flew low over the treetops to ensure a spray swatch of 50 feet. Records indicate that spraying was conducted when there was very little wind.

Reports suggest that there were a limited number of people, both American and Canadian, involved with the two test events. There is a list of the names of 18 people involved in organizing and participating in the testing. In addition, the records show a list of the military units who may have participated in the testing program as well

Although the products used in 1966 and ‘67 testing were not registered in Canada, and therefore not approved for use, it is known that as a result of the manufacturing process, Agent Orange and Agent Purple and Agent White were contaminated with varying levels of Dioxins and Tetrachlorobenzene. Contamination levels varied widely by production run and subsequent management of the products. These products were not registered for use by the Federal Regulatory Agency {PMRA} in Canada.

Research/ Studies

The Fact-Finding Project conducted qualitative research including community outreach through public meetings. Visits and discussions were held with individuals both in their homes and at the project office. The purpose of this outreach work was to gather first-hand information from those who were at the Base or lived in the surrounding communities, about their experiences and feelings regarding the herbicide spray program.

In consultation with the Department of National Defence and Health Canada, the Project coordinated a series of quantitative studies which were divided into several sections. The purpose of these studies was to identify what was sprayed, how it was sprayed, by whom it was sprayed, and to determine, the health risks related to the herbicide spray program at CFB Gagetown.
These studies were contracted through the Government Services Public Contracting System, and were awarded to contractors based on specific criteria. More precisely, successful contractors had to demonstrate experience and expertise in the specific study area in question, and needed to be both nationally and internationally recognized within their respective fields. Finally, all of the studies were double peer reviewed.

Despite having the most qualified experts and private sector contractors to carry out the scientific studies, and a rigorous peer review process, the work often came under attack.

Fact-Finding Task 1

"Military Personnel and Department of National Defence Employees Present at CFB Gagetown During Herbicide Use Since 1952".

The contractor Canadian Development Consultants International Inc. (CDCI) sought to identify, through a paper review and initial contact, former and current serving Canadian Forces members, former and current civilian employees of the Department of National Defence (DND) who were present at CFB Gagetown during the time at which the herbicides in question were sprayed. This task involved the determination of when the above mentioned individuals were present at CFB Gagetown and in what capacity. As a result of the Fact-Finders' outreach work, a number of retired and current CF members, Canadian Forestry Workers, and community residents registered their names and experiences directly with the Project Office.

Fact-finding Task 2

Task 2A: The History and Science of Herbicide Use At CFB Gagetown From 1952 To Present and
Task 2B: Environmental Site Assessment of CFB Gagetown, NB

Under contract to DND, Jacques Whitford Limited. completed the two components of Task 2, a review of the history and science of the spraying of herbicides at CFB Gagetown from 1952 to present, and an Environmental Site Assessment (ESA) in the Range and Training Area (RTA) at the Base.

Fact-finding Task 3

Part 1: Toxicological Human Health Risk Assessment
Part 2: Descriptive Epidemiological Study

Fact-finding Task 3 was divided into two parts **3A** and **3B**: Part 1or **3A** was a health study that assessed potential risks to human health from exposure to herbicides used at CFB Gagetown based on the properties of these products and the probability and degree of exposure (i.e. type, volume, concentration, application condition, and frequency of use). **3A** was further divided into two parts **3A-1** and **3A-2** with part **3A1** further subdivided into three **Tiers**

3A-1, Tier 1 concentrated on the contaminants related to the testing of herbicides in 1966 and 1967; **Tier 2** considered the seven manufacturing impurities associated with the products applied at CFB Gagetown (annual spray program by Canadian Forces) between 1952 and 2004. These include the following chemicals: Dioxins; Hexachlorobenzene; 4,4'-bipyridyl; 2,2'-bipyridyl; 3,3',4,4'-tetrachloroazoxybenzene; 3,3',4,4'-tetrachloroazobenzene; and,4-chloro-2-methylphenol. **Tier 3** focused on the active ingredients in all herbicides sprayed at CFB Gagetown between 1952 and 2004.

3A-2 assessed the potential effects of current exposures on human health of all contaminants of potential concern (copc) identified in environmental site sampling conducted at CFB Gagetown and reported in Task 2B

3B a descriptive epidemiology study that determined the incidence of illness among the population throughout the area surrounding CFB Gagetown, versus a control population from elsewhere in New Brunswick. This study included illnesses that the scientific and medical communities previously associated with exposure to the types of herbicides used at CFB Gagetown.

NB: Executive summaries for the above studies are included in Appendix 'A'

Squaring the Circle

One of the main difficulties with bringing the Fact Finding Project to some understandable and conclusive ending is to determine whether or not the Herbicide Spray Program, spanning fifty years and including the testing of Agent Orange, Agent Purple and Agent White in 1966 and 1967, created any harmful health effects for those who came in contact with the spray at CFB Gagetown.

One must first consider the messages conveyed to the Fact Finders Office, which were laden with passion and determination. Messages claiming, that in fact many, perhaps thousands of individuals suffered from adverse health effects and died as a result of exposure to the herbicides used in the spray programs. To support these claims, the following events were used as supporting evidence:

- the 1966/67 testing by the American army of Agent Orange and Agent Purple and Agent White;
- an incident of "spray drift" caused by a sudden temperature inversion during the annual spray program in 1985 which carried the herbicide to farms in the Upper Gagetown and Sheffield areas whereby certain farmers were compensated for the resulting crop damage by the government of Canada;
- a strong belief, among residents living close to the Base, that the incidence of cancer is much higher in their communities than anywhere else in the Province or country.
- the Federal Government's acknowledgement, and subsequent award of a pension to Brig General Gordon Sellar for exposure to herbicide spray at Base Gagetown;
- the Agent Orange Association of Canada's clear contention and testimony that the spray had adversely effected the health of a large number of veterans and civilians;
- the establishment of a class action law suit;
- the award of pensions by the American and Canadian governments to veterans of the Vietnam war, using a presumptive exposure clause;
- the temporary closure of three sites on the Base, because higher than acceptable levels of dioxin were found in the soil during the site evaluation of Task 2B. While further studies concluded, that the areas were safe, and could therefore be reopened for use. The question, "how could these areas be safe when no remedial work was done" continues to be posed.

All of these incidents, events, and situations conspire to support the belief that many people who came in contact with the spray attribute their current health situation to the spray programs especially since many claim they were in the area when the spray program was being conducted in the early years following 1956. Some claim that they went to the areas immediately following the spray events, while others claim they were directly involved in the mixing and loading of the herbicide, and others claim that they acted as flagrers during the 1966 and 1967 spray testing.

Despite the compelling nature of the anecdotal evidence, it must be cast against the scientific studies. These studies, in summary, conclude that people who lived near or worked at the Base, including most soldiers, were not at risk for long-term adverse health effects from the products used for the herbicide spray programs. Potential long-term health risks were identified as a possibility for only those individuals directly involved with the application of the herbicides or clearing of treated brush soon after herbicide application.

Bystanders, including soldiers, who were directly down-wind less than 800 meters at the time of the aerial spraying may have experienced elevated short-term exposures to some of the herbicides. However this would not have put them at increased risk for long-term, adverse health effects. The studies have determined that the requisite rules and regulations, based on the scientific knowledge of the day, were in place for spraying since the programs began in the mid-fifties and that the rules were upgraded and strengthened as new evidence and knowledge became available. Soil testing was conducted, and based on expert modeling, the soil and vegetation was and is deemed safe. The chemical properties of the herbicides used in the spray program, have been identified and examined and, unless people came in direct contact with the spray as defined, no adverse health effects would have been caused. Spray drift modeling has demonstrated that the spray could only drift 800 meters under normal conditions. The quantities sprayed and the methods used, according to toxicology experts, would not adversely affect human health.

It would appear that no person living near or around the base would have been affected given that only the impact areas were sprayed. Furthermore, these impact areas are located near or well into the interior of the base, eliminating spray drift as a possible factor in exposure to humans.
Therefore, only individuals who may have been allowed access to the sprayed area immediately after the spraying was done or within 24 hours of that time were potentially at risk of incurring negative health effects. Others who may have experienced short term health effects were those who acted as mixers, loaders, and flaggers. Additionally, forestry workers who may have accessed the sprayed area immediately following the spraying in order to assess defoliation results may have suffered short term health effects.
My conclusion is that based on the information gathered and the science as we understand it today Base Gagetown is a safe place to conduct military training, and some people may have been adversely affected by the spraying of herbicides since 1956.

Appendix A

Task 1

Executive Summary

Between March 2006 and June 30, 2006, a team of researchers identified,located, data entered and reconciled more than **115 000**[1] records related to individuals who were stationed at Canadian Forces Base Gagetownbetween 1952 and 2005.

- More than **7000** Regular Force Personnel were identified asstationed at CFB Gagetown during Summer Training for the years 1966 and 1967
- **358** Civilians were identified as employed by CFB Gagetown for the years 1966 and 1967
- **806** family members were identified who may have been associated with the Regular Military and Civilian Employees for1966 and 1967

For the approximately **101 800** Regular Force Personnel identified, we areable to provide the following information about these records:

- At least **75 700** have a Service or SIN number (which is requiredto undertake further research using other records or resources)
- At least **14 000** are still active members of the military
- Approximately **28 000** were stationed at CFB Gagetown after 1986[2]
- About **22 500** were stationed at CFB Gagetown before 1966
- **27** are known to be deceased
- More than **27 000** records contained addresses, phone numbers or email addresses

Challenges with the Records

For this project, no one record provided an individual's complete history ofpostings, occupation(s), rank(s) or unit(s) served. Nominal rolls, newspaper sources, *PeopleSoft* queries, information from Veterans'Associations and other sources provided 'snapshots' of individual records and were collated by researchers.

Given the nature of the historical records accessible to researchers andthe challenges regarding time allotted to complete the database, the final database may contain records that require further research. More than 48000 duplicate records were identified, reconciled and removed from the database.

During the project, researchers consistently updated and modified recordsto reflect multiple duty dates, family information or more details about individuals such as current contact information. There were more than 48000 updates made to the records data that were entered at the Federal Records Centre alone.

Missing Records and Information

In April 2006, CDCI estimated the population of CFB Gagetown from 1954to 2005 at 315 000 (an average of just over 6176 new military and civilian postings or visits to the Base annually over the fifty-one year period ofmilitary activity on-site).

- It is estimated that 98 000 cadets trained at CFB Gagetown.About 1400 cadets are identified and recorded in the final database dated June 30th, 2006. In consultation with officialsfrom Camp Argonaut, no nominal rolls or other records could be readily located. Camp Argonaut opened in 1972 and AnnualHistorical Reports estimated that 2000 - 4000 cadets trained on Base each year. This record was taken into consideration whenproviding the estimated number of cadets at CFB Gagetown.
- Library and Archives Canada holds both military and civilianpersonnel files. At no time did CDCI have access to these records for this project. Alternative sources were used todevelop a profile of regular military, civilian personnel and family members where possible.

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[1] Please note the final MS ACCESS database contains 122 967 records. At least 7300records require further reconciliation and should eventually be deleted.

[2] This number represents Regular Force Personnel who may have been posted for thefirst time at CFB Gagetown after December 31, 1986.

- Throughout the 1950s, the 1st Canadian Infantry Division held Summer Concentrations at Camp Gagetown. Part II Ordersexist for the participating units, but other than a small number of individuals, they do not specify exactly who served during theexercises. The Gagetown Gazette was not published until June 1962. As a result of this lack of documentation, the number ofregular force personnel identified at Gagetown is lower than the April 2006 estimate for the 1950s and early 1960s. Please see **Table 4**.

Data Collected and Analysed

Regular Forces (Personnel): This category represents any regular militarypersonnel identified using the historical sources outlined in **Appendix G**. Soldiers teaching at the Combat Arms School/Combat Training Centre, members of lodger units, and soldiers within units of the 1 Canadian Division (2 and 3 Canadian Infantry Brigade Group) provided the majorityof names collected.

Reserve Forces: Members of the Canadian Militia who were posted toLand Forces Atlantic Area Training Centre, or trained on the Base. Reserve Force Members were identified in pre-1968 records with thesingle digit prefix noted before their service number.

Contractor: Individuals who may have undertaken work at CFB Gagetownunder contract to the Federal Government. This may include individuals hired to spray herbicides, clear bush, pave roads or construct andmaintain buildings and other infrastructure at the base. It would also include individuals contracted to perform specialized services includingresearch and human resources.

Civilian Employee: A non-military, non-public fund employee hired by theDepartment of National Defence or another Federal Government department working at CFB Gagetown.

Visitor: Any individual listed in newspaper sources and guest books ashaving visited the base. If further research is completed, this category may include civilians visiting Base recreational facilities and individualsauthorized to hunt or pick berries in the training area.

Summer Student: Any individual specifically noted as being a summerstudent.

Cadet: Any member of the Sea, Army or Air units of the Royal CanadianCadet Corps training at Camp Argonaut or in other areas of CFB Gagetown.

Foreign Military: During summer training, several Foreign Military unitswere stationed at the base. Foreign military units are listed in Appendix C. No nominal rolls were included in this database.

Table 1: Summary Table From MS ACCESS Database Dated June 30,2006

Personnel Type	Number of Records	1966 and 1967
Regular Force	101 810	7641
Reserve Force	5583	299
Non-Public Fund Employee[3]	1230	2
Civilian Employee	11 255	353
Foreign Military	43	19
Cadets	1447	55
Summer Students	1	0
Visitors	243	20
Family Information	6870	2267[4]

[3] In the final database, Non-Public Fund Employees were identified apart from othercivilian employees as specific sources provided this distinction. See **Appendix A** for a list of the MS ACCESS database fields.

[4] These records have spousal information and/or information about children. 243 entrieshave 3 or more people noted as part of the military unit, including 2 records with 10 family members.

Breakdown of Records by Years From MS ACCESS Database Dated June 30, 2006

As mentioned in the methodological notes that follow, researchers pulledtogether information about individuals posted to, visiting or employed at Canadian Forces Base Gagetown, using a diversity of sources. However,the sources had serious limitations in terms of the breadth and the accuracy of the information provided. For example, not all records capturethe exact dates when an individual was posted to CFB Gagetown or when they left the base.

Table 2: Breakdown of All Records by Start Date – Years[5]

Start Date-Years	Number of Database Records	Family Information
1954 to 1965	23 726	2693
1966 to 1975	17 932	1476
1976 to 1985	19 461	289
1986 to 1995	15 234	215
1996 to 2005	20 514	103
No start Date Available	17 862	N/a
Totals	114 729	4776

Table 3: Breakdown of All Records by End Date – Years[6]

End -Years	Number of Database Records	Family Information
1954 to 1965	13 161	1277
1966 to 1975	12 066	1422
1976 to 1985	15 602	290
1986 to 1995	14 712	126
1996 to 2005	27 071	230
No End Date Available	31 467	N/a
Totals	114 079	3345

It should be noted that the database submitted with this report is fluid andwill be subject to updates and changes over time. This report provides analysis of the material as it stands on June 30th 2006. If additional data oramendments are added it is essential that the statistical analysis be retabulated. In order to provide a more accurate estimate, numbersassociated with the database may be rounded up to the nearest 100 when appropriate.

[5] Please note, the final database has at least 7300 records that require reconciliation andin order to re-create the searches, two steps must be followed. First, a search of the Gagetown From field for dates greater or equal to January 1, 1965 and less than or equalto December 31, 1975 and then a second search that includes 'Record ReconciliationRequired' in the DND Comments II field.

[6] Please note, the final database has at least 7300 records that require reconciliation andin order to re-create the searches, two steps must be followed. First, a search of the Gagetown From field for dates greater or equal to January 1, 1965 and less than or equalto December 31, 1975 and then a second search that includes 'Record ReconciliationRequired' in the DND Comments II field.

Task 2A

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 lookup 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.

Task 2B Stage 1

Executive Summary

Background

Jacques Whitford Limited (Jacques Whitford) was retained by Public Works and Government Services Canada (PWGSC), on behalf of the Department of National Defence (DND), to conduct an Environmental Site Assessment (ESA) related to herbicide use at Canadian Forces Base Gagetown (CFB Gagetown) in Oromocto New Brunswick (NB), Canada.

The ESA forms part of a commitment made by the Federal Government of Canada to identify and report on the historical use of herbicides sprayed at CFB Gagetown, and specifically to consider the trials involving the testing of Agent Orange in 1966 and 1967. The overall historical period considered for the ESA ranges between 1952 and 2005; however, herbicide application records provided indicate herbicide usage only starting in 1956 and extending up to 2004 inclusively.

The intent of the DND statement of requirements (SOR) is to collect and assess information that will allow DND to better understand and determine the existing environmental conditions at CFB Gagetown in order to determine the cumulative effects of historical herbicides applications by DND.

This report deals exclusively with the first phase of the ESA (Stage 1). Task 2B - Stage 1 encompasses two objectives of the DND SOR (a and b): (a) Historical/Document Review; and (b) Strategic Approach Development. The information collected through the initial historical/document review provided key scientific and field data that was used in the rationalization imbedded in the development of the Strategic Approach.

CFB Gagetown Land Use

CFB Gagetown land use totals approximately 110,000 hectares, including 65 lakes, 365 wetlands, and 251 permanent and intermittent streams (OAG, 2003). The RTA represents approximately 30,000 hectares of this land use. A variety of non-military land uses occur within the approximately 80,000 hectares of non-RTA land, including forest management, hunting, fishing, camping, and various other recreational activities. CFB Gagetown houses a significant amount of live-fire military training within designated RTA Impact Areas. As a result, there is a requirement to keep open areas free of softwoods and hardwoods to provide the military with line-of-sight during operations and reduce the risk of wildfires resulting from live firing. CFB Gagetown uses a variety of methods to manage vegetation growth in the training areas; however, chemical vegetation control has generally been the preferred method to manage secondary vegetation in the Impact Areas and firebreak roads because of personnel safety from unexploded explosive ordnance, its effectiveness, and cost per hectare.

Herbicides Used at CFB Gagetown from 1956 up to and including 2004

The term herbicide is a generic name for compounds used for the control of plant growth, or killing of plants and plant parts. Mechanisms of action by which herbicides accomplish their role include a reduction or cessation of photosynthetic activity, respiration, growth, and cellular function. 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 product is a mixture of active ingredients (AIs) that has the herbicidal property, and other ingredients such as carriers (which act as a vehicle for more effective transmission), dilutants, and adjuvants (which modify the action of the principal ingredient). For example, the herbicide product Dycleer is manufactured by Syngenta Crop Protection Canada Inc., and contains the AIs Dicamba and 2,4-D, along with proprietary carriers and adjuvants. In some cases, manufacturing impurities are also found in herbicides as a result of the production of the active ingredient. For example, 2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD) is a manufacturing impurity associated with the production of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T).

Based on the detailed review of the yearly herbicide application program files obtained from DND, Jacques Whitford has compiled a chronological history of the herbicide application at CFB Gagetown. A list of the herbicides applied to CFB Gagetown is as follows:

- 2,4,5-T
- 2,4,5-T, isobutyl ester
- 2,4,5-T, n-butyl ester
- 2,4-D
- Ammate X
- Arsenal
- Dacamine
- Dinitro (Dow General)
- Diquat
- Diurex 80W
- Dycleer
- Fenoprop 2/Silvex/Kuron
- Feruron
- Garlon 4
- Herbec
- Herbec 20P
- Hexachloroacetone
- Karmex
- Krenite
- Krovar
- LV Brush Killer
- M-2993
- M-3142
- M-3189
- Paraquat
- Phytar 160
- Phytar 560G
- Roundup
- Roundup-Transorb
- Silvaprop
- Sodium trichloroacetate
- Spike 5P
- TDB Brushkiller
- Timbertox #10
- Tordon 101
- Tordon 10K
- Tordon 22K
- Trysben 200
- Velpar
- Vision

Herbicide Trials at CFB Gagetown: 1966-1967

In 1966 and 1967 separate herbicide trials were conducted by Canadian and U.S. authorities at CFB Gagetown.

CFS/DND Trials at CFB Gagetown: 1966-1967

The Forestry Branch of the Canadian Forestry Service (CFS) Department of Fisheries and Forestry, Maritimes Region, in cooperation with DND, conducted trials in 1966 and 1967 of several herbicides to second-growth stands of conifers and hardwoods at CFB Gagetown (CFS, 1969) in the Medium Machine Gun (MMG) Field Firing Area. The objective of the testing was to find concentrations of herbicides that would provide effective control of species commonly found at the CFB Gagetown training area.

The objective of the 1966 DND test was to determine the effectiveness of 3 herbicides: a 50:50 mix of 2,4-D and 2,4,5-T, a 50:50 mix of 2,4-D and Fenoprop, and Tordon 101. In 1967, an additional 3 herbicides were applied to the same testing area: Dacamine, TDB Brush Killer, and a formulation of 3 compounds: 2,4-D, 2,4,5-T and sodium trichloroacetate.

The study area was located north of Enniskillen Road within an approximately 11-ha section of the 1,491-ha MMG Field Firing Area of the Enniskillen Range Complex on which the mechanical brush cutter was used in 1965.

USDoA Trials at CFB Gagetown: 1966-1967

In 1965, DND offered the USDoA tracts of wooded areas for the evaluation of various herbicides at CFB Gagetown (USDoA, 1968a,b). These evaluations started in 1966 and continued through 1967.

The objective of the 1966 evaluation was to determine the effectiveness of nine (9) herbicides: Agent Orange; a 70:30 mix of 2,4-D and 2,4,5-T; Agent Purple; Tordon 22K; Tordon 101; M-2993; Diquat; Phytar 160; and, Phytar 560. These herbicides were applied with water in various combinations with or without diluent oil (diesel oil) and the solvent dimethyl sulfoxide (DMSO).

The objective of the 1967 evaluation was to determine the effectiveness of fifteen (15) compounds: 2,4-D; 2,4,5-T; Agent Orange; pentachlorophenol; hexachloroacetone; Dinitro (Dow General); Agent White (Tordon 101) Tordon 22K; Tordon 101; Trysben 200; M-3142; M-3189; Paraquat; Diquat; and Phytar 560G. These compounds were applied with water in various combinations with or without diesel oil and DMSO.

Areas of Herbicide Application at CFB Gagetown: 1956-2004

Although many areas were only sprayed occasionally, others were repeatedly sprayed. These areas of repeated spray were identified, and the spray history verified. Seven areas have been identified as having been sprayed five or more years, and are listed below:

- The Argus Impact Range;
- The General Manoeuvre Areas;
- The Hersey Impact Range;
- The Lawfield Impact Range;
- The Rockwell Impact Range;
- The Tank Driving and Manoeuvre Area (now the Greenfield Impact Range); and,
- Unit Training Area #1 (now the Engineers Skills Training Area 2.)

Strategic Approach

Prioritization of Chemicals of Potential Concern

Jacques Whitford has developed a prioritization methodology for classifying chemicals of potential concern (COPCs) based on important toxicological and physical properties of each herbicide active ingredient (AI) used at CFB Gagetown. The Priority ranking system places chemicals in two categories; Priority 1 and Priority 2. Priority Ranking 1 COPCs are those chemicals that have a combination of toxicological and physical properties which indicate greatest concern to either human or ecological health. The focus of this environmental assessment will allow the field program to target those compounds of greatest concern to either human or ecological health in a more concentrated field sampling approach. Priority 1 COPCs include the following: 2,4-D, 2,4,5-T, 2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD), Hexachlorobenzene, and Picloram. All other chemicals are considered as Priority 2 COPCs.

Categorization of Areas of Potential Environmental Concern

A categorization system was developed by Jacques Whitford focusing on the three aspects of the risk triad – hazard, receptor, and exposure. Furthermore, independent of the fundamentals of scientific approach, the social importance placed on COPCs, or valued ecosystem components (VECs – such as species at risk) was considered. The categorization system provides an approach to consider sampling densities to be applied in specific areas of potential environmental concern (APECs) as discussed in Section 4.4 of the report.

The following general categorization of APECs in order of importance is presented:

Category 1: Areas where Agent Orange (a 50:50 mixture of 2,4-D and 2,4,5-T, with the potential for the manufacturing impurity dioxin (TCDD) being present – Priority 1 chemicals) is suspected to have been applied at CFB Gagetown.

Category 2: All areas at CFB Gagetown, other than Category 1 areas, where Priority 1 chemicals (Table 4-2) have been applied.

Category 3: All areas at CFB Gagetown where human exposure would be the highest and most frequent at CFB Gagetown where multiple applications of any COPC have occurred. This category is meant to be much more discrete in size as opposed to the more area-wide type APECs in Category 2.

Category 4: Ecologically significant areas that may support species at risk or other rare or endangered valued ecosystem components where COPCs have been applied or where these areas could be considered as environmental sinks.

Category 5: Background sampling areas. These areas have been selected based on their relative distance away from historical application areas for all COPCs. They also consider other anthropogenic sources of COPCs as well as historical wind roses.

Category 6: Areas determined to be historical herbicide barrel dump sites based on the results of a concurrent geophysical study being performed by the Base. Note: At the time of drafting of this report, no information on these sites has been provided to Jacques Whitford.

Proposed Field Approach

The majority of COPCs identified in the historical review are organic herbicides or chemicals that are relatively immobile in the soil environment. This is not to suggest that they may not impact other environmental media; such as groundwater, surface water, sediment, air, or biota. Therefore, in addition to soil samples, Jacques Whitford recommends that a limited number of surface water and sediment samples be collected. This will establish potential mobility and transport of the COPCs in the RTA. Water is supplied by groundwater only in the bivouac areas as well as to the guardhouse on Highway 7. Jacques Whitford also recommends that the drinking water source for each of the areas not on municipal supplied water be conducted to ensure concentrations of COPCs are below Canadian Drinking Water Quality Objectives.

With the exception of buried drum areas, it is recommended that nonpotable groundwater samples not be collected during the presence/absence field program. If the program detects concentrations of COPCs that are elevated, then a groundwater monitoring program and survey could be completed in a future round of field sampling as required.

The execution of the targeted field program as proposed in the current Strategic Approach will provide DND with two forms of relevant data: (1) laboratory analytical data for selected media (surface soils, sediments, surface waters, and groundwater) in areas of historical herbicide applications as well as in selected "background" areas within the limits of CFB Gagetown, and (2) visual field observations from our engineers, scientists, and technicians that will be conducting the field program. The combination of these 2 sources/types of data will allow the development of recommendations on further work as appropriate.

Jacques Whitford does not believe that air monitoring samples should be collected during the presence / absence initial survey. High priority COPCs are not likely to be found to any significant degree in ambient air. In the event that COPCs are detected in soil at elevated concentrations air monitoring may be considered in a future stage of field sampling as required.

As can be expected, there are multiple potential outcomes to the field program ranging from all samples submitted coming back with analytical results below the laboratory detection limits (note: this does not exclude the potential of trace concentration below the detection limits) for all COPCs , to multiple samples exhibiting measurable concentrations of COPCs at varying concentrations. Even considering the situation where all samples come back below their laboratory detection limits, a biota sampling program will be recommended in order to rule out the potential for COPCs being bioaccumulated/biomagnified in selected biota. A key outcome of this type of result (non detectable for all samples) would, however, result in a much more limited and targeted biota sampling program that may concentrate more on results from the visual field observations as opposed to the analytical data. These field observations can provide a better understanding of the ecosystem in the sampling areas and could allow the identification of relevant environmental sinks and appropriate biota specimens to consider in future work to conclusively cover all potential receptors and end points in a systematic, logical, and scientifically defendable manner.

The following should be considered: in the development of the targeted biota sampling program: terrestrial and aquatic species surveys (either field derived or through a regional data document review); the determination of appropriate seasonal sampling 'windows' for species of interest; and, the development of a site-specific ecological conceptual site model.

Jacques Whitford will generate a comprehensive Field Program as part of the Stage 2 Report deliverable. This will include specific details on all subjects presented in this Report, including the number of samples to be collected, the environmental media to be targeted and the various sampling approaches to be used.

Task 2B Stage 2

Executive Summary

Jacques Whitford Limited (Jacques Whitford) was retained by Public Works and Government Services Canada (PWGSC), on behalf of the Department of National Defence (DND), to conduct an

Environmental Site Assessment (ESA) related to herbicide use at the 110,000-hectare Range and Training Area (RTA) at Canadian Forces Base Gagetown (CFB Gagetown) in Oromocto New Brunswick (NB), Canada.

Specifically, the ESA is in response to DND's Statement of Requirement (SOR) for Conducting a Site Assessment at CFB Gagetown. This SOR is being contracted through the PWGSC National Capital Region (NCR) Standing Offer Agreement (SOA). The intent of the SOR is to collect and assess information that will allow DND to better understand and determine the existing environmental conditions of the RTA at CFB Gagetown in order to ultimately determine the cumulative effects of herbicides used between 1952 and today.

The ESA forms part of a commitment made by the Federal Government to identify and report on the historical use of herbicides sprayed at CFB Gagetown, and specifically to consider the trials involving the testing of Agent Orange and Agent Purple between 1966 and 1967.

This report deals exclusively with the second stage of Task 2B of the ESA (Stage 2). The key deliverable is to produce a rigorously-developed, scientifically-defensible prioritized field Assessment program/sampling plan to identify the presence or absence of chemicals of potential concern (COPCs) related to historical herbicide applications at CFB Gagetown at established areas of potential environmental concern (APECs). The selection of suitable background sampling locations, away from the inferred influence of historical herbicide applications on the base is also presented in this report.

It is understood that the end goal of this assessment, beyond the assessment of COPCs at CFB Gagetown within the presence/absence field program, is to ensure that if present, COPCs are not in concentrations sufficient in environmental media to result in either human or ecological health risks. Jacques Whitford has developed a categorization system for the APECs in the Task 2B – Stage 1 Strategic Approach Report, which is the cornerstone upon which the detailed field program was developed.

The sampling program will be designed to meet the strategic objectives outlined above, have a site specific health and safety plan designed in consideration of the COPCs as well as UXOs, and will include sampling of the following environmental media:

Surface Soil Category 1 and 2 APECs (APECs 1 to 14) will be defined as sample areas (SA) for surface soil sampling. Each APEC will be sampled as an individual sample area, with six sectors laid out within each SA. Within each sector, six sample sites will be selected, resulting in a total of 36 randomly spaced sample sites from each SA. A total of 504 surface soil samples will be collected at these locations, to depths of 0-10 cm.

Corresponding samples from each sector will be composited together such that 6 composite samples will be produced, each representative of the SA as a whole, giving a total of 84 surface soil samples from the fourteen SAs for laboratory COPC analysis. Composite samples will be produced by first homogenizing and then splitting the individual samples, taking care to wash all equipment between samples.

In addition to the characterization of the wide areas, there will be specific locations that will be subject to targeted surface soil sampling. These are identified as being of special interest due to human and/or ecological exposure and include, but are not limited to:

- Bivouac areas;
- Significant watersheds (Nerepis River and Swan Creek Lake);
- Base boundaries; and,
- Miscellaneous areas (small areas that are on Base property but are openly accessible to members of the public including parks/play areas in the PMQs and soccer fields on the Base).

Sediment and Surface Water

Topographic maps and aerial photographs of the Base training areas have been reviewed, from which a number of surface water bodies have been identified and will be targeted for sediment and surface water sampling, as follows:

- Swan Creek and its tributaries (Brown Brook, Weston Brook, Morton Brook, and Tantawanta Stream) drain through the Hersey Impact Area toward the north before flowing into Swan Creek Lake at the northern edge of the Base.
- Rockwell Stream and its tributaries (McCain Brook and McCarthy Brook) drain from west to east across the Rockwell Impact Area.

- Beckett's Pond is located in the eastern portion of APEC 13 between areas 21 and 26. Dunn's Brook drains Beckett's Pond and flows to the east, ultimately draining into George Lake at the eastern boundary of the Base.
- APEC 21 is designated as the Nerepis River watershed. The Nerepis River drains the south central portion of the Base training areas and flows across the southern boundary of the Base close to Welsford, before discharging into the Saint John River.
- APEC 22 is designated as Swan Creek Lake and is located at the northern boundary of the Base, immediately south of the trans-Canada highway.
- Background Areas 1, 2, and 3: Background 1 will be the South Branch Oromocto, Background 2 the Mad Brook and Background 3 will have samples collected from the series of small lakes and streams.

Three discrete sediment samples and three discrete surface water samples will be collected at evenly spaced intervals along each of the smaller water bodies listed above (APECs 8, 9, 13, Background 1, 2, and 3). For the larger river systems and lakes (APECs 21 and 22), six discrete sediment and surface water samples will be collected.

Vegetation

Vegetation samples will be sampled in APECs 1, 2 and 3, and in the three Background Areas. Vegetation samples collected will be analyzed for Priority 1 COPCs. Details of a proposed limited targeted vegetation sampling program will be presented in a separate letter report.

Potable Water

Potable water supplies have been identified at twelve of the bivouac sites. Tap water samples will be collected at each site in accordance with standard practice for potable supply sampling.

Background Areas

Three areas on CFB Gagetown have been pre-selected as Background Areas for sampling during the field sampling program. These areas are as follows: the southwest corner of Area 52, the southern part of Area 42, and Area 38/39. Each site is slightly different in its biophysical nature. Area 52 is the flattest with the least relief while Areas 42 and 38/39 are in higher elevation areas. Each site has similarities in vegetation composition and cover and will pose no problems for sampling. All sites have watercourses (streams) and sufficient soil for sampling.

Analytical Parameters

Jacques Whitford developed a simplified prioritization methodology for classifying the COPCs. The focus of this environmental assessment is on Priority Ranking 1 COPCs. Priority Ranking 1 COPCs are those chemicals that have a combination of toxicological and physical properties that indicate greatest concern to either human or ecological health. They are known to bioaccumulate and biomagnify in the food chain, they are persistent as defined by CEPA, and are known human carcinogens. Priority Ranking 1 COPCs potentially present at CFB Gagetown are as follows:

- 2,3,7,8-tetrachlorodibenzo-para-dioxin (TCDD);
- hexachlorobenzene;
- picloram;
- 2,4,5-trichlorophenoxyacetic acid (2,4,5-T); and,
- 2,4-dichlorophenoxyacetic acid (2,4-D).

It is important to note that the emphasis on Priority 1 COPCs does not mean that Priority 2 compounds should not be investigated. Priority Ranking 2 compounds would not be expected to be found in all APEC assessment areas identified due to their lack of either persistence in the environment or lack of use. Therefore, Jacques Whitford has developed a sampling protocol to investigate the Priority Ranking 2 compounds in the most likely areas that they would be found, and will only be analyzed for in the APECs that received the most intense or most recent application.

Quality Assurance and Quality Control (QA/QC) protocols will be followed by Jacques Whitford personnel throughout the sampling program, in order to ensure the accuracy of the data collected and reported.

QA/QC measures that will be taken throughout the sampling program in the field include analysis of equipment rinse duplicates, field duplicates, field and trip blanks, as well as ensuring that composite sampling is representative of the targeted area, and checking the reproducibility of results.

Schedule

The field program has been estimated to take five weeks to complete using 3 field team of two individuals, of which one will be an engineer/scientist, and the other an experienced field technician. Each of these teams will require UXO clearance support from the Base while in the SRIA. A forth team of two will be employed in the staging area to coordinate logistics and execute all sample preparation for submission to the laboratory. This is a very aggressive schedule being proposed by Jacques Whitford given the number of samples and the wide area over which they will be required to be collected.

Jacques Whitford understands that CFB Gagetown is a critical asset in the DND organization. Therefore, we are prepared to be flexible in scheduling the timing of when individual APECs are sampled throughout the field program based on the military training requirements at CFB Gagetown.

The report schedule will be dependent on the progress of receiving analytical results from the laboratory. Jacques Whitford will have to discuss with the selected laboratory anticipated turn around times for sample analysis in order to produce a complete report with associated analysis of all field data.

Task 2B Stage 3

Executive Summary

Jacques Whitford Limited (Jacques Whitford) was retained by Public Works and Government Services Canada (PWGSC), on behalf of the Department of National Defence (DND), to conduct an Environmental Site Assessment (ESA) related to historical herbicide use in the Range and Training Area (RTA) of Canadian Forces Base Gagetown (CFB Gagetown) in Oromocto, New Brunswick (NB), Canada. The ESA forms part of a commitment made by the Federal Government of Canada to identify and report on the historical use of herbicides sprayed in the RTA at CFB Gagetown, and specifically to consider trials involving the testing of Agent Orange in 1966 and 1967.

The key deliverable of this Stage of Task 2B was to undertake the prioritized field sampling program to identify the presence or absence of chemicals of potential concern (COPCs) related to historical herbicide applications in the RTA at CFB Gagetown at established areas of potential environmental concern (APECs). Suitable background sampling locations within the RTA, away from the inferred influence of historical herbicide applications on the base by DND, were also included in the sampling program.

FIELD PROGRAM

The field sampling program was completed between September 28, 2005, and November 9, 2005. The sampling program consisted of the collection of surface soil samples, soil core samples, surface water samples, sediment samples, vegetation samples and groundwater samples. Samples were collected in accordance with the sampling methodology discussed in Section 4.0 of this report and the SOPs provided in Appendix B. In all, a total of 1063 discrete surface soil samples were collected (from which 177 composite samples were made) resulting in a total of 1240 soil samples. As well, 30 sediment samples were collected, 30 surface water samples were collected, 12 groundwater samples (from existing potable water wells in bivouacs) were drawn, and 108 vegetation samples were collected and composited during this period. All sampling locations were georeferenced using a GIS system during the field work and plotted on maps provided in Section 7 of the report.

Based on the Strategic Approach used (Jacques Whitford, December 14, 2005), samples were selected for analysis of up to 6 different chemical analytical packages based on the history of applications in the 22 APECs and 3 Background locations. Analyses were performed in order to assess the presence or absence of up to 27 active ingredients/herbicides and two manufacturing impurities (dioxins and hexachlorobenzene) as detailed in Tables 2-1 and 5-1 of the report. The main contract for chemical analyses was issued to RPC Laboratories of Fredericton, New-Brunswick. Due to the large volume of analyses, RPC sub-contracted two of the six analytical packages (packages E and F) for the soils, sediment and water samples to TESTMARK Laboratories Ltd. (Testmark) of Garson, Ontario. As well, all vegetation samples were sub-contracted to Enviro-Test Laboratories (ETL) of Edmonton, Alberta.

In total, 296 surface soil samples (119 discretes and 177 composites), 30 sediment samples, 30 surface water samples, 12 groundwater samples, and 81 composite vegetation samples, were submitted for analysis of various chemical parameters based on the historical herbicide applications. All the results were verified in a thorough quality assurance/quality control (QA/QC) program and transferred in an MS Access database (Appendix K). Collectively the laboratory analysis of COPCs in all sampled media represents almost 6000 analytical results, which does not include quality assurance samples.

As CFB Gagetown is a Federal property; the appropriate federal and provincial regulations were reviewed to identify appropriate screening guidelines/criteria for COPCs. Where possible, federal criteria or guidelines (Canadian Council of Ministers of the Environment – CCME) were identified, however in some cases federal criteria are not available and thus applicable provincial guidelines/criteria were used. Soils, sediment, surface water, and groundwater quality guidelines were identified, and are presented in Table 4-3 in the report. Where different soils criteria were available based on land use, the residential/parkland land use has been presented. Where soils criteria differed based on soil type, the most stringent criteria was selected. A summary of the criteria researched is presented in Section 4-4.

RESULTS

In all of the analyses performed, only concentrations of polychlorinated dibenzop- dioxins and polychlorinated dibenzofurans (PCDD/F) in soil exceeded the CCME soil quality guideline of 4 pg TEQ/g. PCDD/F was detected in all soil, surface water, ground water, and sediment samples, and in only just over 25% of the plant samples submitted for analysis. PCDD/F concentrations were reported as their toxic equivalent of 2,3,7,8-TCDD (pg TEQ/g, pg TEQ/L).

The highest concentrations of PCDD/F in soil were found in APEC 2, the location of the 1967 US DoA test plots. Elevated concentrations of PCDD/F in soil were also found in the Clones bivouac site, the Murphy bivouac site, APEC 3, APEC 4, APEC 13, and two of the roadway firebreak locations.

Principal components analysis (PCA), a multivariate statistical technique, was used to ascertain differences in PCDD/F congener patterns (sample make-up) from samples taken within the RTA at CFB Gagetown. APEC 2, the Murphy bivouac site, and the Clones bivouac site were determined to have different congener compositions than the other sample locations collected from the RTA and within CFB Gagetown. A second PCA was conducted that included congener signatures of samples collected by Hatfield Consultants in the Aluoi Valley of Viet Nam, in known areas of Agent Orange application. These samples had a different congener signature to those collected at CFB Gagetown.

There was no significant difference in sediment sample PCDD/F concentrations across APEC 8, APEC 13, APEC 21, APEC 22 and the three Background Areas. Only one sediment sample had a PCDD/F TEQ concentration that exceeded the CCME probable effect level of 21.5 pg TEQ/g. This sediment sample was collected in Swan Creek Lake.

All collected groundwater and surface water samples had concentrations of PCDD/F on a TEQ basis less than the Ontario Ministry of the Environment (MOE) drinking water quality objective of 15 ng TEQ/L. The highest concentration of PCDD/F in surface water was collected from Background Area 1 (2.1 pg TEQ/L). The Hearst bivouac water source was found to have the highest concentration (1.2 pg TEQ/L) of all of the 12 potable groundwater sources (wells) sampled at bivouac sites across the CFB Gagetown RTA.

Overall, there is no significant difference in vegetation PCDD/F concentrations in APECs 1, APEC 2, APEC 3 and the three Background areas. This suggests that while soil concentrations in these APECs may have varied when compared to Background, the concentrations of PCDD/F in vegetation was actually indistinguishable from background.

Of the remaining 20 COPCs analyzed, 2,4,5-T, 2,4-D, dicamba, picloram, and pentachlorophenol were only measured in one soil sample submitted for laboratory analysis. The chlorinated benzenes were only detected in one water sample from the Clones bivouac, with the HCB concentration fives times less than the corresponding Ontario MOE drinking water quality objective. 2,4-D was also reported in only two vegetation samples. The remaining COPCs (with the exception of polychlorinated dibenzo-p-dioxins and PCDD/F as mentioned above) were not detected in any of the environmental media sampled and submitted for analysis.

RECOMMENDATIONS

The results of analyses for all COPCs, with the exception of PCDD/F in soil, sediment, surface water and vegetation, suggest that no further assessment is required with respect to the analysis of additional samples or APECs in the RTA at CFB Gagetown. The herbicide spray program conducted from 1956 to 2004 does not appear to have significantly added to concentrations of the COPCs in the environment at CFB Gagetown beyond background levels, with the exception of PCDD/F.

A detailed quantitative human health and ecological (HHERA) site specific risk assessment (SSRA) should be conducted for PCDD/F concentrations found in soil, sediment, surface water, groundwater and vegetation collected in the RTA at CFB Gagetown. Although only soil concentrations of PCDD/F exceeded environmental quality guidelines, cumulative pathways of exposure to PCDD/F in all sampled environmental media should be undertaken. The objective of the HHERA should be to develop CFB Gagetown RTA specific soil quality objectives (SQOs) that are protective of actual use and exposure of humans and wildlife throughout the Base by developing a more accurate exposure model based on actual conditions, use, and receptors.

The SQOs could then be used not only to ensure protection of human and ecological health, but to focus additional sampling and analysis where warranted at CFB Gagetown at the various APECs with exceedances of CCME SQGs within this report. For example, if the CFB Gagetown derived SQO (once/if developed) for PCDD/F is greater than the exceedances of the 4 pg TEQ/g SSL, then it is unlikely that additional sampling, delineation or analysis of soils from these areas (APECs 1, 4, 6, and 13) would be further required as long as the analytical results remain below the newly derived SQO. The SQO would also form the basis for a new "Max Test" SSL to be used at CFB Gagetown when evaluating PCDD/F soil quality.

Given that there are no drinking water quality guidelines for three of the chlorinated benzenes, then the groundwater at Clones bivouac should be assessed for its suitability for use. This assessment could form part of the scope of work for the recommended SSRA.

Only a limited amount and type of vegetation was collected and analyzed for PCDD/F concentrations during the presence/absence field program. An ecological risk assessment (ERA) team should be consulted with regard to the requirement for additional PCDD/F data requirements in ecological receptors. For example, terrestrial ecosystem surveys may be required, as well as collection and analysis of soil invertebrates, additional discrete soil plant pairs, or small mammals in order to complete an ERA.

Finally, consideration should be given to delineating PCDD/F soil exceedances in the Clones and Murphy bivouac sites, as well as in APEC 2. At the time of report preparation the Base Commander at CFB Gagetown has restricted access to these three sites pending the results of a human health risk assessment (HHRA). As such, delineation of PCDD/F soil concentrations, both horizontally and vertically, should be considered for the spring of 2006.

TASK 3A-1:

TOXICOLOGICAL RISK ASSESSMENT PERTAINING TO POTENTIAL OCCUPATIONAL AND RELATED EXPOSURES ASSOCIATED WITH HERBICIDE SPRAYING OPERATIONS AT CFB GAGETOWN – TIER 1 – 1966-67 U.S. TRIALS – MANUFACTURING IMPURITIES (CONTAMINANTS)

EXECUTIVE SUMMARY

ES-1.0 INTRODUCTION

The Government of Canada has committed to identifying and reporting on facts surrounding the use of Agent Orange and Agent Purple during June, 1966, and June, 1967, in addition to the use of other herbicides, sprayed at Canadian Forces Base (CFB) Gagetown between 1952 and present day. As part of this commitment, the Government of Canada has engaged nongovernmental experts to assess the possibility military and civilian personnel exposure to herbicides and contaminants within these herbicides, the potential herbicide and contaminant dose received by these personnel and the potential of these herbicides and contaminants to cause harm. Cantox Environmental Inc. was retained to conduct a human health risk assessment to estimate potential exposures, characterize potential health risks, and determine, in an objective manner, whether exposures to herbicides, and associated contaminants, used at CFB Gagetown may be associated with potential human health risks.

The assessment of exposures and related risks arising from Agent Orange, Agent Purple, other herbicides and any herbicide-related contaminants, particularly dioxins, sprayed at CFB Gagetown from 1952 to the present, has been prioritized into three tiers:

- Tier 1 – 1966-67 U.S. Trials - Manufacturing Impurities (contaminants);
- Tier 2 - 1956-2004 - Manufacturing Impurities (contaminants); and,
- Tier 3 - 1956-2004 - All Herbicide Products.

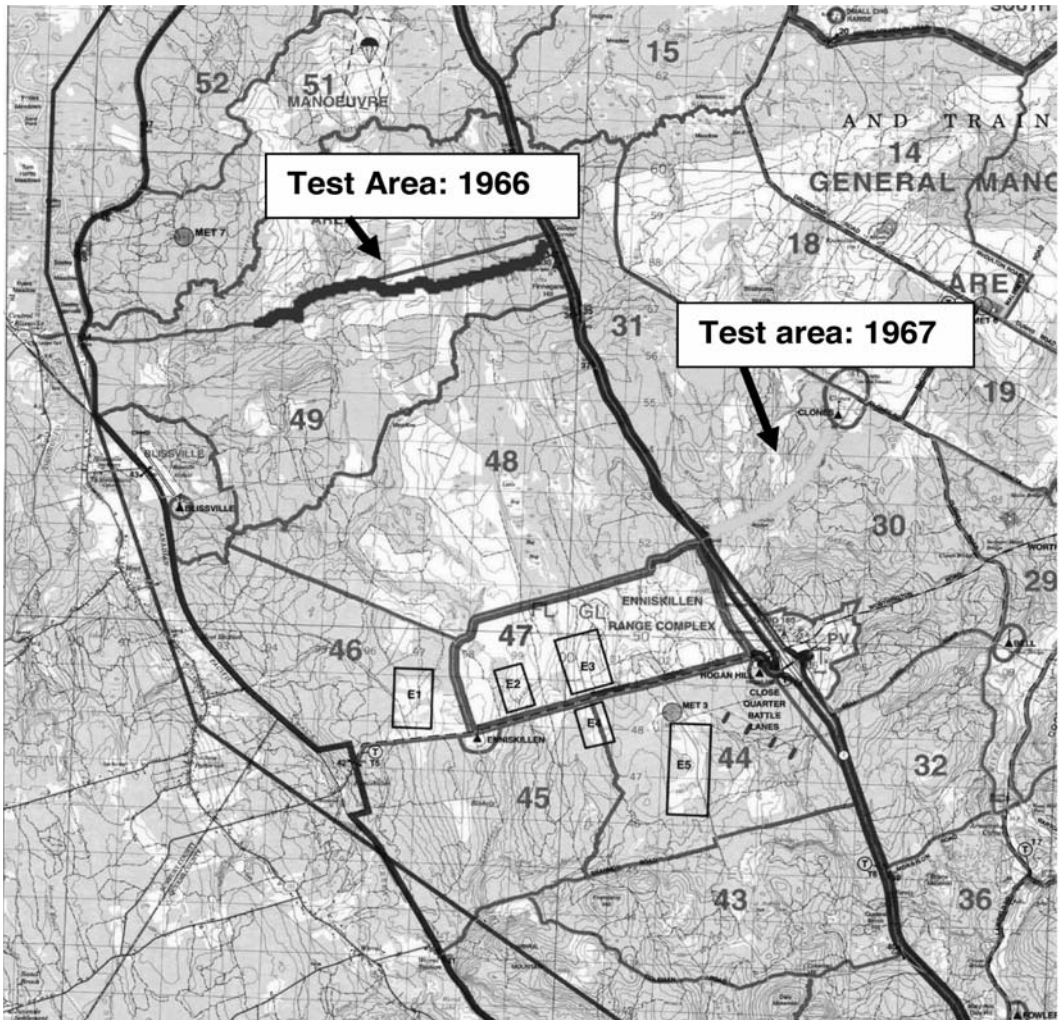
The subject of this report is Tier 1. Tiers 2 and 3 will be the subject of subsequent reports.

ES-2.0 DESCRIPTION OF TIER 1

In March, 1965 the Canadian Ministry of Defence offered the Crops Division of the United States Department of the Army the use of large areas of densely forested land at CFB Gagetown for the purpose of testing defoliant chemicals. The two areas of CFB Gagetown that were affected by this herbicide application in 1966 and 1967 are shown on the map below (Figure ES1). The test site used in 1966 was approximately 360 metres (1,200 feet) wide by 6.4 kilometres (4 miles) long. A total of eight enlisted men and three Officers (the Commanding Officer, a Range Officer and a co-pilot) from the Canadian Military were listed as participating in the project. This information is not available for 1967. Herbicides were applied from a helicopter.

The focus of the Tier 1 report is the contaminants present in some herbicide products applied at CFB Gagetown in the U.S. trials in 1966 and 1967, specifically:

1. 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD; 2,3,7,8-TCDD; dioxin) present in 2,4,5-T (a component of Agent Orange and Agent Purple and an unregistered mixture that contained 2,4,5-T in acid form);
2. Hexachlorobenzene (HCB) present as a contaminant in picloram (Tordon formulations Tordon 22K and Tordon 101);
3. One herbicide formulation (M-2993) contained both 2,4,5-T (contaminated with TCDD) and picloram (contaminated with HCB); and,
4. One herbicide preparation that was applied only in 1967 included polychlorinated dibenzo-p-dioxins (PCDDs) and furans (PCDFs) in pentachlorophenol (PCP).



Map Section of CFB Gagetown Showing Areas of Herbicide Application for 1966 (shown in blue) or for 1967 (shown in green)

S-3.0 HEALTH RISK ASSESSMENT METHODOLOGY

Human health risk assessment is a science based tool used to evaluate the potential for adverse human health effects following exposure to chemicals. The "dose-response" principle of toxicology is fundamental to an understanding of the health risks presented by chemicals. All chemicals possess intrinsic toxicity, which is defined as the ability to cause injury to living systems. However, whether or not injury is realized depends on the amount of the chemical that reaches the living system. In the absence of exposure, no injury will occur. As exposure mounts, the likelihood of injury increases.

Based on this principle, it is generally accepted that the two primary determinants of chemicalbased health risks are the level of ***exposure*** received and the intrinsic ***toxicity*** of the chemical. The principles are often reduced to the simple equation:

RISK = EXPOSURE x TOXICITY

An understanding of these two determinants is critical to the assessment of the health and environmental risks presented by a chemical. Human health risk assessment are conducted using risk assessment procedures which have been developed by regulatory agencies such as Health Canada and the United States Environmental Protection Agency (U.S. EPA). The human health risk assessment followed the four standard steps of any risk assessment (see Figure ES-2).

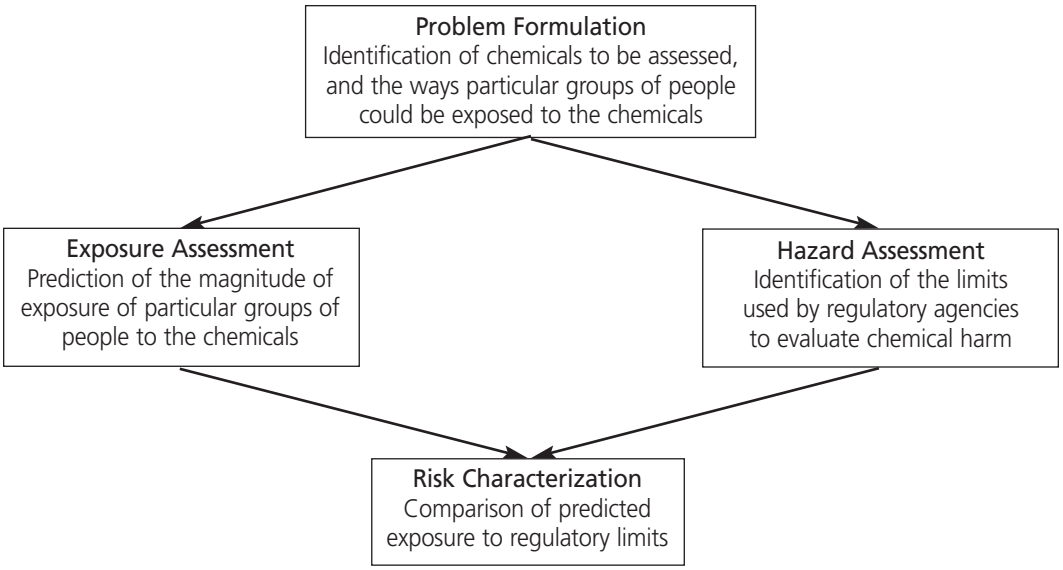


Figure ES-2 The Basic Steps of a Risk Assessment

The chemicals discussed in this report have been linked to both cancer and other non-cancer effects. Risks that link chemical exposure and cancer are calculated differently from other noncancer health risks that are known to be associated with that chemical. In the case of chemicals that do not cause cancer, the level of risk is determined using the ratio of exposure to the level associated with no harm. A ratio less than or equal to 1 is considered to be "acceptable", and indicates that the exposure level does not exceed the safe level or benchmark. In the case of chemicals believed to cause cancer in people, the level of risk experienced after an exposure to a chemical is linked to the possibility that a person could develop cancer sometime during his/her lifetime. The definition of acceptable risk varies among countries or other organizations. Health Canada qualifies the development of an additional cancer in one person out of 100,000 people (*i.e.*, 0.00001) as "*de minimus*" or "essentially negligible". Furthermore, Health Canada views a range of one cancer in 100,000 to one cancer in 1,000,000 as a minimally desirable target, depending on the specific situation and on the degree of conservatism and uncertainty in the risk assessment. A third approach for assessing risks was included in the current human health assessment. For chemicals like dioxin, that are persistent within the body, there is a potential for very high short-term exposures to remain in the body and result in long-term health effects. A body burden based approach was also used to evaluate the potential health risk associated with dioxin exposures.

ES-4.0 PROBLEM FORMULATION

Problem formulation is the information gathering step where the chemicals, receptors (people) and pathways (the ways particular groups of people could be exposed to the chemicals) which need to be assessed are identified. For the Tier 1 risk assessment of the 1966-67 U.S. trials, the chemicals of concern are the manufacturing impurities (contaminants) of the herbicides applied during these trials. These contaminants include PCDD/PCDF (dioxins) and hexachlorobenzene (HCB).

The risk assessment does not evaluate risks to particular people. Rather, risks are assessed for representative groups of people. The following groups of people were assessed:

1. Mixer/Loader – These individuals were responsible for handling, mixing and loading the various herbicide products. For the 1966-67 scenario, this group only included military personnel and it was assumed that different individuals were involved in each year. Exposures of the mixer/loader was assumed to occur during routine mixing and loading activities through the inhalation of vapours and dermal absorption through skin. An accidental scenario was also evaluated in which the mixer/loader experiences an additional dermal exposure event as a result of a spill of concentrated herbicide.
2. Applicator – These individuals are the pilots responsible for applying the herbicide products. For the 1966-67 scenario, this group only included military personnel. It was assumed that all herbicide active ingredients were in liquid form and that exposure occurred as a result of absorption through both dermal and inhalation routes.

3. Flagger – The 1966 and 1967 aerial spray campaigns involved a number of individuals on the ground whose job was to assist the aerial applicator by marking specific locations to begin and end specific spraying events. A flagger was the individual that was responsible for marking the beginning or end of a plot targeted for the aerial application of herbicides. Military personnel were responsible for this activity and it was assumed that an individual was involved in the flagging of all plots receiving chemical mixtures during either the 1966 or 1967 trials. Exposure occurred as a result of absorption through both dermal and inhalation routes.
4. Post-Application Scout – These individuals were responsible for entering the forested area sometime following the application of herbicides for the purpose of making field observations. It was assumed that these receptors would come into direct dermal contact with recently sprayed vegetation. It was assumed that military personnel would be responsible for this activity.
5. On-Site Military Trainee – These military personnel were those who may have spent significant amounts of time in various areas of the base while completing military training, including survival training. It was assumed that this receptor group would have come into direct contact with various environmental media (*i.e.*, soil and wild berries) which have been impacted by the applied herbicide products. For the 1966-67 scenarios, it was assumed that training exercises occurred in direct proximity to the spray areas, during the time of the spraying.

Several receptor groups have not been included in the current assessment (Tier 1). These will be considered in subsequent Tiers. These include:

- Off-Site Civilian – These individuals are those who may have lived near the military base and occasionally used specific areas of the base for recreational purposes (*e.g.*, hunting, walking, berry picking, etc.). This receptor group was not considered for the 1966-67 scenarios as these spray areas are fairly small and remote resulting in limited opportunities for exposures. Spray drift modelling has estimated that virtually all of the herbicide product would have deposited on the foliage and/or ground within 500 ft (152 m) of the flight line, indicating that off-site drift would not have occurred.
- Civilian Spouses – spouses of military personal may have come into contact with the chemicals through contact with clothing brought home by military personnel following spray activities. These potential receptors were not considered as their exposures would have been small as compared to the military personnel directly involved in the spray activities, and as such, these concerns would be less than those quantitatively evaluated.

Exposure pathways (direct and indirect) and scenarios were developed for the following receptor and exposure situations:

- Mixer/loader – routine
- Applicator – routine
- Flagger – routine
- Post Application Scout – routine
- Military Trainee – routine
- Mixer/loader – accident (spill)
- Flagger/trainee – accident (direct spray)

Exposure pathways considered included direct contact (incidental ingestion and dermal contact), inhalation of vapours, contact with impacted soil and/or foliage following spraying, and ingestion of berries impacted by the spraying.

Several potential exposure pathways were eliminated from further consideration. These included:

- Groundwater – No potable groundwater wells exist in close proximity to the 1966 and 1967 spray areas. Base bivouac wells were installed in the mid-1990's and as such were not relevant to the current assessment. The environmental characteristics of dioxins and HCB preclude the likelihood that either dioxin or HCB would migrate from the spray areas to any potable water well either on the base or in its immediate proximity.
- Surface Water – No significant surface water receptors (those with known recreational uses such as fishing) were identified in the vicinity of the 1966 spray area. The 1967 spray area does lie within the watershed that drains the Nerepis River; however, the area is approximately 5 km from the main channel of the river. In addition, environmental characteristics of dioxins and HCB preclude the likelihood that either chemical would migrate from the spray areas to any surface water bodies either on the base or in its immediate proximity.

- Hunting/fishing - this potential pathway was not considered for the 1966-67 scenario as these spray areas are fairly small and remote resulting in limited opportunities for exposures. Spray drift modelling has estimated that virtually all of the herbicide product would have deposited on the foliage and/or ground within 500 ft (152 m) of the flight line, indicating that off-site drift would not have occurred.
- Brush clearing and burning - Brush clearing was not conducted manually in either 1966 or 1967. As such, pathways related to brush clearing and burning were not considered.
- Volatilization following application – given the low vapour pressures of dioxin and HCB this pathway was not considered relevant.
- Contact with chemicals in non-designated spray areas – based on the information provided by the spray drift model which indicated that virtually all of the herbicide product would have deposited on the foliage and/or ground within 500 ft (152 m) of the flight line, drift to non-designated spray areas was not considered. Areas immediately adjacent to the spray plots were considered as part of the actual spray plots.

As appropriate, these pathways will be considered for subsequent Tiers of the human health risk assessment.

ES-5.0 EXPOSURE ASSESSMENT

Exposure assessment estimates the magnitude (level) of exposure for the groups of people and chemicals being assessment. A range of exposures to people at CFB Gagetown in 1966-67 was estimated. The high-case estimate employs a series of individual worst-case assumptions, applied one after another, introducing a bias that represent a worst-case. Similarly, the central and low exposure estimates employed, whenever possible, central (average) and low-end exposure assumptions, respectively. A range of potential exposure values (facilitated through the use of selected low, central and high input parameters) were developed to provide a general appreciation for the level of uncertainty and variability present within the quantitative exposure estimates.

All Canadians are exposed to low levels of dioxins and HCB through background sources such as air, water, soil and foods including those purchased from supermarkets. This background exposure occurs as a result of normal activities unrelated to herbicide use at CFB Gagetown.

ES-6.0 HAZARD ASSESSMENT

Hazard assessment evaluates the toxicological potency of the chemicals of concern and establishes 'safe' levels of exposure. Health effects that may result from exposure to the chemicals are also identified. Dioxins and HCB are known to be associated with various health effects which are summarized below (Table ES-1).

Table ES-1 Chemicals of Concern

Chemical	Major Human Health Effects	
	Non-Cancer	Cancer
Hexachlorobenzene (HCB)	Blood (heme production), as well as liver, ovary, central nervous system effects and	Thyroid cancer, liver cancer, soft tissue sarcoma
Dioxins	Reproductive/hormonal disorders; skin disorders, impaired liver and immune system function, central nervous system pathology, and other developmental effects	Generalized excess of all cancers (linked to occupational exposure and industrial accidents) without any pronounced excess at any specific organ or tissue

The risk assessment uses regulatory limits to predict the potential for these health effects to occur. Most regulatory limits are based on animal studies. Epidemiological studies of which relate exposures to the chemicals of concern and resulting health effects were also reviewed. Studies of Vietnam veterans provide direct evidence of possible health effects of Agent Orange exposure. Therefore, where the risk assessment predicts elevated health risks, the epidemiological information from the Vietnam veterans can be used to identify potential health outcomes among affected individuals who were at CFB Gagetown in 1966-67. It is necessary to point out that the illnesses reported among Vietnam veterans are associated with exposure

to all the chemicals in all the herbicide preparations (and other chemicals) with which they may have come into contact. This report only deals with two contaminants.

Based on the epidemiological evidence, there is sufficient to limited evidence of an association between exposure to herbicides including Agent Orange, among Vietnam veterans who participated in defoliation and chemical spraying (Operation Ranch Hand), and health outcomes including cancer (several forms including soft tissue sarcoma, non-hodgkin lymphoma, hodgkin disease, chronic lymphocytic leukemia, respiratory cancers, prostate cancer); chloracne; peripheral neuropathy; porphyria cutanea tarda; type 2 diabetes (mellitus); and, spina bifida.

There is inadequate or insufficient evidence of an association with other health outcomes including some forms of cancer (acute myelogenous leukemia; hepatobiliary cancers; oral, nasal/nasopharyngeal cancer; bone and joint cancer; breast cancer; female reproductive cancer (cervix, uterus, ovary); urinary bladder cancer; renal cancer; testicular cancer; leukemia (other than CLL); skin cancers), and other non-cancer outcomes such as abnormal sperm characteristics and infertility; spontaneous abortion; neonatal or infant death and stillbirth in offspring of exposed individuals; low birth-weight in offspring of exposed individuals; birth defects (other than spina bifida) in offspring of exposed individuals; neurobehavioral disorders (cognitive and neuropsychiatric); movement disorders, including parkinson's disease and amyotrophic lateral sclerosis (ALS); chronic peripheral nervous system disorders; respiratory disorders; gastrointestinal, metabolic, and digestive disorders (changes in liver enzymes, lipid abnormalities, ulcers); immune system disorders (immune suppression, autoimmunity); circulatory disorders; al amyloidosis; endometriosis; and, effects on thyroid homeostasis.

ES-7.0 RISK CHARACTERIZATION AND CONCLUSIONS

Risk characterization compares the results of the exposure assessment and the hazard assessment and attempts to quantify the chance that an adverse health effect (risk) occurred. The mixer/loader, the applicator, the flagger, the field scout, and the flagger or trainees accidentally exposed during herbicide application were all assumed to have experienced short-term exposures which may have resulted in potential short-term (non-cancer only) and long-term (cancer and/or non-cancer) risks. Military trainees were assumed to have long-term exposure which may potentially relate to long-term risks. Risks associated with dioxin and HCB short- and long-term exposures are listed below.

Dioxins

- With the exception of the Applicator scenario, the short-term risk estimates for all acute exposure scenarios (under the central exposure estimate) were greater than a HQ value of 1.0, indicating that the central exposure estimates exceeded the short-term or acute TRV (200 pg TEQ/kg bw/day). A HQ value greater than 1.0 does not indicate that adverse health effects would have occurred; however, it does indicate that some receptors may have experienced elevated exposures and as such, the potential for elevated risks.
- The short-term risks predicted for all routine exposure scenarios have been classified as "less serious" by ATSDR. "Serious" effects were not noted until exposures of more than 300-fold greater than the acute TRV. These "less serious" exposure levels are not indicative of elevated risks of long-term irreversible health effects, rather, the potential for short-term reversible effects, of the nature considered "less serious".
- Risk estimates predicted for the accident scenarios were indicative of potentially 'serious' effects; however, the occurrence of accidents of this nature during the 1966 and 1967 spray periods remains uncertain. While elevated risks do not necessarily equate to certain effects it does raise the level of concern and indicates that further epidemiological investigation of individuals involved in these operations is warranted.
- Long-term or chronic risk estimates for military trainees who may have inadvertently trained in either the 1966 or 1967 spray areas more than a year following the spray applications were all less than levels that would be indicative of a concern (HQ < 1); as a result, no dioxin related adverse health risks are predicted for military trainees potentially exposed in this manner.
- Elevated body burden were predicted for the two accident scenarios. Elevated body burdens (*i.e.*, levels above the Body Burden TRV) may have persisted in persons experiencing accidental exposures for approximately 52 years following the initial accidental spray/spill event. Background individuals (*i.e.*, those not involved in spraying activities at CFB Gagetown) of the same age were predicted to have dioxin body burden levels above the Body BurdenTRV for 17.5 years. In other words, dioxin body

burden levels among the general population in the 1960's and 1970's were greater than the levels considered acceptable today.

- The body burden results of this assessment are comparable to estimates for the Ranch Hand Veterans who served in Vietnam.
- Based on this assessment, the current body burden levels of individuals who may have experienced elevated exposures during the 1966/67 trials would not likely be distinguishable from the body burden levels of the general population. Although these individuals may currently have body burden levels similar to those of the general population, these individual likely experienced many years of elevated dioxin body burden levels relative to the general population.
- Further investigations of individuals who were present in the vicinity of the spray applications during 1966 and 1967, and may have been experienced these acute exposure events though accidents similar to those considered herein, is warranted. These further investigations could involve body burden analysis, although as indicated above, 40 years after these exposures the body burdens of people are not likely to be distinguishable from the body burden levels of the general population. Additionally, this further investigation could involve an epidemiological study of exposed individuals wherein the incidence of health effects related to the chemicals of concern is investigated.

Hexachlorobenzene

- Short-term or acute estimates for all acute exposure scenarios, with the exception of the mixer/loader accident scenario, are less than levels that would be indicative of a concern (HQ < 1). HQ estimates marginally exceed the 1.0 benchmark for the high end (worst case) mixer/loader accident scenario only. This exposure scenario is considered highly conservative. Given the marginal exceedances estimated and the highly conservative nature of this evaluation, these exceedances are not considered significant or indicative of a potential health risk.
- Long-term or chronic risk estimates for military trainees who may have inadvertently trained in either the 1966 or 1967 spray areas more than a year following the spray applications are all less than levels that are indicative of a concern (HQ < 1 and ILCR < 10 -5 or 1/100,000); as a result, no HCB related adverse health risks are predicted for military trainees potentially exposed in this manner.
- Lifetime cancer risk estimates for all acute exposure scenarios, with the exception of the mixer/loader accident scenario, are less than levels that are indicative of a concern (ILCR < 10^{-5} or 1/100,000). ILCR estimates marginally exceed the 10^{-5} benchmark for the high end (worst case) mixer/loader accident scenario. ILCR estimates for the central tendency receptor are essential equivalent to the benchmark for the 1967 spray period. These risk estimates assume the potential for an increased cancer risk following a one-hit exposure. The evaluation of cancer risks following acute duration exposures is an area of high uncertainty and questionable relevance. Given the marginal exceedances estimated and the highly conservative nature of this evaluation, these exceedances are not considered significant or indicative of an elevated cancer risk.

ES-8.0 UNCERTAINTIES

Where possible, assumptions and estimations were made to err on the side of caution, that is, to over-predict rather than under-predict potential risks. Uncertainties include those surrounding the identification of the people most at risk, how they are exposed to chemicals, concentrations of chemicals in various environmental media (such as air, soil, vegetation), the selection of appropriate regulatory limits (for example, the long-term regulatory limit for dioxins is based on effects in the off-spring of exposed females, which may not be relevant for military personnel in 1966-67), and the use of a body burden approach to estimate risks.

TASK 3A-1 Tier 2

EXECUTIVE SUMMARY

ES-1.0 INTRODUCTION

The Government of Canada has committed to identifying and reporting on facts surrounding the use of Agent Orange and Agent Purple during June, 1966, and June, 1967, in addition to the use of other herbicides, sprayed at Canadian Forces Base (CFB) Gagetown between 1952 and present day. As part of

this commitment, the Government of Canada has engaged non-governmental experts to assess the possibility of military and civilian personnel exposures to herbicides and contaminants within these herbicides, the potential herbicide and contaminant dose received by these personnel, and the potential of these herbicides and contaminants to cause harm. Cantox Environmental Inc. was retained to conduct a human health risk assessment (HHRA) to estimate potential exposures, characterize potential health risks, and determine, in an objective manner, whether exposures to herbicides, and associated contaminants, used at CFB Gagetown may be associated with potential human health risks.

The assessment of exposures and related risks arising from Agent Orange, Agent Purple, other herbicides and any herbicide-related contaminants, particularly dioxins, sprayed at CFB Gagetown from 1952 to the present, has been prioritized into three tiers:

- Tier 1 – 1966-67 U.S. Trials - Manufacturing Impurities (contaminants);
- Tier 2 - 1956-2004 - Manufacturing Impurities (contaminants); and,
- Tier 3 - 1952-2004 - All Herbicide Products, Carriers (*i.e.*, fuel oil), and other chemicals identified on product labels.

The subject of this report is Tier 2. The Tier 1 assessment was released to the public on August 10th, 2006 and, Tier 3 will be the subject of a subsequent report.

Risk Assessment is a tool typically used to address current and future risks. The level of uncertainty resulting from the recreation of activities, some of which occurred more than 50 years ago, coupled with the uncertainties inherent in standard forward-looking risk assessment, is very large. As a result, the expectations regarding the level of precision that this risk assessment exercise can produce should be limited. The risk assessment should be considered part of the weight of evidence needed to identify groups of individuals who may have been adversely affected by historical exposures. By identifying the potential for elevated human health risks for specific groups of individuals and/or activities, the risk assessment can help to guide any future study, such as targeted epidemiological evaluations, by isolating those activities and/or receptor groups of particular interest.

ES-2.0 DESCRIPTION OF TIER 2

The history of herbicide use at CFB Gagetown from 1952 to the present has been documented by Jacques Whitford (JW) as part of Task 2A. The following history has been paraphrased from the Task 2A report:

Herbicides have been applied through ground and aerial applications (helicopter or fixed-wing aircraft) from 1956 to 2004 on CFB Gagetown. No herbicide applications were conducted prior to 1956, in 1959, 1962, or from 1997-1999. JW have confirmed that from 1956 to 2004, a total of 24 products and 14 active ingredients (AI) were applied by DND. In some cases, AIs alone were applied, or in a mix with other AIs. Some products 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 Defense (US DoD) 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, several manufacturing impurities (contaminants) were associated with the products applied. The herbicide products, their active ingredients and the associated contaminants, as identified by JW, were:

1. Dycleer 24 (Active Ingredients: Dicamba and 2,4-D) containing dioxin (from both Dicamba and 2,4-D);
2. Dycleer (Active Ingredient: Dicamba) containing dioxin (from Dicamba);
3. LV Brush Killer 700 (Active Ingredients: Dichloroprop; 2,4-D) containing dioxin (from 2,4-D);
4. Tordon 101 (Active Ingredients: 2,4-D and Picloram) containing dioxin (from 2,4-D) and HCB (from Picloram);
5. Tordon 10K (Active Ingredient: Picloram) containing HCB (from Picloram);
6. Trillion (Active Ingredients: Dicamba, Mecoprop, 2,4-D) containing dioxin (from 2,4-D and Dicamba) and 4-chloro-2-methylphenol (from Mecoprop);

7. Active Ingredient applied directly (2,4,5-T) containing dioxin;
8. Active Ingredients applied directly as a mix (2,4-D and 2,4,5-T) – containing dioxin (from both 2,4-D and 2,4,5-T);
9. Diurex 80 (Active Ingredient: Diuron) containing 3,3',4,4'-tetrachloroazoxybenzene and 3,3',4,4'-tetrachloroazobenzene;
10. Karmex DF (Active Ingredient: Diuron) containing 3,3',4,4'-tetrachloroazoxybenzene and 3,3',4,4'-tetrachloroazobenzene;
11. Krovar (Active Ingredients: Diuron and Bromacil) containing 3,3',4,4'-tetrachloroazoxybenzene and 3,3',4,4'-tetrachloroazobenzene (from Diuron);
12. Active Ingredient applied singly (Active Ingredient: Diquat) containing free 2,2'-bipyridyl;
13. Active Ingredient applied singly (Active Ingredient: Diquat dibromide) containing free 2,2'-bipyridyl (from diquat); and,
14. Active Ingredient applied singly (Active Ingredient: paraquat dibromide) containing free 4,4'-bipyridyl (from paraquat).

The subject of this report is the seven manufacturing impurities associated with the products applied at CFB Gagetown between 1952 and 2004. These include:

- Dioxins;
- Hexachlorobenzene;
- 4,4'-bipyridyl;
- 2,2'-bipyridyl;
- 3,3',4,4'-tetrachloroazoxybenzene;
- 3,3',4,4'-tetrachloroazobenzene; and,
- 4-chloro-2-methylphenol.

Table ES-1 provides a summary of the levels of contaminants in the herbicide products utilized at CFB Gagetown.

Table ES-1 Contaminant Levels for Tier 2 [expressed as ug/g (ppm) of AI]

Active Ingredient	Contaminant	Contaminant Level (ìg/g; ppm)			Reference
		low	central	high	
2,4,5-T	dioxins (TEQ)	0.02	0.5	15.0	Young *et al.*, 1978
2,4-D	dioxins (TEQ)	0	0.00005	0.0001	Health Canada, 2006
Dicamba	dioxins (TEQ)		0.00002		Health Canada, 2006
Picloram (1965-1986)	HCB		200		JW, 2006a
Picloram (1987-1995)	HCB		100		U.S. EPA, 1995; JW, 2006a
Picloram (1996-2001)	HCB		7.4		Health Canada, 2006
Picloram (2002-present)	HCB		5.3		Health Canada, 2006
Diquat	free 2,2'-bipyridyl		10		JW, 2006a
Diuron	3,3',4,4'-tetrachloroazoxybenzene 3,3',4,4'-tetrachloroazobenzene		1-2 10-20		JW, 2006a
Mecoprop	4-chloro-2-methylphenol		15,000		JW, 2006a
Paraquat	free 4,4'-bipyridyl		0.2%		JW, 2006a

For the purposes of the current assessment, all herbicide products applied at the base were assumed to be products registered for use in Canada. As such, contaminant levels have been assumed to fall within levels deemed acceptable through the pesticide registration process. The exception to this pertains to areas sprayed as part of the U.S. Department of Defense (US DoD) and the Canadian Forestry Services (CFS) trial plots. Dioxin levels in unregistered products (Agent Purple and Agent Orange) have been previously documented. Environmental media concentrations and risks estimates for these areas were developed as part of the Tier 1 assessment and are documented therein. For these military products, contaminant levels documented in Tier 1 have been utilized for this assessment.

Figure ES-1 shows the areas of CFB Gagetown where spraying is believed to, or confirmed to, have been carried out between 1956 to 2004, including the test plots. Many areas were only sprayed occasionally, while others were repeatedly sprayed.

Herbicides were applied at CFB Gagetown using aerial and ground based application methods. Helicopter application was the preferred method for spraying from 1965 to 2004, whereas fixed wing aircraft were used predominantly from 1956 to 1964. Applicators also applied herbicides on the ground from trucks or by walking through the

TASK 3A-1 Tier 3

TASK 3A-1: TOXICOLOGICAL RISK ASSESSMENT PERTAINING TO POTENTIAL OCCUPATIONAL AND RELATED EXPOSURES ASSOCIATED WITH HERBICIDE SPRAYING OPERATIONS AT CFB GAGETOWN – TIER 3 – ACTIVE INGREDIENTS (HERBICIDES)

PLAIN LANGUAGE SUMMARY

PLS-1.0 INTRODUCTION

The Government of Canada has committed to identifying and reporting on the facts surrounding herbicide use at CFB Gagetown. As part of this commitment, Cantox Environmental Inc. has been asked to conduct a human health risk assessment to determine, in an independent and objective manner, whether exposures to the herbicides and their associated contaminants may be associated with human health risks.

This assessment has been prioritized into 3 Tiers. The subject of this report is Tier 3, and focuses on the active ingredients in all herbicides sprayed at CFB Gagetown between 1952 and 2004. The Tier 1 assessment, dealing with the contaminants in products tested by the U.S. military in 1966 and 1967, was released to the public on August 10th, 2006, and Tier 2, dealing with all contaminants in all herbicide products used at the Base, was released on December 7th, 2006.

PLS-2.0 DESCRIPTION OF TIER 3

Herbicides have been applied through ground and aerial applications (helicopter or fixed-wing aircraft) from 1956 to the present on CFB Gagetown. No herbicide applications were conducted prior to 1956, in 1959 or 1962, or between 1997 to 1999. Between 1956 and 2004, a total of 24 active ingredients were applied at the base. Evaluation of spraying after 2004 was beyond the scope of this assessment. Certain products 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 of different products. In 1966 and 1967, the Forestry Branch of the Canadian Forestry Service (CFS) and the U.S. Department of Defense (U.S. DOD) conducted tests with various commercially available and military products. In 1990, Dow Chemical of Canada conducted its own evaluation of specific commercially available products. Over the course of these trials, 15 additional products were applied. The herbicide products and their active ingredients are outlined in the following table (Table PLS-1).

Table PLS-1 Herbicide Products and Active Ingredients Used at CFB Gagetown

Herbicide Product	Active Ingredient
Agent Orange	2,4-D; 2,4,5-T
Agent Purple	2,4-D; 2,4,5-T
Agent White	2,4-D; Picloram
Ammate	Ammonium sulfamate
Arsenal	Imazapyr
Decamine	2,4-D; 2,4,5-T
Diurex 80W	Diuron

Table PLS-1 Herbicide Products and Active Ingredients Used at CFB Gagetown

Herbicide Product	Active Ingredient
Dycleer	Dicamba
Dycleer 10P	unknown
Dycleer 24	Dicamba; 2,4-D
Garlon	Triclopyr
Herbec	unknown
Herbec 20P	Tebuthiuron
Karmex DF	Diuron
Krenite Brush Control	Fosamine ammonium
Krovar Diuron;	Bromacil
LV Brush Killer 700	Dichlorprop; 2,4-D
M-2993	picloram; 2,4,5-T
Phytar 160	Sodium Cacodylate; Cacodylic acid
Phytar 560G	Sodium Cacodylate; Cacodylic acid
Roundup	Glyphosate
Roundup Transorb	Glyphosate
Roundup Weathermax with Transorb 2 Technology	Glyphosate
Silvaprop	unknown
Spike (either 5P or 5G)	Tebuthiuron
Spike 5P	Teburthiuron
TBD	2,4-D; 2,4,5-T; 2,3,6-Trichlorobenzoic acid
Timbertox #10	Pentachlorophenol
Tordon 101	2,4-D and Picloram
Tordon 10K	Picloram
Tordon 22K	Picloram
Tordon 22K plus Diquat	Picloram and Diquat
Tordon 22K plus Paraquat	Picloram and Paraquat
Tysben 200	Trichlorobenzoic acid
Trillion	Dicamba, Mecoprop, 2,4-D
Vision	Glyphosate
Active Ingredient applied directly	2,4,5-T
Active Ingredients applied directly as a mixes	2,4-D and 2,4,5-T 2,4-D and 2,4,5-TP (fenoprop) 2,4-D; 2,4,5-T and Sodium trichloroacetate Picloram; Dalapon Hexachloroacetone; 2,4,5-T
Active Ingredient applied singly	Diquat dibromide 2,4-D Picloram Dinitro (dinoseb) Paraquat dichloride

PLS-3.0 METHOD FOR HEALTH RISK ASSESSMENT

HHRA is a scientific evaluation of the potential for exposure to chemicals to result in harmful effects. Most chemicals have the potential to cause harmful effects (*i.e.*, to be toxic) at high enough doses; however, in the absence of high enough exposure, no harm will occur. Generally, as exposure increases, so does the likelihood of harm. The two primary parts of a HHRA are the level of ***exposure*** received and the ***toxicity*** (harmful potential) of the chemical:

RISK = EXPOSURE x TOXICITY

As the chemicals discussed in this report have been linked to both cancer and other illnesses, the HHRAs were conducted using a number of standard methods, developed by regulatory agencies such as Health Canada and the United States Environmental Protection Agency (U.S. EPA):

- In the case of chemicals that do not cause cancer, estimated exposures were compared with safe levels that would not cause harm; and,
- In the case of chemicals that might cause cancer, the lifetime risk of developing cancer was calculated, based on the estimated exposure. Generally, an increased risk ranging between 1 cancer in 1,000,000 people to 1 cancer in 100,000 people is considered to be acceptable.

PLS-4.0 CHEMICALS OF CONCERN AND PEOPLE WHO USE THE BASE

The subject of this report are the 24 active ingredients applied at CFB Gagetown between 1952 and 2004. These include:

- 2,4-D (2,4-dichlorophenoxyacetic acid);
- 2,4,5-T (2,4,5-trichlorophenoxy acetic acid);
- Picloram;
- Dicamba;
- Glyphosate;
- Dichlorprop;
- Pentachlorophenol;
- Diuron;
- Triclopyr;
- Fosamine ammonium;
- Mecoprop;
- Tebuthiuron;
- Paraquat;
- Bromacil;
- Diquat;
- Dinoseb;
- Cacodylic Acid;
- Dalapon;
- Fenoprop (2,4,5-TP);
- Sodium trichloroacetate;
- Imazapyr;
- 2,3,6-Trichlorobenzoic acid;
- Hexachloroacetone; and,
- Ammonium Sulfamate.

In addition, formulants, defined as any substance other than the active ingredient that is intentionally added to a pest control product to improve its physical characteristics, have been considered. Examples of formulants include carriers, surfactants and additives.

The following is a summary of activities and potential receptor groups (a receptor group is a term used to describe a group of people with similar behaviours and/or characteristics that have been considered in the Tier 3 assessment.

- Mixer/Loader – routine aerial and ground applications;
- Applicator – routine aerial and ground applications;
- Flagger – U.S. and CSF herbicide trials
- CFS Timber Worker – post application re-entry of spray areas, and/or the clearing and burning of brush from subject areas that had previously been sprayed with herbicides (brush burning was not quantitatively evaluated);
- Civilian Spouses/Other Family Members (not quantitatively evaluated);
- Bystander (children) – direct contact with spray drift;
- Recreational Users – spending time in areas treated with herbicides;

- Hunters – consumption of wild game caught within watershed areas;
- Resident – off-site exposures as a result of potential drift; and,
- Soldier – routine use of various impacted areas of CFB Gagetown.

PLS-5.0 EVALUATION OF EXPOSURE

All of the ways in which people could come into contact with the contaminants, and the length of time of these exposures, were considered. For each scenario, a range of possible levels of exposures were estimated. High-end exposure estimates were based on a series of worst-case assumptions, applied one after another, so that the final exposure estimates represent an extreme worst-case. Central (average) and low-end exposure estimates were based, whenever possible, on average and low-end assumptions, respectively. These ranges of potential exposure levels provide a general appreciation of the level of uncertainty and variability about the actual exposures that could have occurred. Generally, as much as possible, the assumptions and estimates were made to err on the side of caution, that is, to over-predict rather than underpredict potential exposures and risks. The application of this precautionary approach to the uncertainties arising from the reconstruction of events that occurred 40 years ago means it is very possible that actual exposures and risks were much lower than those estimated.

Different exposure durations were selected based on the historical application data observed at CFB Gagetown. The frequency and duration of herbicide applications varies significantly among different herbicides and, therefore, not all herbicides were treated in the same manner. In some instances, a herbicide may have been applied only once while others may have been applied several times over the course of many years. It was therefore decided to evaluated three possible exposure durations including short-term (or acute), intermediate, and chronic exposure durations. These durations were selected based on typical herbicide application patterns observed at CFB Gagetown.

PLS-6.0 EVALUATION OF HAZARDS (TOXICITY)

At high enough exposures, the herbicide products, and their active ingredients, are known to be associated with adverse health effects, including certain cancers, reproductive effects, hormonal disorders, skin disorders and effects on other organs such as the liver, immune system and nervous system. For comparison purposes, "safe" levels of exposure were determined, which represent the amounts of the chemicals to which a person could be exposed on a daily basis without concern of the exposure causing illness.

PLS-7.0 RESULTS AND CONCLUSIONS

The results of the HHRA must be put into context. The level of uncertainty resulting from the recreation of activities, some of which occurred more than 50 years ago, coupled with the uncertainties inherent in standard forward-looking risk assessment, is very large. As a result, the expectations regarding the level of precision that this risk assessment exercise can produce should be limited. The risk assessment should be considered part of the weight-of-evidence needed to identify groups of individuals who may, or are likely to, have been adversely affected by historical exposures. By identifying the potential for elevated human health risks for specific groups of individuals and/or activities, the risk assessment can help to guide any future study, such as targeted epidemiological evaluations, by isolating those activities and/or receptor groups of particular interest.

The assessment has attempted to ensure that the potential for adverse health effects to occur has not been underestimated. In doing so, numerous assumptions were made to overestimate exposure, toxicity and risk. As a result, in cases where no unacceptable risks are predicted (*i.e.*, for other years, other individuals and/or other activities) there is a degree of confidence that mean and maximum risk estimates have not been underestimated and, therefore, no adverse health effects would be expected to occur.

The following conclusions are drawn:

- Individuals directly involved with herbicide applications (*e.g.*, mixer/loaders, applicators and flaggers), may have experienced elevated short-term exposures to herbicides and as such, the potential for short-term health effects. For many active ingredients, short-term (*i.e.*, acute) toxicity data could not be identified and, therefore, toxicity information protective of long-term exposures were used to characterize acute health risks. As a result, many acute health risk estimates are considered highly uncertain and of questionable relevance. Long-term health risks associated with mean chronic exposure estimates to 2,4,5-T and 2,4-D were identified for mixer/loaders and applicators. As a result,

future investigations should focus on those individuals known to have been involved in the mixing, loading and application of 2,4,5-T and 2,4-D over prolonged periods of time;

- Results indicate that individuals involved in post-application brush clearing and/or scouting may have experienced elevated exposures to herbicides and as such, potentially unacceptable health risks. For many active ingredients, acute and intermediate health risk estimates were derived using chronic (long-term) toxicity data and, therefore, considered highly uncertain. Mean estimates of chronic health risks resulting from long-term exposures to 2,4,5-T; dichlorprop, and diuron were associated with scouting activities. Mean estimates of chronic health risks resulting from long-term exposures to several active ingredients (*i.e.*, 2,4,5-T; 2,4-D; dichlorprop; picloram; diuron; bromacil; diquat, and diesel) were associated with brush clearing. As a result, future investigations should focus on those individuals known to have been involved in the brush clearing and scouting activities over prolonged periods of time;
- It would appear that smoke inhalation is an insignificant exposure pathway based on the modeling assessment conducted by the USDA showing that the airborne herbicide risk to forest workers is insignificant even if the fire occurs immediately after herbicide application;
- A significant amount of evidence exists to suggest that exposure of family members to pesticides through the take-home or track-in pathway can occur. However, it was not possible to quantify this exposure pathway with any level of certainty due to the large number of variables and assumptions required. Based on the information reviewed todate, it is not possible to determine (based on any scientific evidence) the significance of this pathway relative to other pathways and/or receptors. It is expected that risks experienced by family members would be substantially less than those experienced by persons directly involved in spraying and/or forestry activities;
- Bystanders (represented by a preschool child) located directly downwind of the target area at the time of spraying may have experienced elevated short-term exposures to herbicides via inhalation and direct dermal contact with off-target drift (0 to 800 metres from the intended spray line). For several active ingredients (*i.e.*, 2,4,5-T, dinoseb, dalapon, fenoprop, sodium trichloroacetate, 2,3,6-trichlorobenzoic acid, and diesel fuel), short-term risk estimates were derived using toxicity data protective of long-term exposures and, therefore, are considered highly uncertain. Additionally, the majority of active ingredients exceeding a mean HQ value of 1.0 (at 400 metres) were sprayed only as part of the 1966 and 1967 trials, which were controlled in a manner to minimize spray drift. As such, only the acute toxicity reference value for 2,4-D was exceeded (at 400 metres), for active ingredients sprayed repeatedly. Potential bystander exposures were increased on an acute basis only. These elevated short-term exposure levels are not indicative of elevated risks of long-term irreversible health effects, rather, the potential for short-term reversible effects to have occurred;
- No chronic health risks were identified for hunters exposed to herbicides; and,
- Non-occupational receptors (*i.e.*, those not directly involved with herbicide applications) are not expected to have experienced unacceptable long-term human health risks associated with herbicide use at CFB Gagetown.

ES-1.0 INTRODUCTION

The Government of Canada has committed to identifying and reporting on facts surrounding the use of Agent Orange and Agent Purple during June, 1966 and June, 1967 in addition to the use of other herbicides, sprayed at Canadian Forces Base (CFB) Gagetown between 1952 and the present. As part of this commitment, the Government of Canada has engaged non-governmental experts to assess the possibility of military and civilian personnel exposures to herbicides and contaminants within these herbicides, the potential herbicide and contaminant dose received by these personnel, and the potential of these herbicides and contaminants to cause harm. Cantox Environmental Inc. was retained to conduct a HHRA to estimate potential exposures, characterize potential health risks, and determine, in an objective manner, whether exposures to herbicides, and associated contaminants, used at CFB Gagetown may be associated with potential human health risks.

The assessment of exposures and related risks arising from Agent Orange, Agent Purple, other herbicides and any herbicide-related contaminants, particularly dioxins, sprayed at CFB Gagetown from 1952 to the present, has been prioritized into three tiers:

- Tier 1 – 1966 to 1967 U.S. Trials - Manufacturing Impurities (contaminants);
- Tier 2 – 1952 to the present - Manufacturing Impurities (contaminants); and,

- Tier 3 – 1952 to the present - All Herbicide Products, Carriers (*i.e.*, fuel oil), and other chemicals identified on product labels.

The subject of this report is Tier 3, and focuses on the active ingredients in all herbicides sprayed at CFB Gagetown between 1952 and the present. The Tier 1 assessment, dealing with the contaminants in products tested by the U.S. military in 1966 and 1967, was released to the public on August 10th, 2006, and Tier 2, dealing with all contaminants in all herbicide products used at the Base, was released on December 7th, 2006.

Risk Assessment is a tool typically used to evaluate current and future risks. The level of uncertainty resulting from the recreation of activities, some of which occurred more than 50 years ago, coupled with the uncertainties inherent in standard forward-looking risk assessment, is very large. As a result, the expectations regarding the level of precision that this risk assessment exercise can produce should be limited. The risk assessment should be considered part of the weight-of-evidence needed to identify groups of individuals who may have been adversely affected by historical exposures. By identifying the potential for elevated human health risks for specific groups of individuals and/or activities, the risk assessment can help to guide any future study, such as targeted epidemiological evaluations, by isolating those activities and/or receptor groups of particular interest.

ES-2.0 DESCRIPTION OF TIER 3

The history of herbicide use at CFB Gagetown from 1952 to 2004 has been documented by JW (2006a) as part of Task 2A. The following history has been paraphrased from the Task 2A report: Herbicides have been applied through ground and aerial applications (helicopter or fixed-wing aircraft) from 1956 to the present on CFB Gagetown. No herbicide applications were conducted prior to 1956, in 1959, 1962, or from 1997 to 1999. Evaluation of spraying after 2004 was beyond the scope of this assessment. JW (2006a) have confirmed that from 1956 to 2004, a total of at least 24 products and 14 active ingredients were applied by DND. In some cases, AIs were applied alone, or in a mixture with other AIs. Some products 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 CFS and the U.S. DOD 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. The herbicide products and their active ingredients, as identified by JW (2006a), are outlined in the following table (Table ES-1).

Table ES-1 Herbicide Products and Active Ingredients Used at CFB Gagetown

Herbicide Product	Active Ingredient
Agent Orange	2,4-D; 2,4,5-T
Agent Purple	2,4-D; 2,4,5-T
Agent White	2,4-D; Picloram
Ammate	Ammonium sulfamate
Arsenal	Imazapyr
Decamine	2,4-D; 2,4,5-T
Diurex 80W	Diuron
Dycleer	Dicamba
Dycleer 10P	Dicamba
Dycleer 24	Dicamba; 2,4-D
Garlon	Triclopyr
Herbec	Tebuthiuron
Herbec 20P	Tebuthiuron
Karmex DF	Diuron
Krenite Brush Control	Fosamine ammonium
Krovar	Diuron; Bromacil
LV Brush Killer 700	Dichlorprop; 2,4-D

M-2993	picloram; 2,4,5-T
Phytar 160	Sodium Cacodylate; Cacodylic acid
Phytar 560G	Sodium Cacodylate; Cacodylic acid
Roundup®	Glyphosate
Roundup® Transorb	Glyphosate
Roundup® Weathermax with Transorb 2 Technology	Glyphosate
Silvaprop	2,4-D, butoxyethyl ester
Spike (either 5P or 5G)	Tebuthiuron
Spike 5P	Teburthiuron
TBD	2,4-D; 2,4,5-T; Trichlorobenzoic acid
Timbertox #10	Pentachlorophenol
Tordon 101	2,4-D and Picloram
Tordon 10K	Picloram
Tordon 22K	Picloram
Tordon 22K plus Diquat	Picloram and Diquat
Tordon 22K plus Paraquat	Picloram and Paraquat
Tysben 200	Trichlorobenzoic acid
Trillion	Dicamba, Mecoprop, 2,4-D
Vision	Glyphosate
Active Ingredient applied directly	2,4,5-T
Active Ingredients applied directly as mixtures	2,4-D and 2,4,5-T 2,4-D and 2,4,5-TP (fenoprop) 2,4-D; 2,4,5-T and sodium trichloroacetate Picloram; Dalapon Hexachloroacetone; 2,4,5-T
Active Ingredient applied individually	Diquat dibromide 2,4-D Picloram Dinitro (dinoseb) Paraquat dichloride

Figure ES-1 shows the areas of CFB Gagetown where spraying is believed to, or confirmed to, have been carried out between 1956 to 2004, including the test plots. Many areas were only sprayed occasionally, while others were repeatedly sprayed.

Herbicides were applied at CFB Gagetown using aerial and ground based application methods. Helicopter application was the preferred method for spraying from 1965 to 2004, whereas fixed wing aircraft were used predominantly from 1956 to 1964. Applicators also applied herbicides on the ground from trucks or by walking through the bush with a backpack hand sprayer.

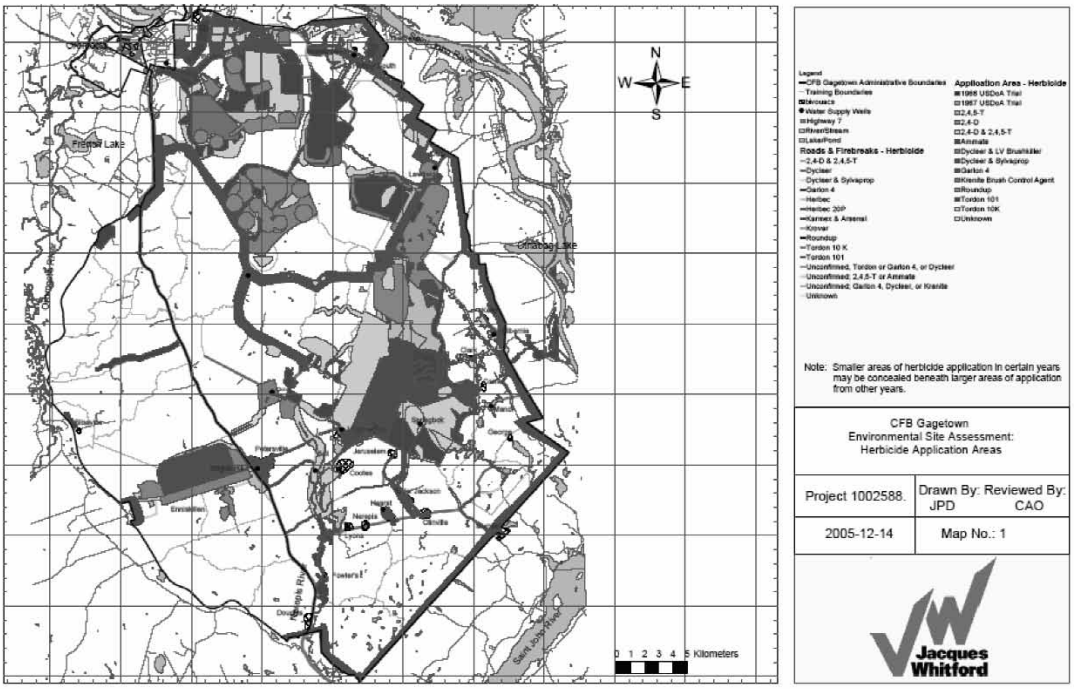


Figure ES-1 Herbicide Application Areas (from JW, 2005)

ES-3.0 HEALTH RISK ASSESSMENT METHODOLOGY

HHRA is a science based tool used to evaluate the potential for adverse human health effects following exposure to chemicals. The "dose-response" principle of toxicology is fundamental to an understanding of the health risks presented by chemicals. All chemicals possess intrinsic toxicity, which is defined as the ability to cause injury to living systems. However, whether or not injury is realized depends on the amount of the chemical that reaches the living system. In the absence of exposure, no injury will occur. As exposure mounts, the likelihood of injury increases.

Based on this principle, it is generally accepted that the two primary determinants of chemicalbased health risks are the level of exposure received and the intrinsic toxicity of the chemical. The principles are often reduced to the simple equation:

RISK = EXPOSURE x TOXICITY

An understanding of these two determinants is critical to the assessment of the health and environmental risks presented by a chemical. HHRA are conducted using risk assessment procedures which have been developed by regulatory agencies such as Health Canada and the United States Environmental Protection Agency (U.S. EPA). The HHRA followed the four standard steps of any risk assessment (see Figure ES-2).

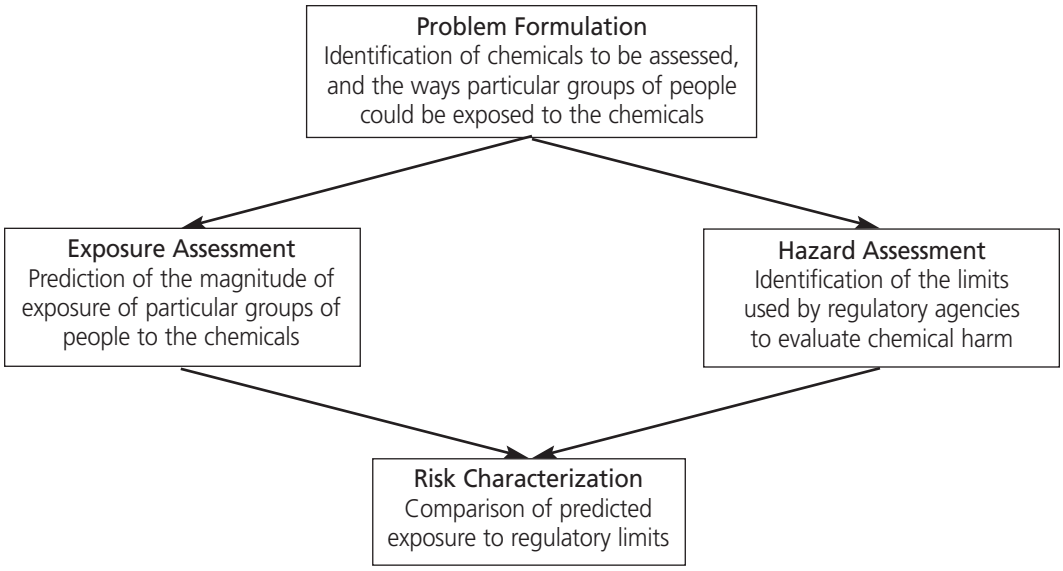


Figure ES-2 The Basic Steps of a Risk Assessment

The chemicals discussed in this report have been linked to both cancer and other non-cancer effects. Risks that link chemical exposure and cancer are calculated differently from other noncancer health risks that are known to be associated with that chemical. In the case of chemicals that do not cause cancer, the level of risk is determined using the ratio of exposure to the level associated with no harm. A ratio (known as the hazard quotient or HQ value) less than or equal to 1 is considered to be "acceptable", and indicates that the exposure level does not exceed the safe level or benchmark. A HQ value greater than 1 indicates the need for further consideration and evaluation. In the case of chemicals believed to cause cancer in people, the level of risk experienced after an exposure to a chemical is linked to the possibility that a person could develop cancer sometime during his/her lifetime. The definition of acceptable risk varies among countries or other organizations. Health Canada qualifies the development of an additional cancer in 1 person out of 100,000 people (*i.e.*, 0.00001) as "*de minimus*" or "essentially negligible". Furthermore, Health Canada views a range of 1 cancer in 1,000,000 to 1 cancer in 100,000 as a minimally desirable target, depending on the specific situation and on the degree of conservatism and uncertainty in the risk assessment

ES-4.0 PROBLEM FORMULATION

From 1956 to 2004, the DND was responsible for the application of 24 herbicide products and 14 active ingredients throughout the Base (JW, 2006a). During this period, some products were used over the course of many years (*e.g.*, Tordon 101 or 10k were used from 1965 to 2003) while others were only used once (*e.g.*, Krovar was only used in 1994). While the use of herbicide products may have varied significantly, certain active ingredients remained in use for almost the entire duration of interest. Various herbicide products containing the active ingredient 2,4-D were applied from 1956 until 2000. Following a spray drift incident in 1964 in which several market gardens were damaged, DND switched from the use of a 2,4-D and 2,4,5-T mixture to Tordon 101which was applied using helicopters. This formulation and method of application was used almost exclusively until 1975 when the use of Tordon 10k pellets became the preferred product (JW, 2006a). While the use of Tordon 10k pellets was common until 1983, a variety of herbicide products were used from 1983 to 2000. Most recently (Post 2001), the majority of herbicide applications at CFB Gagetown have used a form of Roundup® (JW, 2006a).

In 1966, 1967, and 1990, CFB Gagetown was host to herbicide trials designed to test the efficacy of different products and active ingredients. In 1966 and 1967, the Forestry Branch of the CFS and the U.S. DOD conducted separate trials testing various commercially available and military products, as well as various concentrations and mixes of active ingredients. In 1990, Dow Chemical of Canada conducted an evaluation of several commercially available products. Over the course of these trials, 15 additional products (13 active ingredients), not used by DND in annual herbicide spray programs, were applied.

The subject of this report are the 24 active ingredients applied at CFB Gagetown between 1952 and 2004. These include:

- 2,4-D (2,4-dichlorophenoxyacetic acid);
- 2,4,5-T (2,4,5-trichlorophenoxy acetic acid);
- Picloram;
- Dicamba;
- Glyphosate;
- Dichlorprop;
- Pentachlorophenol;
- Diuron;
- Triclopyr;
- Fosamine ammonium;
- Mecoprop;
- Tebuthiuron;
- Paraquat;
- Bromacil;
- Diquat;
- Dinoseb;
- Cacodylic Acid;
- Dalapon;
- Fenoprop (2,4,5-TP);
- Sodium trichloroacetate;
- Imazapyr;
- 2,3,6-Trichlorobenzoic acid;
- Hexachloroacetone; and,
- Ammonium Sulfamate.

In addition, formulants, which are defined as any substance other than the active ingredient that is intentionally added to a pest control product to improve its physical characteristics, and includes carriers, surfactants, and additives have been considered. The formulants were ranked with PMRA's list of approved formulants and those classified as List 1 or 2 were retained for further evaluation as they are considered to be of significant concern to human health. Therefore, diesel was retained for further evaluation in the human health risk assessment. The following is a summary of activities and potential receptor groups that have been considered in the Tier 3 assessment.

- Mixer/loader – routine aerial and ground applications;
- Applicator – routine aerial and ground applications;
- Flagger- routine aerial applications;
- CFS Timber Worker – post application re-entry and brush clearing;
- Bystander (Preschool Child) – direct contact with off-target drift;
- Recreational Users – spending time in areas treated with herbicides;
- Hunters – consumption of wild game caught within the CFB Gagetown;
- Resident – off-site exposures as a result of potential drifting and impacted clothing; and,
- Soldier – routine use of various impacted areas of CFB Gagetown.

ES-5.0 EXPOSURE ASSESSMENT

The exposure assessment typically provides estimates of the daily intake (or exposure) of specific groups of individuals to chemicals of concern (COCs). A range of exposure estimates of different groups of people at CFB Gagetown was provided. The high-end exposure estimates employed a series of individual worst-case assumptions, applied one after another, introducing a bias that represents a worst-case. Similarly, the central and low exposure estimates employed, whenever possible, central (average) and low-end exposure assumptions, respectively. A range of potential exposure values (facilitated through the use of selected low, central and high input parameters) were developed to provide a general appreciation for the level of uncertainty and variability present within the quantitative exposure estimates.

Different exposure scenarios were selected based on the historical application data observed at CFB Gagetown. The frequency and duration of herbicide applications varies significantly among different

herbicides and, therefore, not all herbicides were treated in the same manner. In some instances, a herbicide may have been applied only once while others may have been applied several times over the course of many years. It was therefore decided to evaluated three possible exposure durations including short-term (or acute), intermediate, and chronic exposure durations. These durations were selected based on typical herbicide application patterns observed at CFB Gagetown. Section 6.0 describes the rationale behind the selection of toxicity reference values (TRVs) for each exposure duration of concern. Section 5.0 provides further details regarding which herbicides were assessed under each of the three potential exposure durations. The following provides a summary of the parameters used to define each exposure duration.

1. **Short-term (Acute)**
   Short-term exposures were characterized as ranging from 1 to 7 days. Acute exposures were considered for all herbicides since a short-term event could occur with the use of any herbicide, regardless of the frequency and duration of application. However, those herbicides that were applied during a single year at CFB Gagetown in less than 7 spray days via aerial or ground application were of particular focus. These include many of the herbicides applied during the U.S. 1966 and 1967 trials such as paraquat, dinoseb, dalapon, sodium trichloroacetate, 2,3,6-trichlorobenzoic acid, hexachloroacetone and pentachlorophenol.
2. **Intermediate-term**
   Intermediate-term exposures were characterized as ranging from 7 days to 3 months. Intermediate exposures were considered for only those herbicides that were applied (via aerial or ground based methods) for durations greater than 7 days in any given year.
3. **Long-term (Chronic)**
   Long-term intermediate occupational exposures classified by the U.S. EPA as greater than 6 months were also include in this category. For the purpose of this assessment, chronic exposure durations were assumed to be approximately 6 months to a lifetime in duration. Chronic exposures were calculated when a herbicide was applied during more than one spray season. Chronic occupational exposures were also calculated in circumstances where a particular herbicide may have been sprayed for multiple years; however, only for several days each year. With the exception of the bystander (preschool child) scenario, all non-occupational receptors were evaluated under a chronic exposure scenario (*i.e.*, for herbicides that were sprayed in more than a single year).

ES-6.0 HAZARD ASSESSMENT

At high enough exposures, the herbicide products, and their active ingredients, are known to be associated with adverse health effects, including certain cancers, reproductive effects, hormonal disorders, skin disorders and effects on other organs such as the liver, immune system and nervous system. For comparison purposes, "safe" levels of exposure were determined, which represent the amounts of the chemicals to which a person could be exposed on a daily basis without concern of the exposure causing illness.

The exposure limits employed in the current assessment were obtained from regulatory agencies including Ontario Ministry of the Environment (OMOE); Health Canada, the Canadian Council of the Ministers of the Environment (CCME); the World Health Organization (WHO); the United States Environmental Protection Agency (U.S. EPA); the U.K. Product Safety Directorate Databases (PSD), and the Pest Management Regulatory Agency (PMRA).

TRVs were divided into three specific exposure durations. These durations were selected based on typical herbicide application patterns observed and scenarios evaluated at CFB Gagetown.

1) **Short-term (Acute)**
   These TRVs were utilized for those herbicides that were applied during a single year at CFB Gagetown in less than seven spray days via aerial or ground application. These include many of the herbicides applied during the U.S. 1966 and 1967 trials such as paraquat, dinoseb, dalapon, sodium trichloroacetate, 2,3,6-trichlorobenzoic acid, hexachloroacetone and pentachlorophenol. These short-term TRVs were also used with herbicides (*i.e.*, mecoprop, bromacil, and ammonium sulfamate) applied to routine treatment areas at CFB Gagetown.
2) **Intermediate-term**
   These TRVs were only used when historical records indicated that herbicide applications (via aerial or ground based methods) may have lasted more than 7 days in any given year.

3) Long-term (Chronic)

For the purpose of this assessment, chronic exposure durations were assumed to be approximately 6 months to a lifetime in duration. Chronic TRVs were used when a herbicide was applied during more than one spray season. Chronic TRVs were also applied in circumstances where a particular herbicide may have been sprayed for multiple years; however, only for several days within each year.

When toxicity data for a particular active ingredient were available from multiple regulatory agencies, or multiple values were available from a single agency, all exposure limits were reviewed and professional judgement was used to select the most appropriate regulatory exposure limit for the current assessment. The most critical considerations in selecting TRVs were the source (it must be derived by a reputable agency), the date it was derived (it must be as up to date as possible) and its relevance in terms of duration and route of exposure.

The agencies considered when selecting TRVs were as follows:

- PMRA;
- Health Canada (Contaminated sites Program);
- U.S. EPA IRIS;
- U.S. EPA (other sources); and,
- Other jurisdictions such as the WHO.

For many of the herbicides (*e.g.*, picloram, glyphosate, mecoprop and diuron) regulatory agencies such as the U.S. EPA, PMRA or the PSD indicate that specific exposure durations and/or routes of exposure do not need to be evaluated. For instance, the U.S. EPA (1995) indicated that a short-term TRV was not required for picloram as no short term toxicological concerns were indicated for occupational exposures.

When exposure limits were not available for certain exposure durations or routes of exposure other TRVs were utilized.

ES-7.0 RISK CHARACTERIZATION

Individuals Directly Involved with Herbicide Applications (Mixer/loaders, Applicators and Flaggers)

Acute Scenarios

It is noted that for a number of active ingredients (*i.e.*, 2,4,5-T; dinoseb; dalapon; fenoprop; sodium trichloroacetate; 2,3,6-trichlorobenzoic acid; hexachloroacetone; ammonium sulfamate, and diesel) acute HQ values were derived using chronic RfD values and, therefore, these HQ estimates are highly uncertainly and of questionable relevance.

Aerial Application

The mixer/loader was associated with largest number of HQ estimates exceeding a value of 1.0 under aerial applications. With the exception diuron and imazapyr, all maximum HQ estimates exceeded a value of 1.0. Maximum HQ estimates reflect limited use of PPE equipment and the lack of modern occupational practices. With the exception of those products applied in the 50's and 60's (2,4,5-T; 2,4-D, and picloram), these risk estimates are of little relevance. Mean to low HQ estimates reflect potential hazards which are likely indicative of more modern application practices and protective equipment. With few exceptions (2,4,5-T; 2,4-D; paraquat; dinoseb; diquat; hexachloroacetone, and diesel), all mean HQ estimates for the applicator were less than a value of 1.0. HQ estimates for the applicator and flagger were lower than the mixer/loader under aerial application methods and exceeded a value of 1.0 for 2,4,5-T; 2,4-D; paraquat; diquat, and dinoseb. HQ estimates also exceeded 1.0 for the phenoxyalkanoic acids group and the bipyridyls group of active ingredients for the mixer/loader, applicator and flagger.

Ground Applications

Mixer/loader results were consistent with the aerial application scenario. The ground applicator had the largest number of HQ values exceeding a value 1.0. Elevated mean HQ estimates for the applicator were observed for 2,4 5-T; 2,4-D; dicamba; paraquat; diquat; mecoprop; dinoseb; dalpon; fenoprop; 2,3,6-trichlorobenzoic acid; hexachloroacetone; teburthiuron, and diesel. HQ estimates also exceeded 1.0 for the phenoxyalkanoic acids group and the bipyridyls group of active ingredients for the mixer/loader. All group HQ estimates exceeded 1.0 for the applicator.

Intermediate Scenarios

Aerial Application

Intermediate mean HQ estimates exceeded a value of 1.0 for the mixer/loader, applicators and flaggers for 2,4 5-T and 2,4-D. All other mean intermediate HQ estimates were either less than a value of 1.0 or not assessed due to the duration of the exposure event (*i.e.*, < 7 days in duration).

Ground Applications

Under the scenario of ground-based application methods, intermediate mean HQ for the mixer/loader were less than 1.0 with the exception of 2,4,5-T and 2,4-D. Mean intermediate HQ estimates for the applicators exceeded a value 1.0 for 2,4,5-T; 2,4-D; dicamba and diesel. It is noted that intermediate HQ estimates for 2,4,5-T; dichloroprop, and diesel were derived using chronic RfD values.

Chronic Scenarios

Aerial Application

Chronic mean HQ estimates for 2,4,5-T and 2,4-D exceeded a value of 1.0 for the mixer/loader. All HQ estimates (including maximum predictions) resulting from chronic application and flagging activities were less than a HQ value of 1.0. Maximum chronic HQ estimates from mixing/loading were exceeded a value of 1.0 for 2,4,5-T; 2,4-D; dichlorprop; picloram; diuron, and diesel fuel.

Ground Applications

For ground-based application methods, the maximum chronic HQ estimates for the mixer/loader and the applicator exceeded a value of 1.0 for 2,4,5-T; 2,4-D; dichlorprop; picloram; diuron, and diesel fuel. Mean chronic HQ estimates for the mixer/loader and the applicator exceeded a value of 1.0 for 2,4,5-T and 2,4-D.

Individuals Involved in Brush Clearing and Scouting Activities

Acute Scenarios

Brush clearing related exposures and associated health risks are generally greater than those predicted for the scout. This is primarily due to the different dermal contact rates for each type of activity. Brush clearing activities have dermal contact rates that are several times greater than those of the scout. For the majority of active ingredients, HQ estimates greater than 1.0 were observed for brush clearing activities. Although scouting related risks were lower than those of the brush clearer, several active ingredients (*i.e.*, 2,4,5-T, bromacil, dinoseb, diquat, cacodylic acid, dalapon, fenoprop, sodium trichloroacetate, 2,3,6-thrichlorobenzoic acid, hexachlorobenzene, and pentachlorophenol) had mean HQ estimates greater than a value of 1.0. A number of acute HQ estimates (*i.e.*, 2,4,5-T; dinoseb; dalapon; fenoprop; sodium tricholoracetate; 2,3,6-trichlorobenzoic acid; hexachloroacetone, and diesel) were derived using chronic RfD values.

Intermediate Scenarios

For a number of active ingredients (*i.e.*, 2,4,5-T; 2,4-D; bromacil; dichlorprop; diquat; dinoseb; diesel fuel, and tebuthiuron), mean HQ estimates greater than 1.0 were identified with brush clearing activities. Although scouting related risks were lower than those of the brush clearer, several active ingredients (*i.e.*, 2,4,5-T; 2,4-D; bromacil, and dichlorprop) had mean HQ estimates greater than 1.0.

Chronic Scenarios

Elevated mean HQ estimates (*i.e.*, greater than a value of 1.0) for the Scout were identified for 2,4,5-T, dichloroprop and diuron. Elevated mean HQ estimates for the Brush Clearer were identified for 2,4,5-T; 2,4-D; dichloroprop; picloram; diuron; bromacil; diquat, and diesel fuel.

Individuals Not Directly Involved in Herbicide Spray Activities (Preschool Children (Bystanders), Civilians, Hunters/Anglers, Recreational Users)

Acute Scenarios

Bystander (represented by preschool children)

In general, short-term HQ estimates were considered elevated for most active ingredients of concern. Exposures (and associated risks) resulting from direct dermal contact with spray drift were several orders of magnitude higher than inhalation related risk estimates.

At the 800 metres down wind of the intended target area, 11 active ingredients were associated with mean HQ values greater than 1.0, (*i.e.*, 2,4,5-T; 2,4-D; dicamba, paraquat, dinoseb, diquat, dalapon, fenoprop, sodium trichloroacetate, hexachloroacetone and pentachlorophenol). Several of active ingredients (*i.e.*, 2,3,5-T; dinoseb; dalapon; fenoprop; sodium trichloroacetate; 2,3,6- Trichlorobenzoic acid, and diesel) have no acute RfD values and, therefore, long-term chronic RfD data were used to characterize health risks resulting from a short-term event.

Chronic Scenarios

A comparison between site-related and background HQ estimates suggest that individuals who were not directly involved in the herbicide application process, may have been subjected to siterelated exposures that were, in general, much lower (*i.e.*, several times to orders of magnitude lower) than non-site related (*i.e.*, background) exposures. In some instances (such as picloram and glyphosate), site-related risks were similar to those associated with background; however, the addition of background and site-related risks were still several order of magnitude less than the chronic RfD used to derive the HQ estimate.

Hunters

No chronic health risks were identified for hunters potentially exposed to herbicides.

Recreational Users, Soldiers and Civilians

No chronic human health risks were identified for all other recreational users, soldiers or civilians potentially exposed to herbicide residues via incidental soil ingestion, direct dermal contact with soil, dust inhalation and the consumption of wild berries.

ES-8.0 CONCLUSIONS

The results of the HHRA must be put into context. The level of uncertainty resulting from the recreation of activities, some of which occurred more than 50 years ago, coupled with the uncertainties inherent in standard forward-looking risk assessment, is very large. As a result, the expectations regarding the level of precision that this risk assessment exercise can produce should be limited. The risk assessment should be considered part of the weight-of-evidence needed to identify groups of individuals who may, or are likely to, have been adversely affected by historical exposures. By identifying the potential for elevated human health risks for specific groups of individuals and/or activities, the risk assessment can help to guide any future study, such as targeted epidemiological evaluations, by isolating those activities and/or receptor groups of particular interest.

The assessment has attempted to ensure that the potential for adverse health effects to occur has not been underestimated. In doing so, numerous assumptions were made to overestimate exposure, toxicity and risk. As a result, in cases where no unacceptable risks are predicted (*i.e.*, for other years, other individuals and/or other activities) there is a degree of confidence that mean and maximum risk estimates have not been underestimated and, therefore, no adverse health effects would be expected to occur.

The following conclusions are drawn:

- Individuals directly involved with herbicide applications (*e.g.*, mixer/loaders, applicators and flaggers), may have experienced elevated short-term exposures to herbicides and assuch, the potential for short-term health effects. For many active ingredients, short-term (*i.e.*, acute) toxicity data could not be identified and, therefore, toxicity information (*i.e.*, TRVs) protective of long-term exposures were used to characterize acute health risks. As a result, many acute health risk estimates are considered highly uncertain and of questionable relevance. Long-term health risks associated with mean chronic exposure estimates to 2,4,5-T and 2,4-D were identified for mixer/loaders and applicators. As a result, future investigations should focus on those individuals known to have been involved in the mixing, loading and application of 2,4,5-T and 2,4-D over prolonged periods of time.
- Results indicate that individuals involved in post-application brush clearing and/or scouting may have experienced elevated exposures (dermal route) to herbicides and as such, potentially unacceptable health risks. For many active ingredients, acute and intermediate health risk estimates were derived using chronic (long-term) toxicity data and, therefore, considered highly uncertain. Mean estimates of chronic health risks resulting from long-term expsosures to 2,4,5-T; dichlorprop, and diuron were

associated with scouting activities. Mean estimates of chronic health risks resulting from long-term expsosures to several active ingredients (*i.e.*, 2,4,5-T; 2,4-D; dichlorprop; picloram; diuron; bromacil; diquat, and diesel) were associated with brush clearing. As a result, future investigations should focus on those individuals known to have been involved in the brush clearing and scouting activities over prolonged periods of time.

- It would appear that smoke inhalation is an insignificant exposure pathway based on the modeling assessment conducted by the USDA showing that the airborne herbicide risk to forest workers is insignificant even if the fire occurs immediately after herbicide application;
- A significant amount of evidence exists to suggest that exposure of family members to pesticides through the take-home or track-in pathway can occur. However, it was not possible to quantify this exposure pathway with any level of certainty due to the large number of variables and assumptions required. Based on the information reviewed todate, it is not possible to determine (based on any scientific evidence) the significance of this pathway relative to other pathways and/or receptors. It is expected that risks experienced by family members would be substantially less than those experienced by persons directly involved in spraying and/or forestry activities;
- Bystanders (represented by a preschool child) located directly downwind of the target area at the time of spraying may have experienced elevated short-term exposures to herbicides via inhalation and direct dermal contact with off-target drift (0 to 800 metres from the intended spray line). For several active ingredients (*i.e.*, 2,4,5-T, dinoseb, dalapon, fenoprop, sodium trichloroacetate, 2,3,6-trichlorobenzoic acid, and diesel fuel), short-term risk estimates were derived using toxicity data protective of long-term exposures and, therefore, are considered highly uncertain. Additionally, the majority of active ingredients exceeding a mean HQ value of 1.0 (at 400 metres) were sprayed only as part of the 1966 and 1967 trials, which were controlled in a manner to minimize spray drift. As such, only the acute TRV for 2,4-D was exceeded (at 400 metres), for active ingredients sprayed repeatedly. Potential bystander exposures were increased on an acute basis only. These elevated short-term exposure levels are not indicative of elevated risks of long-term irreversible health effects, rather, the potential for short-term reversible effects to have occurred.
- No chronic health risks were identified for hunters exposed to herbicides; and,
- Non-occupational receptors (*i.e.*, those not directly involved with herbicide applications) are not expected to have experienced unacceptable long-term human health risks associated with herbicide use at CFB Gagetown.

ES-9.0 UNCERTAINTIES

Where possible, assumptions and estimations were made to err on the side of caution, that is, to over-estimate rather than under-estimate potential risks. Uncertainties include those surrounding the identification of the people most at risk, how they are exposed to chemicals, concentrations of chemicals in various environmental media (such as air, soil, vegetation), and the selection of appropriate regulatory limits.

TASK 3A-2

Executive Summary

This risk assessment addresses the potential for adverse health effects associated with potential exposures to herbicide residues at Canadian Forces Base (CFB) Gagetown. Health Canada has commissioned Dillon Consulting and RBR Consulting to prepare this risk assessment to address concerns that those who currently might work at, or otherwise come into contact with the base might be exposed to residuals of herbicides and herbicide-related compounds such as polychlorinated dibenzo-p-dioxins and furans (PCDD and PCDF) associated with the spraying of Agent Orange and related herbicides there decades ago.

CFB Gagetown occupies approximately 110,000 hectares with its main offices located adjacent to the community of Oromocto, New Brunswick. A range training area (RTA), which is used for live-fire training, accounts for about 30,000 hectares of this land and is closed to public access. The remaining 80,000 hectares are used for military training, but also accommodate a number of non-military activities including forest management, hunting, fishing and other recreational activities. The current land uses for CFB Gagetown are not expected to change in the foreseeable future.

The Federal Government has launched an initiative that will report on the facts surrounding the use of Agent Orange, Agent Purple and other herbicides and herbicide-related chemicals during the specific test periods in June 1966 and June 1967. The initiative also encompasses the identification and reporting of facts surrounding the use of herbicides and herbicide-related chemicals used as CFB Gagetown between 1952 to the present day. This *Human Health Risk Assessment* (HHRA) represents Fact-Finding Task 3A-2, and evaluates potential human exposures to current levels of herbicides and herbicide-related chemicals for people who could be expected to be on the site currently or in the future. It addresses potential exposure and the associated hazards and/or risks for military personnel and members of the general public who may access the base for recreational purposes and who may come into contact with residual levels of herbicides and herbicide-related chemicals while on the base.

In order to develop exposure scenarios that adequately describe potential exposures for the various user groups, it was necessary to identify distinct exposure *Subject Areas* (SAs) across the base that reflect the variation in exposure potential that exists across the Base. The SAs included in the HHRA and the receptors considered on each are listed below.

Subject Area	Receptors
SA 1 – 1966 Test Area	Soldiers & Recreational Users
SA 2 – Rippon Road	Soldiers & Timber Harvesters
SA 3 – Murphy Bivouac	Soldiers, Youth Campers & Recreational Users
SA 4 – Clones Bivouac	Soldiers
SA 5 – Base Administration and Parks	Soldiers & Recreational Users
SA 6 – Static Range Impact Area	Soldiers
SA 7 – General Manoeuvres Area	Soldiers
SA 8 – Base Perimeter and Fire Breaks	Soldiers & Recreational Users
SA 9 – Nerepis River	Anglers
SA 10 – Swan Creek Lake	Anglers
SA 11 – CFB Gagetown	Hunters

Detailed review of the environmental quality data for surface soil, groundwater, surface water, sediment and vegetation showed that polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) were the only chemicals that were present in these environmental media at levels that exceed the *Environmental Quality Guidelines* (screening criteria) established by the Canadian Council of Ministers of the Environment (CCME). Thus PCDD/PCDF was the only chemical considered in the HHRA. The levels of the other chemicals evaluated in the ESA were all below their respective screening criteria and would not represent a potential concern for human health at the concentrations in the environmental media reported for the Base.

The risk assessment evaluated exposures for the relevant exposure pathways (ways that a receptor could come into contact with a chemical) for the receptors identified in each of the SA considered in the HHRA. Although the relevant exposure pathways evaluated varied between the SAs, the following exposure pathways were considered for one or more of the SAs:

- Inadvertent ingestion of soil;
- Dermal contact with soil;
- Inhalation of soil particulate;
- Inadvertent ingestion of sediment;
- Dermal contact with sediment;
- Inadvertent ingestion of groundwater;
- Dermal contact with groundwater;
- Inadvertent ingestion of surface water;
- Dermal contact with surface water;
- Ingestion of deer or moose;
- Ingestion of fish; and
- Ingestion of berries.

The results of the HHRA showed that for all receptors, except the angler, the Hazard Indices (HI) calculated for base-related exposures are well below the hazard acceptability benchmark of 0.2 (20% of the Toxicity Reference Value (TRV), established by Health Canada (Health Canada, 2004). In most cases, the HIs are 100 to 1,000-fold lower than the 0.2 benchmark.

For the general population background exposures to PCDD/PCDF from food and other sources range between 1.32 pg TEQ/kg-day for the adult to 5.92 pg TEQ/kg-day for the infant. Base-related exposures to PCDD/PCDF in soil, sediment, surface water, groundwater, deer, moose and berries represent incremental increases of less than 1% in these background exposures.

The predicted HI values for the angler exceed established benchmarks. While this by itself does not indicate that unacceptable non-cancer hazard exists, it suggests that additional consideration of this pathway may be warranted. It is important to note that the results for the angler rely heavily on foodchain (bioaccumulation) modeling that can reliably be expected to over estimate the actual concentration of PCDD/PCDF in fish tissue. As such, these results should be viewed with caution.

Further consideration, possibly direct measurement of fish tissue, may be warranted.

Based on the results of the HHRA, the following recommendations can be made for the individual *Subject Areas*:

- **Subject Area 1 – 1966 Test Area**
  Exposures to PCDD/PCDF in the 1966 Test Area do not represent a potential concern for human health for either the soldier or recreational receptor. Therefore, restricting access to this area to limit potential exposures to PCDD/PCDF for these receptors is not warranted.
- **Subject Area 2 – Rippon Road**
  Exposures to PCDD/PCDF in the Rippon Road area do not represent a potential concern for human health for either the soldier or timber harvester. Therefore, restricting access to this area to limit potential exposures to PCDD/PCDF for these receptors is not warranted.
- **Subject Area 3 – Murphy Bivouac**
  Exposures to PCDD/PCDF in the Murphy Bivouac area do not represent a potential concern for human health for the soldier, youth camper or recreational user. Therefore, restricting access to this area to limit potential exposures to PCDD/PCDF for these receptors is not warranted.
- **Subject Area 4 – Clones Bivouac**

  Exposures to PCDD/PCDF in the Clones Bivouac area do not represent a potential concern for human health for the soldier. Therefore, restricting access to this area to limit potential exposures to PCDD/PCDF for this receptor is not warranted.
- **Subject Area 5 – Base Administration and Parks**
  Exposures to PCDD/PCDF in the Base Administration and Parks area do not represent a potential concern for human health for the soldiers or recreational receptor. Therefore, restricting access to this area to limit potential exposures to PCDD/PCDF for these receptors is not warranted.
- **Subject Area 6 – Static Range Impact Area**
  Exposures to PCDD/PCDF in the Static Range Impact Area do not represent a potential concern for human health for the soldier receptor. Therefore, restricting access to this area to limit potential exposures to PCDD/PCDF for this receptor is not warranted.
- **Subject Area 7 – General Manoeuvres Area**
  Exposures to PCDD/PCDF in the General Manoeuvres Area do not represent a potential concern for human health for the soldier receptor. Therefore, restricting access to this area to limit potential exposures to PCDD/PCDF for this receptor is not warranted.
- **Subject Area 8 – Base Perimeter and Fire Breaks**
  Exposures to PCDD/PCDF in the Base Perimeter and Fire Breaks do not represent a potential concern for human health for the soldier or recreational receptor. Therefore, Human Health Risk Assessment for Page iv Current Exposures to Herbicides & Herbicide-Related Chemicals July 14, 2006 CFB Gagetown, Oromocto, N.B. Dillon Consulting Limited restricting access to this area to limit potential exposures to PCDD/PCDF for these receptors is not warranted.
- **Subject Area 9 – Nerepis River**
  Exposures to PCDD/PCDF in soil, sediment and surface water in the Nerepis River area do not represent a potential concern for human health for the angler receptor. Therefore, restricting access to this area to limit potential exposures to PCDD/PCDF in soil, sediment and surface water is not warranted.

Further consideration of the potential exposures to PCDD/PCDF through the ingestion of fish may be warranted.

- **Subject Area 10 – Swan Creek Lake**
  Exposures to PCDD/PCDF in soil, sediment and surface water in the Swan Creek Lake area do not represent a potential concern for human health for the angler receptor. Therefore, restricting access to this area to limit potential exposures to PCDD/PCDF in soil, sediment and surface water is not warranted. Further consideration of the potential exposures to PCDD/PCDF through the ingestion of fish may be warranted.
- **Subject Area 11 – CFB Gagetown**
  Exposures to PCDD/PCDF in the CFB Gagetown Area do not represent a potential concern for human health for hunter receptor. Therefore, restricting access to this area to limit potential exposures to PCDD/PCDF for this receptor is not warranted.

These results indicate that for all receptors and pathways considered, with the possible exception of the ingestion of fish caught in the Nerepis River or Swan Creek Lake, exposures to PCDD/PCDFs in soil, sediment, surface water, groundwater, moose, deer and berries clearly do not and will not represent a potential concern for human health at CFB Gagetown.

Task 3B

Executive Summary

1. The purpose of this descriptive epidemiologic study was to determine whether there is evidence of increased chronic disease risk, particularly cancers, in residents of a region comprising CFB Gagetown and surrounding areas, that was identified by the community as being exposed to herbicides and herbicide-related contaminants used at CFB Gagetown from 1952 to 2004 (heretofore called the Gagetown Study Region, or GSR), compared to the risk for chronic disease in all residents of the Province of New Brunswick.
2. Of special concern are the health risks that may have resulted from exposure to experimental applications of Agent Orange and Agent Purple during the specific test periods in June 1966 and June 1967 and other herbicides used at the base. Diseases were chosen on the basis of the results of a recently completed review of the current scientific literature that identified certain outcomes as being more likely to be associated with exposure to herbicides that were sprayed in the GSR. This list was further refined based upon the quality of diagnostic information related to these health effects and upon the availability of validated data in New Brunswick.
3. Five year average age- standardized mortality and cancer incidence rates and 95% confidence intervals were calculated (via the direct method) for the selected diseases for both males and females and for five year time intervals for the GSR and for the Province of New Brunswick for the time interval of 1980 (mortality) or 1984 (cancer incidence) to 2003. The time period was chosen on the basis of the period for which data were available. Standardized incidence ratios (SIR) and standardized mortality ratios (SMR) and 95% confidence intervals were computed in order to present a composite picture of the comparative health experience of Gagetown Study Region residents versus the Province of New Brunswick residents during corresponding time periods. Also population attributable risks for several diseases were generated to estimate the 'health impact' that are associated with living in and, hence, being exposed to the Gagetown region.
4. For both men and women, Gagetown Study Region residents' overall experience with mortality and cancer incidence was similar to that calculated for the Province as a whole over the entire period of study. Men in the GSR had a slightly reduced risk of dying from cancer than the entire province. For most of the specific disease outcomes, there were few differences between the GSR population and the Province of New Brunswick as a whole for both mortality and cancer incidence. Breast cancer incidence was slightly but statistically significantly elevated for all four time periods for women. Because there was no information about the multiple risk factors for breast cancer, including environmental exposures, obesity and smoking, that may explain this finding, it was not possible to draw conclusions about what might be possible explanations for this result, or whether indeed this was clinically significant.

5. Nasopharyngeal cancer for female GSR residents compared to female Province of New Brunswick residents was observed to be significantly elevated in 1999-2003 and suggestively elevated in 1984-1988. This is a very rare form of cancer and subject to considerable statistical uncertainty. No Gagetown cases were observed for the other two time intervals. For the entire 20 year interval, the standardized incidence ratio was mildly elevated at 1.4 but this finding was not statistically significant. These data were also based on very few cases (total = 4). There were no nasopharyngeal cancer deaths in GSR women during the study period which prevented calculation of mortality rates for this outcome. Nasal sinus cancer incidence or mortality risk did not appear to be elevated in GSR women compared to New Brunswick women.
6. Nasopharyngeal cancer incidence appeared elevated for GSR men compared to New Brunswick men during 1984-1988 (SIR= 2.07) though the 95% confidence interval was large and was not statistically significant. Standardized incidence ratios were lower for other time periods and were not statistically significant. Statistically elevated SMRs for nasopharyngeal cancer mortality in GSR males were observed for 1984-1988, and the point estimates for nasopharyngeal cancer SMRs were of similar magnitude (SMR= 1.76, 1.96, 1.57; not statistically significant) during 1980-1984, 1989-1993 and 1994-1998 but not for the most recent time interval when there were no deaths from this cancer in men. These ratios are all based upon sparse data; there were only 3 nasopharyngeal cancer deaths observed in GSR for the 25 year span.
7. Development of individual exposure profiles to the CFB Gagetown experimental sprays was not possible due to lack of accessible, systematic information that would be required to perform this analysis. Differentiation between health effects resulting from the experimental herbicides and others sprayed in routine applications at the base was also not possible due to the current lack of this information. Separation of health outcomes that resulted from exposure to the range of herbicides used at CFB Gagetown from those factors that may have been caused by other environmental or lifestyle and genetic factors was also not possible without complete exposure histories of those employed or otherwise exposed at the base.
8. This is an exploratory study that may lead to future research; feasibility of further work would depend upon the extent of documentation related to the identity of those exposed and the nature of those individuals' exposures. Possible studies might include a record-linkage cohort study of the health experience of CFB Gagetown personnel who worked as mixers, loaders, applicators or flaggers during the applications and CFB Gagetown civilian and military personnel who worked in post-herbicide-application brush cleaning operations. Prior to proceeding with such work, study design features, including an assessment of whether sufficient numbers of cases were likely to occur to support such an analysis. Other concerns would be loss of the ability to follow up cases due to fact that perhaps many of the most vulnerable subjects may no longer be living and the lack of adequate information about past personal exposures.
9. This study makes no attempt to draw conclusions about the causes of a particular individual's disease or death. This is the responsibility of that individual patient's physician who is able, through collection of a careful clinical and environmental history and diagnostic information from the patient, to identify those factors that are contributory to the development and prognosis of an individual's disease.

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Task 3

SUMMARY REPORT

INVESTIGATION OF POTENTIAL HEALTH EFFECTS FROM THE USE OF HERBICIDES AND ANY HERBICIDE-RELATED CONTAMINANTS, PARTICULARLY DIOXINS USED AT CFB GAGETOWN FROM 1952 TO THE PRESENT

This report serves to integrate the findings of the CFB Gagetown Task 3A and the Task 3B reports in order to provide an assessment of the documented or potential exposures to the combination of previous herbicide exposures that occurred at the base from 1952 to 2003 and health effects. Recommendations for future research and the feasibility of conducting such investigations are described.

Highlights – Task 3A Report

The Task 3A Human Health Risk Assessment Report was prioritized into three tiers:

- Tier 1 – 1966 to 1967 U.S. Trials - Manufacturing Impurities (contaminants);
- Tier 2 – 1952 to the present - Manufacturing Impurities (contaminants); and,
- Tier 3 – 1952 to the present - All Herbicide Products, Carriers (*i.e.*, fuel oil), and other chemicals identified on product labels.

The overall assessment identified that most people who lived and worked at or near CFB Gagetown were not at risk. Only specific populations were at possible risk. These included those directly involved with herbicide applications (mixers and loaders, applicators, flaggers) and post application activities (brush clearing and scouting, soon after application). The conclusions of the overall assessment were as follows:

- Individuals directly involved with herbicide applications (e.g., mixer/loaders, applicators and flaggers), may have experienced elevated exposures to herbicides and contaminants (including dioxin); as such, the potential for health effects cannot be eliminated;
- Individuals involved in post-application brush clearing and/or scouting soon after application may have experienced elevated exposures (dermal route) to herbicides and contaminants; and, as a results, these individuals may have experienced potentially unacceptable health risks;
- It was not considered possible to provide any meaningful evaluation related to smoke inhalation during burning of brush. However, it would appear that smoke inhalation is an insignificant exposure pathway based on assessments conducted by the U.S. Department of Agriculture;
- A significant amount of evidence exists to suggest that exposure of family members to pesticides through the take-home or track-in pathway can occur. However, it was not possible to quantify this exposure pathway with any level of certainty due to the large number of variables and assumptions required. Based on the information reviewed todate, it is not possible to determine (based on any

scientific evidence) the significance of this pathway relative to other pathways and/or receptors. It is expected that risks experienced by family members would be substantially less than those experienced by persons directly involved in spraying and/or forestry activities;

- Bystanders located directly downwind of the target area at the time of spraying may have experienced elevated short-term exposures to herbicides via inhalation and direct dermal contact with off-target drift. Potential bystander exposures were increased on an acute basis only. These elevated short-term exposure levels are not indicative of elevated risks of long-term irreversible health effects, rather, the potential for short-term reversible effects to have occurred;
- No chronic health risks were identified for hunters exposed to herbicides; • Due to the lack of historical water and sediment data, no conclusions concerning human health risks associated with historical exposures via the consumption of water or fish can be provided at this time; • Non-occupational receptors (*i.e.*, those not directly involved with herbicide applications such as soldiers training at the Base) are not expected to have experienced unacceptable long-term human health risks associated with herbicide use at CFB Gagetown; and,
- Accidents (*e.g.*, direct spray and/or direct contact with a spill with inadequate personal protection equipment) could produce unacceptable risks.

It must be noted, that the level of uncertainty resulting from the reconstruction of activities, some of which occurred more than 50 years ago, coupled with the uncertainties inherent in standard forward-looking risk assessment, is large. The expectations regarding the level of precision that this risk assessment exercise can produce, as a result, should be limited. The risk assessment should be considered part of the weight-of-evidence needed to identify groups of individuals who may have been adversely affected by historical exposures.

- Using the U.S. Institute of Medicine evaluation of evidence criteria, a thorough Scientific Literature Review of the published epidemiological studies about the health effects associated with the herbicides used at CFB Gagetown determined that conclusions related to causal relationships between exposure to any of the CFB Gagetown herbicide classes and chronic diseases or reproductive outcome were not supported by current evidence. There was sufficient evidence, however, to support conclusions of positive associations between exposure to chlorophenoxy herbicides and the development of soft tissue sarcoma and non-Hodgkin's lymphoma. In earlier years, chlorophenoxy herbicides were known to have contained manufacturing impurities, including dioxin as contaminants. There was also preliminary evidence of positive associations between exposure to chlorophenoxy herbicides and laryngeal cancer, breast cancer, prostate cancer, Hodgkin's disease, multiple myeloma, chronic lymphocytic leukemia, spina bifida, spontaneous abortions, Parkinson's disease, and type 2 diabetes;
- Paraquat has important neurotoxicological properties that deserve further exploration. The Scientific Literature Review indicated there is limited or suggestive evidence between exposure to this compound and the occurrence of Parkinson's disease. Paraquat use at CFB Gagetown was limited to a few experimental plots sprayed in 1966. The Human Health Risk Assessment study predicted very low levels of exposures to this agent at CFB Gagetown;
- Preliminary evidence from the Scientific Literature Review supported conclusions of positive associations between both pentachlorophenol and glyphosate exposures and non-Hodgkin's lymphoma. There was also preliminary evidence that exposure to pentachlorophenol was associated with rectal cancer. The Human Health Risk Assessment study predicted very low levels of exposures to pentachlorophenol at CFB Gagetown;
- Hexachlorobenzene is a contaminant that also needs further scrutiny. From the literature, there was preliminary evidence to support a conclusion of a positive association between exposure to hexachlorobenzene and breast cancer, prostate cancer, testicular cancer and spontaneous abortions. The capacity of this agent to bioaccumulate in the human body is of concern and there is a need for more research on this agent. The Human Health Risk Assessment study predicted very low levels of exposures to this agent at CFB Gagetown;
- Examination of the health outcomes identified in the Scientific Literature Review in the descriptive epidemiological study of Gagetown Region residents did not generally reveal significant excess disease risks compared to the Province of New Brunswick as a whole. A slight statistical but not clinically significant excess of breast cancer in CFB Gagetown women was observed. The risk for breast cancer has been associated with a full range of factors, including smoking, fertility, obesity and many other genetic, lifestyle and environmental factors. It was not possible to identify what might explain the slightly higher rates observed in CFB Gagetown; and,

- Detailed analysis for exposure-related health effects was not possible due to the nature of the data that were available. It was not possible to calculate herbicide-specific population attributable risk estimates. It was also not possible to comment, due to the fact that individual level information was not available, on the extent to which other known risk factors, such as smoking or genetic factors, influenced the health findings. Due to the uncertainty of the data, absence of evidence from these analyses does not necessarily mean that there were no health effects resulting from the exposures to the CFB Gagetown herbicides.

Summary

In summary, the results of the conservative assumptions used in the human health risk assessment (HHRA) proposed that only certain identifiable segments of the population may have been at greater risk for developing adverse health outcomes that could be linked to herbicide use at CFB Gagetown. The epidemiological literature review assisted to identify priority health outcomes that might be observed in this population. Due to data limitations and other difficulties in identifying the key population of interest (those exposed to the agents), the epidemiologic investigation was constrained to a study of primarily the cancer experience of residents of the Gagetown Study Region. No overall consistent patterns of significantly increased risk emerged over the four study time periods. Though this investigation provided preliminary information about the number of cases and suggestive increased risks for certain disease outcomes during more recent time periods, significant limitations precluded drawing conclusions that there was or was not an increased risk in CFB Gagetown exposed personnel. Further research may potentially provide more detailed evidence of effects in support of predictions of the HHRA.

Recommendations for Future Research

Based upon the findings from the risk assessment, further investigations into the state of health of individuals who were directly involved with herbicide applications and post application brushclearing activities, are warranted. These further investigations could involve either targeted epidemiological evaluation of these populations or body burden analysis. The epidemiological studies might focus on the 'at risk' CFB Gagetown populations, as described above. Due to the period of time that has lapsed since exposures occurred, predictions indicate that in even the most highly exposed individuals, body burdens would likely be indistinguishable from the general population and will likely not be helpful.

Feasibility studies would be needed to determine whether the populations at risk have been documented in a systematic way, and whether these records contain details about when and where these individuals worked, before a larger epidemiological study could go forward. Power calculations would also be required to estimate the likelihood that sufficient numbers of cases have occurred to allow a meaningful analysis. As encountered in the descriptive epidemiological study, small numbers limit the likelihood of finding statistically significant conclusions. Other study design issues, such as problems of survival of those who may have been highly exposed, and sources of study bias, would need to be carefully considered before proceeding with such an investigation.

Appendix B

Advisory Panel

February 3, 2006

Dr. Dennis Furlong, coordinator of the Base Gagetown and Area Fact-finder's Project, and Karen Ellis, Assistant Deputy Minister Infrastructure and Environment with the Department of National Defence, have announced the members of the independent panel that will provide advice and expertise to guide the Project's three central fact-finding tasks.

The Advisory Panel has the following membership:

Dr. Dennis Furlong - Co-Chair of the Panel as the Coordinator for the Base Gagetown and Area Fact-Finding and Outreach Project and physician in the Province of New Brunswick .

MS Cynthia Binnington - Co-Chair of the Panel as the Chair of the federal Interdepartmental Committee on Herbicide Use at CFB Gagetown, and the Assistant Deputy Minister of Infrastructure and Environment for the Department of National Defence.

Dr. Christofer Balram - Provincial Epidemiologist for the Ministry of Health and Wellness in the Province of New Brunswick .

Dr. Barry Brown - retired Associate Professor of Philosophy at the University of Toronto , providing advice to the panel as an ethicist.

Mr. Wayne Cardinal - veteran of the Canadian Forces and former member of the Black Watch (Royal Highland Regiment) of Canada .

Mr. John J. Chisholm - Veteran of the Canadian Forces and former member of the 1st, 2nd, 3rd, 4th Artillery Regiments and the Canadian Airborne Regiment

Ms. Diane Lutes - retired Law Librarian for the Law Society of New Brunswick. providing advice in the area of libraries and archives area.

Dr. David MaGee - Chair of the Chemistry Department at the University of New Brunswick ., providing advice and expertise for the office of the Dean of Science.

Ms. Barbara McGill - Vice President Community Programs and Chief Nursing Officer, Atlantic Health Sciences Corporation .

Dr. Michael Perley - Family Physician for the Woodstock First Nation and Tobique First Nation.

Mrs. Gloria Sellar - Widow of Brigadier General Gordon Sellar, Black Watch (Royal Highland Regiment) of Canada .

Ms. Pam Sheridan - Administrative Officer of Maintenance Company, Technical Services Branch in CFB Gagetown.

Mr. John Tarrel – Consulting actuary and Mayor of the Village of Gagetown.

Responsibilities of the Advisory Panel will include, among other things, the provision of advice and perspective on: any additional potential sources of information; stakeholder interests and balancing divergent or competing interests; and, means to engage stakeholders over the longer term.