Initial study of terrestrial forces training sites potentially contaminated by energetic materials, CFB Petawawa

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Study prepared for
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and CFB Petawawa

By

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Avis

Le présent document a été conçu à l'aide des informations disponibles à l'époque, soit à l'été 2000. Depuis, certains travaux ont été réalisés ou sont en cours sur certains sites. La nature de ces travaux consiste principalement en la caractérisation des sites à laquelle s'ajoute des analyses d'échantillons d'eau. Pour connaître les derniers résultats, il est fortement suggéré de consulter des ouvrages émis après l'année 2000, s'il y a lieu. En somme, la présente classification ne tient pas compte des résultats recueillis après l'été 2000.

Notice

The current document is a preliminary study. It has been made with the data available at summer 2000. Since then, fieldwork have been undertaken on particular sites in order to have a better understanding of the hydrogeological system. Furthermore, water analysis have been realised on samples taken in the studied areas. For up to date information, it is suggested to verify if other documents, more recent (2000-present), have been issued. This classification does not take into account the data acquired after the summer 2000.

January 2003

Résumé

Le présent rapport évalue le potentiel que pose les différents champs de tir de la base de Petawawa sur l'environnement et la santé humaine. Il traite des récents travaux d'évaluation environnementale effectués sur cette base. Ces travaux s'inscrivent dans le cadre d'un vaste projet de conformation et de gestion environnementale des bases militaires canadiennes entrepris par le Centre de Recherche pour la Défense Valcartier (CRDV).

Le rapport contient en premier lieu une présentation générale de la base. La situation géographique, l'historique et les activités actuelles ayant cours sur la base de Petawawa y sont décrits. Ensuite, les sites sélectionnés sont décrits en détail et sont évalués selon une méthode dérivée de celle du CCME (Conseil Canadien des Ministres de l'Environnement). Ces sites sont ceux où des matériaux énergétiques sont employés. Dans l'ensemble, le risque posé par ces sites est de moyen à fort, en raison des possibilités élevées de transport des matériaux énergétiques dans les eaux de surface et souterraines, ainsi que de la proximité des récepteurs potentiels.

Des conclusions et recommandations sont ensuite émises quant à la gestion des champs de tir de Petawawa et quant aux possibilités d'améliorer les évaluations effectuées. Parmi celles-ci, une meilleure connaissance des eaux souterraines et du degré réel de contamination des sites pourraient aider à définir les risques sur les récepteurs potentiels avec plus de précision.

Abstract

The following report provides an assessment of the potential risk associated with the shooting ranges of CFB Petawawa with respect to the environment and human health. The report gives account of the recent environmental evaluation work of performed in this base. This work is part of a major environmental compliance and management project of the Canadian military bases undertaken by the Defence Research Establishment of Valcartier (DREV).

The report first provides a general introduction to the base. The geographic setting, the site history and the current activities on the base are outlined. Then, the selected sites are described and evaluated with a method inspired by (and compatible with) the CCME's (Canadian Council of Ministers of the Environment) method. The sites are generally selected if their use involves energetic materials. The risk associated with the ranges is medium to high, due to the high migration potential of energetic materials in groundwater and surface water and due to the proximity of potential receptors.

Finally, conclusions and recommendations are made on the environmental management of the firing ranges and on the possible improvements to the evaluations, which were made of the sites. Among others, a better knowledge of the hydrogeological settings and of the actual state of contamination on the base could help better define the possible receptors and environmental risks with more accuracy.

CONTENTS

TABLE LIST

1. Introduction

1.1 Context

While developing an environmental management program for the Department of National Defence (DND) sites, it was agreed to do a study of the terrestrial forces training sites where the use of energetic materials could threaten the environment. This study, that represents a first step toward the environmental management of DND sites, will allow the identification and classification of potentially contaminated sites by energetic materials so that the need of complementary characterisation, the priority of intervention and the remedial actions be established. The study will also permit a synthesis of available information on each DND site to be done.

In this perspective, some training sites from Canadian Forces military Base (CFB) of Petawawa have been chosen by the DND and submitted to a preliminary evaluation of environmental risks. This evaluation, as well as a synthesis of the available information on each sites, are the subject of this study.

1.2 Evaluation method

The evaluation method used to classify potentially contaminated training sites is mainly based on the method developed by the Canadian Council of Ministers of the Environment (CCME, 1992). The CCME's method is simple, reliable and versatile. However, a few adjustments inspired by a method developed by the French "Bureau des Recherches Géologiques et Minières" (BRGM, 1997) have been made in order to remedy the deficiencies of the CCME method. Consequently, the evaluation of each site will follow these steps (reference of documents in parenthesis) :

- Site description sheet (CCME)
- Checklist of necessary information (CCME)
- Short evaluation form of site (CCME)
- Site classification (modified) worksheet (CCME &BRGM)
- Site classification computerised worksheet (Excel worksheet; INRS Géoressources)

A detailed description of CCME evaluation method and a summary of the modifications brought to it are presented in appendix A. Site classification computerised sheet can be found in appendix B, along with the documents corresponding to each step mentioned above.

The structure of the two studied methods (CCME and BRGM) is divided in three basic steps leading to a contamination:

1) Presence and characteristics of contaminants ;
2) Exposure pathways of contaminant ;
3) Presence of receptors for contaminants.

This structure has been kept in the modified method.

Although the evaluation method gives a good idea of the site's risk potential, it does not provide a quantitative risk assessment. Furthermore, the study (consisting in the sites evaluations) is only a preliminary step. It should be completed with complementary characterisation studies in some cases. These actions can however be realised afterwards.

2 Characteristics of Petawawa Canadian force base

2.1 Geographic and climatic background

The CFB Petawawa is located in the Ottawa valley and more precisely in the Renfrew county municipality. It is located at 150 km west of Ottawa and 200 km east of North Bay. Its current area covers approximately 21 968 ha. Petawawa garrison's town is at the crossing of the Ottawa River and the Barron River (Topographic map MCE 132 TR89 Ed 7).

The eastern part of the Training and Range Area is mostly flat. There are some hills close to the Sturgeon Lake like Highview Tower Hill. Numerous lakes are found in this area. The western part of the CFB Petawawa is a less flat terrain. Many hills are found throughout the area. Once again, many lakes are found on this part of the base (see Appendix E for maps).

Except for the north-western part, CFB Petawawa is located within the Renfrew Climatic Region. Data show that the average annual temperature is approximately 5°C and that the mean annual precipitation is 711 mm. The mean annual surplus water of 280 mm flows by runoff.

The western part of the Training and Range area is located in the Canadian Shield. Hence, the bedrock is mainly Precambrian rocks (metamorphic and intrusive). Amphibolite, granulite, mafic, ultramafic and anorthositic rocks are commonly found in this area. Over the bedrock, there are some irregular layers of deposits. During the quaternary period, the Champlain Sea was covering the Saint-Lawrence River valley and a part of the Ottawa River valley. This is why marine sediments are found in the eastern part of CFB Petawawa. These sediments are mostly fine sand and are surrounded by sandy till.

The drainage system of the CFB Petawawa is separated in four watersheds: the Ottawa River watershed, the Barron River watershed, the Petawawa River watershed and the Sturgeon Lake watershed. The Petawawa River is a tributary of the Barron River, which is, with the Sturgeon Lake, tributary of the Ottawa River. The direction flow of the Ottawa River is towards south. The Petawawa River is the only one that flows through the military base. Its direction flow is south-east while the Barron River flows towards east.

The study contains the evaluation of 11 training sites that present a potential risk of contamination due to energetic materials. These areas include grenade ranges, impact ranges, demolition range, fighting in built up area (FIBUA) and field firing ranges (direct and indirect firing).

2.2 Property's boundaries

The limits of CFB Petawawa are mostly rivers, park and lakes. The Barron River borders the southern part of the Training Area. The west shore of the Ottawa River constitutes another border of the base. On the western side of the Training and Range Area, the Algonquin Provincial Park defines the border. However, the northern frontier is not well defined. It goes along First Egan

Lake, Corry Lake, Porch Lake and the western end of Sturgeon Lake but there some parts that simply go through the wooden area and do not follow any precise physical element.

There are a few municipalities located around the Training and Range Area. The most densely populated are Pembroke, Petawawa and Chalk River. Beside these larger cities, there are some parishes, which are formed due to the low population density in these areas. A list of the main cities and parishes that surround CFB Petawawa is presented in table 1.

TABLE 1 – POPULATIONS OF MUNICIPALITIES AND PARISHES AROUND CFB PETAWAWA

Municipalities	Population
Petawawa	15 015
Pembroke	70 000
Chalk River	25 000
Parishes	
Black Bay	N/A
Fort William	N/A

2.3 Historical and actual activities

The government of Canada bought the land in 1904 but the military activities did not begin until 1905. Before World War I, the "A" and "B" Batteries of the Royal Canadian Horse Artillery, the infantry and the cavalry were training at the base. During the war, CFB Petawawa served as a training site for all Canadian artillery units. Moreover, the Russian government, in accordance with the Canadian government, tested 100 mm shells made in Canada.

World War II gave to Petawawa military base an important role. Three training centres were in operation. There was one for the engineer units and two for the artillery units. The highest number of troops which were present and training during wartime was 20 000.

After the Second World War, Petawawa became a training site for the regular army and some militia units as it was before. In 1948, the 1st Battalion of the Royal Canadian Regiment and the Royal Canadians Dragoons settled at Petawawa. In 1951, the military base became officially a permanent camp and in 1966, it was renamed Canadian Forces Base Petawawa (CFB Petawawa).

Nowadays, the basic training for the infantry, militia and cadet is provided at CFB Petawawa. In addition, the Special Service Forces, which include:
- Infantry
- Artillery
- Armour engineer
- Helicopter
- Support
- Combat service support
- Field ambulance
- Military police headquarter
- Military headquarter

- Signal units

These units are now garrisoned at the base. These units undergo routinely manoeuvres in the Training Area, which involves weapons and pyrotechnics. Small weapons are used on a daily basis either on conventional or on expediate ranges. Heavier weapons such as howitzer and mortar are also use but it occurs sporadically.

2.4 Information sources

Most information were found in the study conducted by Jacques Whitford Environment Limited and on the topographic map of the CFB Petawawa Range and Training Area (MCE 132 TR 89 Ed 7). Some information concerning either energetic materials or the sites were also communicated through contacts at the CFB Petawawa and at the DREV. A list of the persons contacted is presented below.

- Defence Research Establishment Valcartier (DREV) (418) 844 - 4000
    - Stéphane Jean, Environmental agent ext. 4263
- Petawawa military base (CFB Petawawa) (613) 687-5511
    - Mr. Chris Hogan, Environmental officer
    - Mr. Sean Moyles, Range Control officer

Appendix C presents a table containing properties and criteria related to energetic materials. This table is also shown at the end of each site classification worksheet.

3. Sites studied

3.1 Training Area D

3.1.1 Site characteristics

3.1.1.1 Geographic setting

The Impact Area D, now known as the Training Area D, is located at the eastern part of CFB Petawawa and especially, between the square by these co-ordinates: 5092000m N, 5096700m N, 317800m E and 322250m E in the UTM system (NAD 83). The site covers an area of approximately 8.78314 km². This value includes the area occupied by Chalk Bay and Clement Lake. The range is characterised by a flat terrace bordered by a steep slope going towards Ottawa River's level on the eastern side and by another steep slope going uphill towards areas C and L's level. The soil along Chalk Bay is cover with trees. As for the rest of the range, it is covered by either sand or grass. There are some fragile areas such as marshes along Clement Creek in the northern part of the area.

3.1.1.2 Site boundaries

All the limits are well defined on this site. The northern border goes along Deluthier Road. Both Chalk Bay and Ottawa River define the eastern limit. As for the western limit, it is represented by Thackray road. Finally, Bostwick Lake defines partly the southern limit.

3.1.1.3 Site history and activities

When CFB Petawawa started its activities at the beginning of the century, this area was used as an impact zone for artillery exercises. During the World War I, the Russian Army was testing the 100 mm shells on the eastern part of the base. The vocation of this site stood until a few years ago when it became a training area. Nowadays, no artillery exercise occurs in this area, but only troop manoeuvres.

3.1.1.4 Description of installations

The access to this site is controlled by three gates. On the southern part of the area, there are gates F2 on Clement Road and F3 on River Road. As for the northern part, gate C2 restrains the access on Deluthier Road. PTT Tower is the only major structure within the area. It is used to simulate a building invasion. No explosive ammunition are used on this site.

3.1.1.5 Geological, hydrogeological and hydrological contexts

The geology of Training Area D is composed of limestone, minor dolostone, shale and sandstone. The bedrock is mostly overlain by younger alluvium in terrace remnants and more precisely sand and gravely sand. This layer of sediments is commonly known as the Petawawa Sand Plain. This plain was formed during the Quaternary Period by a delta formed by Petawawa, Barron, Indian and Ottawa Rivers. At that time, the great Champlain Sea was covering the Saint-Lawrence Valley and the Ottawa River Valley. However, there are some small areas near the northern border that show some outcrops sometimes covered by thin drift cover. As for Clement Point, the bedrock is underneath a layer of poorly sorted till. Finally, the shore of the Ottawa River is more likely covered by modern unsubdivided alluvium like clay, silt, sand, gravel and muck.

The hydrogeological context is not well known due to the fact that no study was undertaken in the past. Hence, there are no monitoring well on the base. The only sampling campaigns were done few years ago by both provincial and federal governments. The observation wells were set at the end of the Petawawa River. The analysis of water samples did not concern energetic materials, but showed a high concentration of nitrates and metals.

According to the nature of surface deposits, it seems that the aquifer is unconfined. As for the bedrock, it may allows water to flow rapidly or not. The velocity of water depends on the hydraulic conductivity, porosity and hydraulic gradient. Numerous factors influence the hydraulic conductivity like the porosity, the grain size and the presence of fractures. The higher this criteria is, the more easily the water can flows. In the case of Training Area D, the hydraulic conductivity of the bedrock has been neglected because of the lack of information and by comparison with the main material, which composed most of the surface deposits, i.e. the sand. The hydraulic conductivity of the sand has been estimated to vary between 10^{-5} m/s and 10^{-2} m/s because of its porous nature (Freeze and Cherry, 1979).

The depth of the water table is another important information that is unknown. The closer it is of the surface, the more rapidly the contaminants can reach it. No estimate has been done for this criteria because the classification form do not consider it.

The direction of groundwater flow is presumed to be towards south-west considering the Ottawa River and the Petawawa River as discharge zones. The Sand Plain itself constitutes a recharge zone of the aquifer due to its high permeability.

3.1.2 Risk identification

3.1.2.1 Potential or known sources of contamination

The potential sources of contaminant come from the use of explosive ammunitions, which contain energetic materials. The risk of threatening the environment occurs when these projectiles do not or partially explode. Once these duds are in the ground, there is a possibility that a leak occurs and then, cause some damages to the receptors located downstream.

3.1.2.2 Potential contaminants

The ammunitions used at Rocket Launcher Range are:

- ATGM BGM 71AE HE (TOW)
- BLANK AMMUNITION
- CS RIOT GAS
- CTG .38
- CTG .50mm
- CTG 5.56mm
- CTG 7.62mm
- CTG 9mm
- CTG 38mm FLITERITE
- CTG 38mm SPEDEHETE CS
- CTG 60mm MOR HE
- CTG 60mm MOR SMK WP
- CTG 60mm MOR III
- CTG 76mm HESH
- CTG 76mmSH/P
- CTG 76mmSMK (HOW)
- CTG 81mm MOR HE
- CTG 81mm MOR SMK WP
- CTG 81mm MOR III
- CTG 84mm HEAT FFV 551
- CTG 84mm TP/T
- CTG 105mm HE PD (HOW)
- CTG 105mm ILL (HOW)
- CTG 105mm SMK WP (HOW)
- CTG 105mm SMK (HOW)
- CTG 105mm SMK HCBE (TK)
- CTG 105mm SMK WP (TK)
- MISSILE BLOWPIPE
- PROJ 155mm HE M107
- PROJ 155mm ILL
- PROJ 155mm SMK

- PROJ 155mm SMK WP
- PYROTECHNICS
- RKT 2.75in HE
- RKT 21mm SUB-CAL(M72)

This ammunition list can be found in appendix D (Training Area Authorisation Form). Heavy metals and energetic materials are contained in these ammunitions. The ratios and weights of these materials are unknown.

Ammunitions contain energetic materials that can decompose into numerous metabolites. These derivative products are sometimes more toxic and mobile than the original compound. TNT is a good example; there are approximately 21 metabolites. Some of these are even more soluble than the TNT itself.

3.1.2.3 Potential sources of contamination outside the site

According to the flow direction of surface water and topography, there is a low risk of contamination by other sites. The southern part of Impact Area A appears to be the most probable source of contaminants. Otherwise, the neighbouring sites are not classified as dangerous area. Actually, the odds of finding unexploded ammunitions in the ground of Training Areas C, F and L are non-existent except if these sites were used as training manoeuvres with the support of ammunitions containing energetic materials. Special considerations must be make on groundwater flow direction and to the understanding of the role of watercourses in the base's area, i.e. whether or not they are recharge zones. If so, the concentration of energetic materials in groundwater would increases and hence, constitutes a greater danger for receptors susceptible to be in contact with it.

3.1.2.4 Natural or human risks of increasing damages

Few factors could increase the potential damages caused by a contamination with energetic materials. A decrease in the quality of ammunitions would cause an increase of non-exploded projectiles, which could be dangerous. Moreover, an increase in precipitation or less frequent cleaning of the site (leading to a greater possibility of transfer of the energetic materials) could be harmful to the environment. Finally, levelling or bulldozing the soil could cause some duds to be buried in the ground, leading to a greater threat for the environment. Tanks or heavy vehicles movements can also be a cause of ground disturbance.

3.1.3 Hazard evaluation

3.1.3.1 Potential pathways for contaminants

Two pathways for transport of energetic materials are possible: aerial and aqueous. When a misfire occurs, the energetic materials present in the ammunition under a powdered form, can either be dissolved in water or be easily moved by the wind.

3.1.3.1.1 Groundwater

As known (see section 3.1.1.5), groundwater flow direction is not known due to the fact that no study on the hydrogeological context has been made. The hypothetical direction has been choose because of the sampling campaign done by both governments on the influence of military activities on the quality of water. In regard of the Training Area D, groundwater would flows into Chalk Bay or into the Ottawa River.

As for the depth of the water table, it is also unknown. Even if this criteria is not taken into account into the classification, it is important to consider it. If the sand aquifer has a shallow water table, the contaminants will reach the water table more easily and the contaminant can spread in the aquifer.

The energetic materials undergo biodegradation, so does the metabolites. Some of these, derived from TNT are highly soluble. However, they are also easily absorbed by organic matter and clay particles. This could explain why the lest soluble RDX can travel as fast or more then TNT if biodegradation is considered (Thiboutot *et al.*, 1998).

3.1.3.1.2 Surface water

Surface water appears to be another pathway considering the runoff. Chalk Bay and the Ottawa River are watersheds that border what is now Training Area D to the east and the north. The flow is towards south-east. As for Clement Lake, it drains water of the western part of the site and the eastern part of Training Area C. Clement Creek is a link, which is tributary of the Chalk Bay.

3.1.3.1.3 Aerial transport

Explosive compounds such as RDX, TNT and HMX are not volatile. When used in ammunition, they are under a powder state. After the explosion, there is a possibility that particles present at the surface of the ground or in the air undergo an aerial transport. Another possibility would involve that these explosive materials can be absorbed by soil particles, which are also susceptible to aerial transport. Some ammunitions contain energetic materials that release toxic fumes while burning. As an example, the hexachloroethane (HC) fumes are harmful to the fauna and flora because of their persistence in the environment.

The direction of the wind varies a lot, but is more often towards east (Climatic atlas of Canada, 1988). If an aerial transport occurs due to the destruction or the leakage of an unexploded shell, the cities that are more likely to be affected are Petawawa (south-east) and Fort William (East).

Otherwise, the others habitat possibly affected would be the aquatic fauna of the Ottawa River and the closest fragile areas, i.e. the marshes located along Clement Creek.

3.1.3.2 Receptors

Receptors are those located downstream of the site potentially contaminated with energetic materials. As for CFB Petawawa, the groundwater flow direction is assumed to be the same as the surface water. Receptors have been divided in two groups: humans and other receptors. This classification has been made to facilitate an overview of either living being or fragile areas that might be affected by a contamination with energetic materials. It does not suggest any value judgement. In fact, the same attention is provided to every receptors.

3.1.3.2.1 Humans

The closest city to the site is Fort William in the Province of Québec on the eastern shore of the Ottawa River. However, considering the flow direction of the river and the direction of the wind, the Town of Petawawa located approximately 7 km south-east of the range, would be the most probable receptor affected by a contamination by energetic materials. Furthermore, the water plant intake is situated downstream of the range.

People working on the site are mainly military personnel. Moreover, they are healthy and aware of hazards related to energetic materials.

3.1.3.2.2 Other receptors

This category contains both wildlife and vegetation. Large mammals such as White-tailed Deer, Moose and Black Bear can be found in this area. Other species living in this area include Red Fox, Beaver, Muskrat Grouse and Cottontail Rabbit.

As for marshes, they constitute fragile habitats that can easily be affected by any changes. Thus, there are some of these fragile areas along Clement Creek in the northern part of the range. A survey of the marshes did many years ago showed some high priority marshes in Training Areas C and L. The influence of energetic coming from Training Area D would have to be proved considering both groundwater flow direction and wind directions.

3.1.3.3 Known contamination cases

According to the *Environmental Impact Assessment of Military Training Activities at CFB Petawawa* and to Mr. Chris Hogan, B.Env.O., there is no known contamination case caused by the past activities on Training Area D at CFB Petawawa either in the past or nowadays. However, the presence of old unexploded shells in the ground always constitutes a threat for troops and a potential source of contamination.

3.1.3.4 Potential hazards inherent in site

The site presents a high risk of soil erosion especially because of its proximity to the Ottawa River and to Chalk Bay. Furthermore, the lack of vegetation increases the sensitivity to aerial erosion of the area. Flood is another risk of propagation of energetic materials because of the relatively flat terrain. During a flood, all energetic materials particles would be in suspension and would undergo an aquatic transport until they set in place downstream. Moreover, explosion risks related to duds are a constant threat to military personnel especially if clearance operations are not conducted frequently.

3.1.4 Prevention and emergency measures

To our knowledge, no emergency measures were ever taken on the site since it has been operated. Nevertheless, clearance operation are not conducted on a regular basis. The philosophy of CFB Petawawa regarding unexploded shells is to wait until there is one reported and then, taking care of it. However roads and areas that have an extensively use have been in part clean. There is still a possibility that duds located deep in the ground come back to the surface because of the combining actions of thaw/frost.

The last major clearance operation occurred in the late 80's. However, newly constructed roads and installations have been clean in order to create a zone where there is no doubt about security.

The following table shows the different level of clearance. Level 1 is the more frequently used. The only existing records of a level 2 clearance operation were for the construction of roads and other structures in the impact area 2. As for level 3, it is not often used mostly because of its important cost.

TABLE 2 – CLEARANCE LEVELS

Clearance level	Method
1	Clearing of surface duds by visual observation on the site.
2	Clearing of a soil layer (30-45 cm) from duds, with the help of a magnetic detector.
3	Complete clearing of the area of the site to any depth, until nothing is detected.

3.1.5 Site classification

The Training Area D is being given a score of 72.7 ± 4.3 /100, or between 68.4 and 76 /100. This score puts the site in class 1; thus, the potential risk is high. However, it could changes to a medium potential risk if there were more information available on this site. In order to respect the limits, many special considerations have been lowered. The evaluation has been based on the uses of this site in the past years. Nowadays, there is no high explosives ordnance fired on this range. The sections concerning the environment, the groundwater and the surface water receive the maximum amount of points because of the lack of information.

Threats to humans and to other receptors are quite low mostly because of the distance that separates the range from fragile areas.

As shown in the special considerations of section IIA (groundwater), the adsorption of energetic materials on fine particles slows down the transfer from surface to the aquifer. This situation could facilitate an eventual cleanup and makes biodegradation possible to occur before contamination reaches the aquifer.

The uncertainty associated to the total score originate from the lack of information regarding the availability of alternate drinking water supply, flood potential and aerial transport.

3.1.6 Recommendations and supplementary information required

Due to the lack of information, many parts of the evaluation still involve some uncertainty. Some simple actions could be taken in order to improve knowledge on the site. This could probably lower the score of the range.

The first uncertainty concerns the quantity of contaminants in presence. In the present situation, nature and quantity of the contaminants are unknown; this makes it difficult to estimate the importance of the contamination. Furthermore, because of this lack of information, contamination has been estimated with the area of the site, without knowing if contamination was effectively spread on the whole area. Consequently, it would be important to get further information on the nature and quantity of ammunition used. Knowing the exact impact or training locations (for example the locations of the targets used if so, would also help to estimate the real potentially contaminated area and to determine the direction followed by contaminants (this direction can vary depending on the part of the range where contamination occurs).

The other major point of uncertainty consists in the understanding of groundwater flow. It has been supposed that the aquifer lay in the quaternary deposits. Groundwater flow direction and hydraulic conductivity of the sediments should be established; while waiting for information, groundwater has been supposed to go towards south-east, i.e. towards Ottawa River and hydraulic conductivity of the sand has been estimated between 10^{-5} and 10^{-2} m/s (Freeze and Cherry, 1979). Hydraulic conductivity of sediments and hydraulic heads appear to be a key factor to localise the areas of recharge and discharge of the aquifer.

Finally, information on possibility of aerial transport of energetic materials and on flood potential would help to get a more precise idea of the risks of contamination on and off the site. It is to be noted that a major cleaning of the site helps to prevent contamination of the area and of the surroundings.

3.2 Demolition Range

3.2.1 Site characteristics

3.2.1.1 Geographic setting

The Demolition Range, is located within Impact Area 8 on the south-western part of CFB Petawawa and especially, at these co-ordinates: 305700m E and 5083300m N in the UTM system (NAD 83). The site covers an area is less than 1 km^2. The range is located in an area characterised by important hills. However, the Demolition area is on a flat terrain. Biggar Lake is the closest basin approximately 300m north. That portion of Impact Area 8 is covered with grass and sand, but surrounded by trees and marshes. These marshes are considered as fragile habitats. They are concentrated around Biggar Lake and along Biggar Creek.

3.2.1.2 Site boundaries

The Demolition Range is located within the Area 8 and especially at the southern part of it. There is no particular physical feature, which could delimit precisely the area. Biggar Lake and Biggar Lake Road are the only features present within the range and the security area.

3.2.1.3 Site history and activities

When CFB Petawawa started its activities at the beginning of the century, the eastern areas were used as impact zones for artillery exercises. During the World War I, the Russian Army was testing the 100 mm shells at Petawawa. Gradually, the government expropriated the lands located in the western part. Progressively, military exercises were undergoing in the western part of CFB Petawawa leaving the eastern areas as dry-firing ranges.

3.2.1.4 Description of installations

The area where duds are destroyed do not exceed 3 ha. It is a small range surrounded by a fireguard and a wired fence. Near the gate, there is a bunker where military personnel can witness the destruction of ammunition, explosives, etc.

3.2.1.5 Geological, hydrogeological and hydrological contexts

The geology of Demolition Range is composed of Precambrian rocks (metamorphic and intrusive). That land is a part of the Canadian Shield. The bedrock is overlain by gravel, gravely sand, sand and by poorly sorted till.

The hydrogeological context is not well known due to the fact that no study was undertaken in the past. Hence, there are no monitoring well on the base. The only sampling campaigns were done few years ago by both provincial and federal governments. The observation wells were set at the end of the Petawawa River. The analysis of water samples did not concern energetic materials, but showed a high concentration of nitrates and metals.

According to the nature of surface deposits, it seems that the aquifer is unconfined. As for the bedrock, it may allows water to flow rapidly or not. The velocity of water depends on the hydraulic conductivity, porosity and hydraulic gradient. Numerous factors influence the hydraulic conductivity like the porosity, the grain size and the presence of fractures. In the case of the Demolition Range, the hydraulic conductivity of the bedrock has been neglected because of the lack of information and its nature. The comparison with the materials that overlain the bedrock, i.e. gravel, gravely sand, sand and poorly sorted till. The hydraulic conductivity of the deposits has been estimated to vary between 10^{-12} m/s and 10^{-2} m/s depending of the material and its porous nature (Freeze and Cherry, 1979).

The depth of the water table is another important information that is unknown. The closer it is of the surface, the more rapidly the contaminants can reach it. No estimate has been done for this criteria because the classification form do not consider it.

The groundwater flow direction is presumed to be towards south-west considering the Barron River as a discharge. As for the recharge areas, there is no information that specified where the aquifer recharges. However, mountains are usually known to be a recharge zone due to the contact between bedrock and permeable surface deposits. The influence of Biggar Lake is not well known. It could be either a discharge or a recharge zone.

3.2.2 Risk identification

3.2.2.1 Potential or known sources of contamination

The potential sources of contaminant come from the use of explosive ammunitions which contain energetic materials. The risk of threatening the environment occurs when these projectiles do not or partially explode. Once these duds are in the ground, there is a possibility that a leak occurs and then, cause some damages to the receptors located downstream.

3.2.2.2 Potential contaminants

The ammunitions used at Rocket Launcher Range are:

- EXPLOSIVES

This ammunition list can be found in appendix D (Training Area Authorisation Form). Heavy metals and energetic materials are contained in these ammunitions. The ratios and weights of this material are unknown.

Ammunitions contain energetic materials that can decompose into numerous metabolites. These derivative products are sometimes more toxic and mobile than the original compound. TNT is a good example; there are approximately 21 metabolites. Some of these are even more soluble than the TNT itself.

3.2.2.3 Potential sources of contamination outside the site

According to the flow direction of surface water and topography, there is a risk of contamination by other sites. The Impact Area 8 constitutes the most probable source of contaminants because the Demolition Range is a part of it. Otherwise, the neighbouring sites do not appear to be potential sources of contamination. Area P and Area Q are not classified as dangerous, which lower the possibility of finding duds in the ground. As for Impact Area 6, its location downstream of the Demolition Range classify this site as potentially contaminated. Finally, the Petawawa River separates Impact Area 7 from Impact Area 8. It implies that energetic materials will go downstream. Considerations on the groundwater flow direction must be made to provide a good analysis of a particular site.

3.2.2.4 Natural or human risks of increasing damages

Few factors could increase the potential damages caused by a contamination with energetic materials. A decrease in the quality of ammunitions would cause an increase of non-exploded projectiles, which could be dangerous. Moreover, an increase in precipitation or less frequent cleaning of the site (leading to a greater possibility of transfer of the energetic materials) could be harmful to the environment. Finally, levelling or bulldozing the soil could cause some duds to be buried in the ground, leading to a greater threat for the environment. Tanks or heavy vehicles movements can also be a cause of ground disturbance.

3.2.3 Hazard evaluation

3.2.3.1 Potential pathways for contaminants

Two pathways for transport of energetic materials are possible: aerial and aqueous. When a misfire occurs, the energetic materials present in the ammunition under a powdered form, can either be dissolve in water or be easily moved by the wind.

3.2.3.1.1 Groundwater

As known (see section 3.2.1.5), groundwater flow direction is not known due to the fact that no study on the hydrogeological context has been made. The hypothetical direction has been choose because of the sampling campaign done by both governments on the influence of military activities on the quality of water. In regard of the Demolition Range, groundwater would flows into Barron River.

As for the depth of the water table, it is also unknown. Even if this criteria is not taken into account in the classification, it is important to consider it. If the aquifer has a shallow water table, the contaminants will reach the water table more easily and the contaminants can spread in the aquifer.

The energetic materials undergo biodegradation, so does the metabolites. Some of these, derived from TNT are highly soluble. However, they are also easily absorbed by organic matter and clay particles. This could explain why the lest soluble RDX can travel as fast or more then TNT if biodegradation is considered (Thiboutot et al., 1998).

3.2.3.1.2 Surface water

Surface water appears to be another pathway considering the runoff. The Demolition Range does not have any well-defined border like river, pond or lake. However, Biggar Lake is located in the middle of the area. It defines the area as well drained. According to the topography, surface water flows towards the centre. Biggar Creek drains the water to the Barron River, which is the closest watershed in this part of the Training Area. There are some wetlands surrounding Biggar Lake that might be affected by energetic materials.

3.2.3.1.3 Aerial transport

Explosive compounds such as RDX, TNT and HMX are not volatile. Furthermore, they are under a powder state when used in ammunitions. However, there is a possibility particles present at the surface of the ground undergo an aerial transport. What also happen is that these explosive materials can be absorbed by soil particles, which are also susceptible to aerial transport. It exists some ammunition, which contain energetic materials that release toxic fumes while burning. For example, the hexachloroethane (HC) fumes are harmful to the fauna and flora because of their toxicity and their persistence in the environment.

The wind has a relatively important influence on the Petawawa ranges. Eastern lands were in the past and nowadays influenced by the wind. As for the western lands, their rocky composition lowers the wind incidence. However, drift cover might undergo an aerial transport. For this reason, aerial transport can not be neglected. Predominant winds are usually coming from west, south-west and north-west. As for the velocity, ranges from 13 km/h to 17 km/h depending on its direction (Climatic atlas of Canada, 1988).

The CFB Petawawa is located in a remote area. The closest city is located far east of the Demolition Range. Beside the Town of Petawawa (including the garrison), the lands that might be influenced by the energetic materials

3.2.3.2 Receptors

Receptors are those located downstream of the site potentially contaminated with energetic materials. As for CFB Petawawa, the groundwater flow direction is assumed to be the same as the surface water. Receptors have been divided in two groups: humans and other receptors. This classification has been made to facilitate an overview of either living being or fragile areas that might be affected by a contamination with energetic materials. It does not suggest any value judgement. In fact, the same attention is provided to every receptors.

3.2.3.2.1 Humans

CFB Petawawa is located in a remote area of north-eastern Ontario. The cities surrounding the base have for the majority, a low population. If we consider the groundwater flow, the cities that is the more likely to be affected would be the garrison and the town of Petawawa and other municipalities that have its water supplies downstream into the Ottawa River. Otherwise, the remoteness of the range lower the risks that energetic materials that are undergoing an aerial transport affect the cities in the areas surrounding the base.

People working on the site are mainly military personnel. Moreover, they are healthy and aware of hazards related to energetic materials.

3.2.3.2.2 Other receptors

This category contains both wildlife and vegetation. Large mammals such as White-tailed Deer, Moose and Black Bear can be found in this area. Other species living in this area include Red Fox, Beaver, Muskrat Grouse and Cottontail Rabbit.

As for marshes, they constitute fragile habitats that can easily be affected by any changes. Thus, there are some of these fragile areas along Clement Creek in the northern part of the range. A survey of the marshes did many years ago showed some high priority marshes in Training Areas C and L. The influence of energetic coming from Training Area D would have to be proved considering both groundwater flow direction and wind directions.

3.2.3.3 Known contamination cases

According to the *Environmental Impact Assessment of Military Training Activities at CFB Petawawa* and to Mr. Chris Hogan, B.Env.O., there is no known contamination case caused by the past activities on Demolition Range at CFB Petawawa either in the past or nowadays. However, the presence of old unexploded shells in the ground always constitutes a threat for troops and a potential source of contamination.

3.2.3.4 Potential hazards inherent in site

The site shows a high risk of soil erosion especially because of the presence of Biggar Lake within the area. However, the vegetation that partly surrounds the lake lowers the sensitivity to both aerial and water erosion. The terrain just east of the lake is treeless which makes it propitious to both erosion and flooding. If these events occur, energetic material particles would be in suspension and undergo an aquatic transport until they set in place downstream. Moreover, explosion risks related to duds are a constant threat to military personnel especially if clearance operations are not conducted frequently.

3.2.4 Prevention and emergency measures

To our knowledge, no emergency measures were ever taken on the site since it has been operated. Nevertheless, clearance operation are not conducted on a regular basis. The philosophy of CFB Petawawa regarding unexploded shells is to wait until there is one reported and then, taking care of it. As for the Demolition Range, the presence of UXO in the ground is probable but do not represent a major concern. The issue is more the residues of energetic material thrown away after an explosion.

There is still a possibility that duds located deep into the ground of the security area fired a long time ago come back to the surface because of the combining actions of thaw/frost.

The following table shows the different levels of clearance. Level 1 is the more frequently used. The only existing records of a level 2 clearance operation were for the construction of roads and other structures in the Impact Area 2. As for level 3, it is not often used mostly because of its important cost.

TABLE 3 – CLEARANCE LEVELS

Clearance level	Method
1	Clearing of surface duds by visual observation on the site.
2	Clearing of a soil layer (30-90 cm) from duds, with the help of a magnetic detector.
3	Complete clearing of the area of the site to any depth, until nothing is detected.

3.2.5 Site classification

The Demolition Range receives a score of 61 ± 4.3 /100 or ranging from 56.7 to 65.3 /100. This grade puts the site in class 2 and the risk potential associates with this classification is medium.

Higher grades were given for the groundwater, surface water and the receptors. The lack of information concerning the geological, hydrogeological and hydrological contexts forced us to some suppositions especially for the flow direction of water in and on the ground. As for the hydraulic conductivity of the aquifer, it was estimated in accordance with the nature of the surface deposits and to with the chart of values of hydraulic conductivity and permeability (p.34 of the site classification worksheet). However, the map of the surface deposits was not precise enough to characterise the real nature of materials in place. That is why an average value of hydraulic conductivity was given. There was no trace of engineered or natural containment system. The presence of Biggar Lake can not be neglected. In fact, we think it represents the main drainage basin and the potential pathway for the contaminants contained in runoff water by spreading down the slopes beside the lake and then, towards Biggar Creek. The marshes around the lake increase the score for the presence of fragile sites to its maximum value.

The receptors received a low grade because of the remoteness of the site. The closest village is Black Bay located approximately 10 km east. Another reason is that the site is within the Impact Area 8 where ordnance land. Furthermore, only military personnel has an access to this part of the base

Even if the Demolition Range had a low score, it does not mean that there is no chances of a contamination by energetic materials. On the contrary, it is on these small areas often used that the concentration of contaminants in water ought to be higher than usual. If traces of TNT, RDX or HMX are in the water, it would be hard to determine the real influence of the Demolition Range. For this reason, it is important to see the global influence of the ranges upstream and see which sites had and still have an extensive use that could be directly related to the contamination.

As shown in the special considerations of section IIA (groundwater), the adsorption of energetic materials on fine particles slows down the transfer from surface to the aquifer. This situation could facilitate an eventual cleanup and makes biodegradation possible to occur before contamination reaches the aquifer.

The uncertainty associated to the total score originate from the lack of information regarding the availability of alternate drinking water supply, flood potential and aerial transport.

3.2.6 Recommendations and supplementary information required

Due to the lack of information, many parts of the evaluation still involve some uncertainty. Some simple actions could be taken in order to improve knowledge on the site. This could probably lower the score of the range.

The first uncertainty concerns the quantity of contaminants in presence. In the present situation, nature and quantity of the contaminants are unknown; this makes it difficult to estimate the importance of the contamination. Furthermore, because of this lack of information, contamination has been estimated with the area of the site, without knowing if it was effectively spread on the whole area. Consequently, it would be important to get further information on the nature and quantity of materials destroyed.

The other major point of uncertainty consists in the understanding of groundwater flow. It has been supposed that the aquifer lay in the quaternary deposits. Groundwater flow direction and hydraulic conductivity of the sediments should be established in order to obtain these data necessary to know the direction a potential contamination would follow. While waiting for information, groundwater has been supposed to go towards south-east, i.e. towards the Barron River and hydraulic conductivity of the surface deposits has been estimated to range between 10^{-8} and 10^{-02} m/s (Freeze and Cherry, 1979). Hydraulic conductivity of sediments and hydraulic heads appear to be a key factor to localise the areas of recharge and discharge of the aquifer.

Finally, information on possibility of aerial transport of energetic materials and on flood potential would help to get a more precise idea of the risks of contamination on and off the site. It is to be noted that a major cleaning of the site helps to prevent contamination of the area and of the surroundings.

3.3 DZ Anzio Area 1

3.3.1 Site characteristics

3.3.1.1 Geographic setting

The DZ Anzio Area 1 is located at the eastern part of CFB Petawawa and especially, between the square formed by these co-ordinates: 5089350m N, 5092450m N, 315000m E and 318200m E in the UTM system (NAD 83). The site covers an area of approximately 5.44656 km^2. The range is characterised by a flat terrain with small hills sparsely located. The soil along Highway 17 and along Impact Area 4's limit is cover with trees. The rest of the range looks like a corridor covered by either sand or grass. There are some fragile areas such as marshes along Tucker Creek in the northern part of the Impact Area 4.

3.3.1.2 Site boundaries

The DZ Anzio Area 1's borders are well defined. Actually, this site is located within the area defined by Gust Trail, Old Bran Road, Stewart Road, tucker Road, Orange Road and Road 17.

3.3.1.3 Site history and activities

When CFB Petawawa started its activities at the beginning of the century, this area was used as an impact zone for artillery exercises. During the World War I, the Russian Army was testing the 100 mm shells on the eastern part of the base. The vocation of this site stood until a few years ago when it became a training area. Nowadays, no artillery exercise occurs in this area, but only troop manoeuvres.

3.3.1.4 Description of installations

The access to this site is controlled by eight gates. On the southern part of the area, there are gates 1D and 1C which control the access to Gust Trail. As for the northern part, gate 4C restrains the access to Tucker Lake Road from Orange Road. The western part of the area contains three gates. Two of these gates, i.e. 4A and 4B, control the access to Totalize Road that goes across the area. As for the third one(4G), it restrains the traffic coming from the south on Old Bran Road. Finally, gates 1A and 1B control the eastern side of the area that come from Messer Trail. Their is also a building within the area located west of gate 1A.

3.3.1.5 Geological, hydrogeological and hydrological contexts

The geology of DZ Anzio Area 1 is composed of limestone, minor dolostone, shale and sand-stone. The bedrock is mostly overlain by fine sand. This layer of sediments is commonly known as the Petawawa Sand Plain. This plain was formed during the Quaternary Period by a delta formed by Petawawa, Barron, Indian and Ottawa Rivers. At that time, the great Champlain Sea was covering the Saint-Lawrence Valley and the Ottawa River Valley.

The hydrogeological context is not well known due to the fact that no study was undertaken in the past. Hence, there are no monitoring well on the base. The only sampling campaigns were done few years ago by both provincial and federal governments. The monitoring wells were set at the end of the Petawawa River. The analysis of water samples did not concern energetic materials, but showed a high concentration of nitrates and metals.

According to the nature of surface deposits, it seems that the aquifer is unconfined. As for the bedrock, it may allows water to flow rapidly or not depending on its nature and . The velocity of water depends of the hydraulic conductivity, porosity and hydraulic gradient. Numerous factors influence the hydraulic conductivity like the porosity, the grain size and the presence of fractures. In the case of DZ Anzio Area 1, the hydraulic conductivity of the bedrock has been neglected because of the lack of information and by comparison with the main material, which composed most of the surface deposits, i.e. the fine sand. The hydraulic conductivity of the fine sand has been estimated to vary between 10^{-6} m/s and 10^{-4} m/s because of its relatively porous nature (Freeze and Cherry, 1979).

The depth of the water table is another important information that is unknown. The closer it is of the surface, the more rapidly the contaminants can reach it. No estimate has been done for this criteria because the classification form do not consider it.

The groundwater flow direction is presumed to be towards south-west considering the Ottawa River and the Petawawa River as discharge zones. The Sand Plain itself constitutes a recharge zone of the aquifer due to its high permeability.

3.3.2 Risk identification

3.3.2.1 Potential or known sources of contamination

The potential sources of contaminant come from the use of explosive ammunitions, which contain energetic materials. The risk of threatening the environment occurs when these projectiles do not or partially explode. Once these duds are in the ground, there is a possibility that a leak occurs and then, cause some damages to the receptors located downstream.

3.3.2.2 Potential contaminants

The ammunitions used at DZ Anzio Area 1 are:

- BLANK AMMUNITION
- CS RIOT GAS
- CTG .50mm
- CTG 5.56mm
- CTG 7.62mm
- CTG 9mm
- CTG 38mm FLITERITE CS
- CTG 38mm SPEDEHETE CS
- PYROTECHNICS

This ammunition list can be found in appendix D (Training Area Authorisation Form). Heavy metals and energetic materials are contained in these ammunitions. The ratios and weights of these materials are unknown.

Ammunitions contain energetic materials that can decompose into numerous metabolites. These derivative products are sometimes more toxic and mobile than the original compound. TNT is a good example; there are approximately 21 metabolites. Some of these are even more soluble than the TNT itself.

3.3.2.3 Potential sources of contamination outside the site

According to the flow direction of surface water and topography, there is a low risk of contamination by energetic materials coming from other sites. Preferential pathway of surface water outside the site is more likely towards west and south. Other neighbouring sites are not classified as danger areas. The risk of contamination by water coming from Area C, E, L and O is improbable. Special considerations must be make on groundwater flow direction. In addition, the understanding of the role of waterways in the base's area, i.e. whether or not they are recharge zones. If so, the concentration of energetic materials in groundwater would increases and hence, constitutes a greater danger for receptors susceptible to be in contact with it.

3.3.2.4 Natural or human risks of increasing damages

Few factors could increase the potential damages caused by a contamination with energetic materials. A decrease in the quality of ammunitions would cause an increase of non-exploded projectiles, which could be dangerous. Moreover, an increase in precipitation or less frequent cleaning of the site (leading to a greater possibility of transfer of the energetic materials) could be harmful to the environment. Finally, levelling or bulldozing the soil could cause some duds to be buried in the ground, leading to a greater threat for the environment. Tanks or heavy vehicles movements can also be a cause of ground disturbance.

3.3.3 Hazard evaluation

3.3.3.1 Potential pathways for contaminants

Two pathways for transport of energetic materials are possible: aerial and aqueous. When a misfire occurs, the energetic materials present in the ammunition under a powdered form, can either be dissolve in water or be easily moved by the wind.

3.3.3.1.1 Groundwater

As known (see section 3.3.1.5), groundwater flow direction is not known due to the fact that no study on the hydrogeological context has been made. The hypothetical direction has been choose because of the sampling campaign done by both governments on the influence of military activities on the quality of water. In regard of the DZ Anzio Area 1, groundwater would flows towards Petawawa River.

As for the depth of the water table, it is also unknown. Even if this criteria is not taken into account in the classification, it is important to consider it. If the aquifer has a shallow water table, the contaminants will reach the water table more easily and the contaminants can spread in the aquifer.

The energetic materials undergo biodegradation, so does the metabolites. Some of these, derived from TNT are highly soluble. However, they are also easily absorbed by organic matter and clay particles. This could explain why the lest soluble RDX can travel as fast or more then TNT if biodegradation is considered (Thiboutot et al., 1998).

3.3.3.1.2 Surface water

Surface water appears to be another pathway considering the important runoff. Soils and surface deposits are mostly composed of fine sand. The DZ Anzio Area 1 does not have any well defined border like river, pond or lake. However, Tucker Creek and Duke Lake are the closest basin where surface water could tip into it by runoff because of the absence of watercourse within the area. Due to the important distance which separate basins from this area, it is considered as poorly drained. There are some wetlands located along Tucker Creek that might be affected by energetic materials and then, flow towards Sturgeon Lake.

3.3.3.1.3 Aerial transport

Explosive compounds such as RDX, TNT and HMX are not volatile. When used in ammunition, they are under a powder state. After the explosion, there is a possibility that particles present at the surface of the ground or in the air undergo an aerial transport. Another possibility would involve that these explosive materials can be absorbed by soil particles, which are also susceptible to aerial transport. Some ammunitions contain energetic materials that release toxic fumes while burning. As an example, the hexachloroethane (HC) fumes are harmful to the fauna and flora because of their persistence in the environment.

The wind has a relatively important influence on the Petawawa ranges. Western lands with their rocky composition are not so influenced by the wind. As for the eastern lands, the sandy content in the surface materials are more propitious to be modified by the wind. Drift cover might undergo an aerial transport. For this reason, aerial transport can not be neglected especially at DZ Anzio Area 1 where records show the modifications of the topography trough time. Impact Area A is a different case because of its highly dense wooded areas and the use of non explosive ordnances. Predominant winds are usually coming from west, south-west and north-west. As for the velocity, it ranges from 13 km/h to 17 km/h depending on its direction (Climatic atlas of Canada, 1988).

The direction of the wind varies a lot, but is more often towards east. If an aerial transport occurs due to the destruction or the leakage of unexploded shells, the cities that are more likely to be affected are Petawawa (south-east) and Fort William (East). Otherwise, the others habitat possibly affected would be the aquatic fauna of the Ottawa River and the closest fragile areas, i.e. the marshes located along Clement Creek.

3.3.3.2 Receptors

Receptors are those located downstream of the site potentially contaminated with energetic materials. As for CFB Petawawa, the groundwater flow direction is assumed to be the same that surface water. Receptors have been divided in two groups: humans and other receptors. This classification has been made to facilitate an overview of either living being or fragile areas that might be affected by a contamination with energetic materials. It does not suggest any value judgement. In fact, the same attention is provided to every receptors.

3.3.3.2.1 Humans

The closest city to the site is the Town of Petawawa that would be the most probable receptor affected by a contamination by energetic materials.

People working on the site are mainly military personnel. Moreover, they are healthy and aware of hazards related to energetic materials.

3.3.3.2.2 Other receptors

This category contains both wildlife and vegetation. Large mammals such as White-tailed Deer, Moose and Black Bear can be found in this area. Other species living in this area include Red Fox, Beaver, Muskrat Grouse and Cottontail Rabbit.

As for marshes, they constitute fragile habitats that can easily be affected by any changes. Thus, there are some of these fragile areas along Tucker Creek in the northern part of the range. A survey of the marshes did a few years ago showed that they were classified as high priority marshes in. The influence of energetic coming from Training Area D would have to be proved considering both groundwater flow direction and wind directions.

3.3.3.3 Known contamination cases

According to the *Environmental Impact Assessment of Military Training Activities at CFB Petawawa* and to Mr. Chris Hogan, B.Env.O., there is no known contamination case caused by the past activities on DZ Anzio Area 1 at CFB Petawawa either in the past or nowadays. However, the presence of old unexploded shells in the ground always constitutes a threat for troops and a potential source of contamination.

3.3.3.4 Potential hazards inherent in site

The site presents a low risk of soil erosion especially because of the distance that separates it from the closest basins. However, the absence of vegetation and the type of surficial deposits, i.e. fine sand, constitute a propitious environment to aerial erosion and erosion caused by runoff water. Flooding in this area are not considered as a potential hazard due to the distance to Ottawa River. Moreover, explosion risks related to duds are a constant threat to military personnel especially if clearance operations are not conducted frequently.

3.3.5 Prevention and emergency measures

To our knowledge, no emergency measures were ever taken on the site since it has been operated. Nevertheless, clearance operation are not conducted on a regular basis. The philosophy of CFB Petawawa regarding unexploded shells is to wait until there is one reported and then, taking care of it. However roads and areas that have an extensively use have been in part clean. There is still a possibility that duds located deep in the ground come back to the surface because of the combining actions of thaw/frost.

There is still a possibility that duds located deep into the ground of the security area fired a long time ago come back to the surface because of the combining actions of thaw/frost.

The following table shows the different levels of clearance. Level 1 is the more frequently used. The only existing records of a level 2 clearance operation were for the construction of roads and other structures in the Impact Area 2. As for level 3, it is not often used mostly because of its important cost.

TABLE 4 – CLEARANCE LEVELS

Clearance level	Method
1	Clearing of surface duds by visual observation on the site.
2	Clearing of a soil layer (30-90 cm) from duds, with the help of a magnetic detector.
3	Complete clearing of the area of the site to any depth, until nothing is detected.

3.3.5 Site classification

The DZ Anzio Area 1 receives a score of 71.3 ± 4.3 /100 or varying between 67 and 75.6 /100. This result puts the range in either class 1 or class 2. The risk potential associated with this score goes from medium to high.

The higher scores have been given for groundwater, contaminant quantity and receptors (environment). According to the topographic map and the one of surface deposits, there is no trace of containment system either natural or engineered. The hydraulic conductivity has been estimate in regard of the nature of the deposits. Thus, the materials in place is mostly sand. This results in a range of high values of hydraulic conductivity of the aquifer of concern (see p.34 of the site classification worksheet). The marshes beside Clement Creek increase the score in the section proximity to fragile areas. As for the groundwater resources, we assume that Quaternary deposits constitutes a permeable recharge area, which increase the sensibility of the site to contamination. Finally, the quantity of contaminants has been estimate according to the area of the range because of the lack of information concerning the number of ordnance fired throughout the time. The facts that no register was hold in the past and that the quality of ammunition used was sensibly lower than nowadays, are a concern because of the potential contamination risks. Moreover, it appear to be a treat for the militaries who are walking in a "mine field".

The lower scores have been given to the receptors (humans and others). The main reasons are that the water plant intake is located 5 km south-east and that people who are using the site are militaries. Furthermore, the closest city is the Town of Petawawa approximately 6 km south-east. Nowadays, there is no artillery exercises but more troop manoeuvres.

As shown in the special considerations of section IIA (groundwater), the adsorption of energetic materials on fine particles slows down the transfer from surface to the aquifer. This situation could facilitate an eventual cleanup and makes biodegradation possible to occur before contamination reaches the aquifer.

The uncertainty associated to the total score originate from the lack of information regarding the availability of alternate drinking water supply, flood potential and aerial transport.

3.3.6 Recommendations and supplementary information required

Due to the lack of information, many parts of the evaluation still involve some uncertainty. Some simple actions could be taken in order to improve knowledge on the site. This could probably lower the score of the range.

The first uncertainty concerns the quantity of contaminants in presence. In the present situation, nature and quantity of the contaminants are unknown; this makes it difficult to estimate the importance of the contamination. Furthermore, because of this lack of information, contamination has been estimated with the area of the site, without knowing if contamination was effectively spread on the whole area. Consequently, it would be important to get further information on the nature and quantity of ammunition used. If a contamination due to energetic materials is detected in this area, it would be because of the presence of either unexploded shells in the ground or transport of materials by pathways like aerial transport, groundwater and surface water.

The other major point of uncertainty consists in the understanding of groundwater flow. It has been supposed that the aquifer lay in the surface deposits mostly composed of sand modified by the wind. Groundwater flow direction and hydraulic conductivity of the sediments should be established. Because of the absence of monitoring wells, it becomes harder to have a precise knowledge of the actual quality of water on the base and the groundwater flow direction. All we can do is make some hypothesises on what would be logical. For this reason, groundwater has been supposed to go towards south-east, i.e. towards Petawawa River and the hydraulic conductivity of the sand has been estimated between 10^{-06} and 10^{-03} cm/s (Freeze and Cherry, 1979). Hydraulic conductivity of sediments and hydraulic heads appear to be a key factor to differentiate the areas of recharge from the areas of discharge of the aquifer.

Finally, information on possibility of aerial transport of energetic materials and on flood potential would help to get a more precise idea of the risks of contamination on and off the site. DZ Anzio Area 1 appears to be the area the more influenced by wind erosion. As for the flood potential, it is quite non existent mostly because of the distance that separates the site from the nearest watercourse. In addition, the water level of the Ottawa River would have to raise up of more than 30 m. Even local flood in the Tucker Lake area, due to heavy rainfalls or melting of snow, could not affect the site.

It is to be noted that a major cleaning of the site helps to prevent contamination of the area and of the surroundings.

3.4 Impact Area A

3.4.1 Site characteristics

3.4.1.1 Geographic setting

The Impact Area A is located on the north eastern part of CFB Petawawa and especially, between the square formed by these co-ordinates: 5094600m N, 5100500m N, 313200m E and 319500m E in the UTM system (NAD 83). Chalk River is the closest city situated at 3 km west. Approximately 9 km separate the site from CFB Petawawa. The site covers an area of approximately 22.5926 km². This value includes the area occupied by Sturgeon Lake, Gwatkin Lake, Rafting Bay and Thompson Bay. The range is characterised by its topography. There is a flat area beside the southern limit. The Rifle Ranges B, C, D and E are located within it. As for the rest of the site, it is more undulating. Furthermore, trees cover almost all the area. Only the riffle ranges and the Rocket Launcher Range are treeless and covered mostly with sand and grass. There are some fragile habitats and especially marshes close to Chalk River Road. The locations of these fragile sites in the UTM system (NAD 83) are: 317850m E, 5099900m N and 317600m E, 5099100m N.

3.4.1.2 Site boundaries

The western part of Impact Area A is well delimited by Road 17. As for the southern border, it goes along Deluthier road. A cut line and the southern end of Perch Lake define the northern frontier. On the East Side, there is no physical feature. The neighbouring site is the Training Area B.

3.4.1.3 Site history and activities

When CFB Petawawa started its activities at the beginning of the century, this area was used as an impact zone for artillery exercises. During the World War I, the Russian Army was testing the 100 mm shells on the eastern part of the base. The vocation of this site stood until a few years ago when it became a training area. Nowadays, no artillery exercise occurs in this area, but mostly firing exercises. Due to its proximity to the nuclear power plant, only training rockets, i.e. without explosives, are used to avoid or lower the risks of a forest fire.

3.4.1.4 Description of installations

Two gates, C1 and C2, control the access on Deluthier Road that constitutes the southern border of Impact Area A. C1, which location is 315550m E and 5094650m N, restrains the traffic coming from highway 17. As for C2, which location is 318000m E and 5095200m N, it regulates the traffic coming from Impact Area A. These two gates isolate the Rocket Launcher Range and the Rifle Ranges B, C, D and E, which are one beside each other. These ranges have a firing point at the southern extremity and the targets are at the northern extremity. The topography of ranges B, C, D and E is flat. However, range A, i.e. Rocket Launcher Range is more undulating. Finally, gate B1 controls the access to Deluthier Road.

3.4.1.5 Geological, hydrogeological and hydrological contexts

The geology of Impact Area A is composed of limestone, minor dolostone, shale and sandstone. The bedrock is partly overlain by younger alluvium in terrace remnants and more precisely sand and gravely sand. These sediments cover the southern part of the area. This layer of sediments is commonly known as the Petawawa Sand Plain. This plain was formed during the Quaternary Period by a delta formed by Petawawa, Barron, Indian and Ottawa Rivers. At that time, the great Champlain Sea was covering the Saint-Lawrence Valley and the Ottawa River Valley. However, the geology in the region surrounding Sturgeon Lake is different. There are some small areas that show abundant bedrock exposures. Sometimes, it is underneath a thin and/or discontinuous drift cover. Some glaciofluvial outwash and deltaid deposits that recover the bedrock are surrounding the older alluvium.

The hydrogeological context is not well known due to the fact that no study was undertaken in the past. Hence, there are no monitoring well on the base. The only sampling campaigns were done few years ago by both provincial and federal governments. The observation wells were set at the end of the Petawawa River. The analysis of water samples did not concern energetic materials, but showed a higher concentrations of nitrates and metals.

According to the nature of surface deposits, it seems that the aquifer is unconfined. As for the bedrock, it may allows water to flow rapidly or not. The velocity of water depends of the hydraulic conductivity, porosity and hydraulic gradient. Numerous factors influence the hydraulic conductivity like the porosity, the grain size and the presence of fractures. In the case of Impact Area A, the hydraulic conductivity of the bedrock has been neglected because of the lack of information and by comparison with the main material, which composed most of the surface deposits, i.e. the sand. The hydraulic conductivity of the sand has been estimated to vary between 10^{-05} m/s and 10^{-02} m/s because of its porous nature (Freeze and Cherry, 1979).

The depth of the water table is another important information that is unknown. The closer it is of the surface, the more rapidly the contaminants can reach it. No estimate has been done for this criteria because the classification form do not consider it.

The groundwater flow direction is presumed to be towards south-west considering the Ottawa River and the Petawawa River as discharge zones. The Sand Plain itself constitutes a recharge zone of the aquifer due to its high permeability.

3.4.2 Risk identification

3.4.2.1 Potential or known sources of contamination

The potential sources of contaminant come from the use of explosive ammunitions, which contain energetic materials. The risk of threatening the environment occurs when these projectiles do not or partially explode. Once these duds are in the ground, there is a possibility that a leak occurs and then, cause some damages to the receptors located downstream.

3.4.2.2 Potential contaminants

The ammunitions used at Impact Area A are:

- CTG .38
- CTG .50mm
- CTG 5.56mm
- CTG 7.62mm
- CTG 9mm
- CTG 60mm MOR HE
- CTG 60mm MOR SMK WP
- CTG 60mm MOR III
- CTG 76mm HESH
- CTG 76mmSH/P
- CTG 81mm MOR HE
- CTG 81mm MOR SMK WP
- CTG 81mm MOR III
- CTG 84mm HEAT FFV 551
- CTG 84mm TP/T
- CTG 105mm HE PD (HOW)
- CTG 105mm ILL (HOW)
- CTG 105mm SMK (HOW)
- PROJ 155mm HE M107
- PROJ 155mm ILL
- PROJ 155mm SMK
- PROJ 155mm SMK WP
- PYROTECHNICS
- RKT 66mm HEAT(M72)

This ammunition list can be found in appendix D (Impact Area Authorisation Form). Heavy metals and energetic materials are contained in these ammunitions. However, the ratios and weights of these materials are unknown except for the RKT 66mm which contains Octol; the main explosive compound. It includes 60 % of HMX, 20 % of TNT and 10 % of RDX. One rocket is filled with 300g of this explosive mixture.

Ammunitions contain energetic materials that can decompose into numerous metabolites. These derivative products are sometimes more toxic and mobile than the original compound. TNT is a good example; there are approximately 21 metabolites. Some of these are even more soluble than the TNT itself.

3.4.2.3 Potential sources of contamination outside the site

According to the flow direction of surface water and topography, there is low risk of contamination by other sites surrounding the Impact Area A. The pathway of surface water is towards Sturgeon Lake. So do most of the waterways present in this area. Neighbouring sites do not appear to be potential sources of contamination. Training Area C and Petawawa National Forest Institute are not classified as dangerous areas. The odds of finding any duds in the ground are low. Special considerations on groundwater have to be made. Recharging zones and direction flow have to be known for a better analysis of that particular site.

3.4.2.4 Natural or human risks of increasing damages

Few factors could increase the potential damages caused by a contamination with energetic materials. A decrease in the quality of ammunitions would cause an increase of non-exploded projectiles, which could be dangerous. Moreover, an increase in precipitation or less frequent cleaning of the site (leading to a greater possibility of transfer of the energetic materials) could be harmful to the environment. Finally, levelling or bulldozing the soil could cause some duds to be buried in the ground, leading to a greater threat for the environment. Tanks or heavy vehicles movements can also be a cause of ground disturbance.

3.4.3 Hazard evaluation

3.4.3.1 Potential pathways for contaminants

Two pathways for transport of energetic materials are possible: aerial and aqueous. When a misfire occurs, the energetic materials present in the ammunition under a powdered form, can either be dissolve in water or be easily moved by the wind.

3.4.3.1.1 Groundwater

As known (see section 3.4.1.5), groundwater flow direction is not known due to the fact that no study on the hydrogeological context has been made. The hypothetical direction has been choose because of the sampling campaign done by both governments on the influence of military activities on the quality of water. In regard of the Impact Area A, groundwater would flows into Chalk Bay or into the Ottawa River.

As for the depth of the water table, it is also unknown. Even if this criteria is not taken into account in the classification, it is important to consider it. If the aquifer has a shallow water table, the contaminants will reach the water table more easily and the contaminants can spread in the aquifer.

The energetic materials undergo biodegradation, so does the metabolites. Some of these, derived from TNT are highly soluble. However, they are also easily absorbed by organic matter and clay particles. This could explain why the lest soluble RDX can travel as fast or more then TNT if biodegradation is considered (Thiboutot et al., 1998).

3.4.3.1.2 Surface water

Surface water appears to be another pathway considering the important runoff. Chalk Bay borders the impact area A to the south. Sturgeon Lake occupies the centre part of the land. All these basins define the area as well drained. According to the topography, surface water flows towards both Sturgeon Lake and Chalk River. There are some wetlands sparsely located within the area that might be affected by energetic materials.

3.4.3.1.3 Aerial transport

Explosive compounds such as RDX, TNT and HMX are not volatile. When used in ammunition, they are under a powder state. After the explosion, there is a possibility that particles present at the surface of the ground or in the air undergo an aerial transport. Another possibility would involve that these explosive materials can be absorbed by soil particles, which are also susceptible to aerial transport. Some ammunitions contain energetic materials that release toxic fumes while burning. As an example, the hexachloroethane (HC) fumes are harmful to the fauna and flora because of their persistence in the environment.

The wind has a relatively important influence on the Petawawa ranges. Western lands with their rocky composition are not influenced by the wind. As for the eastern lands, the sandy content in the surface materials are more propitious to be modified by the wind. Drift cover might undergo an aerial transport. For this reason, aerial transport can not be neglected. Impact Area A is a different case because of its highly dense wooded areas and the use of non explosive ordnance. Predominant winds are usually coming from west, south-west and north-west. As for the velocity, ranges from 13 km/h to 17 km/h depending on its direction (Climatic atlas of Canada, 1988).

The CFB Petawawa is located in a remote area. The closest city is located south-east of the site. It is the city of Fort William on the border between the province of Quebec and the Ontario. Beside this small village, the Town of Petawawa (including the garrison) represent the other major land that might be influenced by the energetic materials.

3.4.3.2 Receptors

Receptors are those located downstream of the site potentially contaminated with energetic materials. As for CFB Petawawa, the groundwater flow direction is assumed to be the same that surface water. Receptors have been divided in two groups: humans and other receptors. This classification has been made to facilitate an overview of either living being or fragile areas that might be affected by a contamination with energetic materials. It does not suggest any value judgement. In fact, the same attention is provided to every receptors.

3.4.3.2.1 Humans

CFB Petawawa is located in a remote area of north-eastern Ontario. The cities surrounding the base have for the majority low population. If we consider the groundwater flow, the cities that are the more likely to be affected would be the garrison and the town of Petawawa and other municipalities that have its water supplies downstream into the Ottawa River. Otherwise, the remoteness of the range lower the risks of an aerial transport of energetic materials towards cities in the surrounding areas of the base.

People working on the site are mainly military personnel. Moreover, they are healthy and aware of hazards related to energetic materials.

3.4.3.2.2 Other receptors

This category contains both wildlife and vegetation. Large mammals such as White-tailed Deer, Moose and Black Bear can be found in this area. Other species living in this area include Red Fox, Beaver, Muskrat Grouse and Cottontail Rabbit.

As for marshes, they constitute fragile habitats that can easily be affected by any changes. Thus, there are some of these fragile areas along Chalk River in the north-western part of the range. A survey of the marshes did many years ago showed some high priority marshes just south of the tree nursery. The influence of energetic materials coming from Impact Area A would have to be proved considering both groundwater flow direction and wind directions.

3.4.3.3 Known contamination cases

According to the *Environmental Impact Assessment of Military Training Activities at CFB Petawawa* and to Mr. Chris Hogan, B.Env.O., there is no known contamination case caused by the past activities on Training Area A at CFB Petawawa either in the past or nowadays. However, the presence of old unexploded shells in the ground always constitutes a threat for troops and a potential source of contamination.

3.4.3.4 Potential hazards inherent in site

The site presents a high risk of soil erosion especially because of its proximity to the Sturgeon Lake. However, the presence of vegetation lowers the sensitivity to both aerial and water erosion. The terrain surrounding the lake is relatively flat and low which makes it sensible to flooding. If it occurs, energetic material particles would be in suspension and undergo an aquatic transport until they set in place downstream. Moreover, explosion risks related to duds are a constant threat to military personnel especially if clearance operations are not conducted frequently.

3.4.4 Prevention and emergency measures

To our knowledge, no emergency measures were ever taken on the site since it has been operated. Nevertheless, clearance operation are not conducted on a regular basis. The philosophy of CFB Petawawa regarding unexploded shells is to wait until there is one reported and then, taking care of it. However roads and areas that have an extensively use have been in part clean. There is still a possibility that duds located deep in the ground come back to the surface because of the combining actions of thaw/frost.

There is still a possibility that duds located deep into the ground of the security area fired a long time ago come back to the surface because of the combining actions of thaw/frost.

The following table shows the different levels of clearance. Level 1 is the more frequently used. The only existing records of a level 2 clearance operation were for the construction of roads and other structures in the Impact Area 2. As for level 3, it is not often used mostly because of its important cost.

TABLE 5 – CLEARANCE LEVELS

Clearance level	Method
1	Clearing of surface duds by visual observation on the site.
2	Clearing of a soil layer (30-90 cm) from duds, with the help of a magnetic detector.
3	Complete clearing of the area of the site to any depth, until nothing is detected.

3.4.5 Site classification

The Impact Area A receives the score 69.8 ± 4.3 /100 or ranging between 65.5 and 74.1 /100. This grade puts the site in both classes 2 and 1. The risk potential associated with this classification goes from medium to high.

The higher scores have been given for groundwater, contaminant quantity and receptors (environment). According to the topographic map and the one of surface deposits, there is no trace of containment system either natural or engineered. The hydraulic conductivity has been estimated in regard of the nature of the deposits. Thus, the materials in place are mostly sand, gravely sand and gravel. This results in a range of high values of hydraulic conductivity of the aquifer of concern (see p.34 of the site classification worksheet). The presence of Sturgeon Lake had an impact on the section related to surface water. The marshes within the site increase to the maximum amount of points allowed for the proximity to fragile areas. As for the groundwater resources, we assume that Quaternary deposits constitutes a permeable recharge area, which increase the sensibility of the site to contamination. Finally, the quantity of contaminants has been estimate according to the area of the range because of the lack of information concerning the number of ordnance fired throughout the time. The facts that no register was hold in the past and that the quality of ammunition used was sensibly lower than nowadays, are a concern because of the potential contamination risks. Moreover, it appear to be a treat for the militaries who are walking in a "mine field".

The lower score have been given to the receptors (humans and others). The main reasons are that the water plant intake is located 9.5 km downstream and that people who are using the site are militaries. Nowadays, there is no more high explosive shells used on this site due to the risks of starting a forest fires that could be a danger for the nuclear power plant.

As shown in the special considerations of section IIA (groundwater), the adsorption of energetic materials on fine particles slows down the transfer from surface to the aquifer. This situation could facilitate an eventual cleanup and makes biodegradation possible to occur before contamination reaches the aquifer.

The uncertainty associated to the total score originate from the lack of information regarding the availability of alternate drinking water supply, flood potenial and aerial transport.

3.4.6 Recommendations and supplementary information required

Due to the lack of information, many parts of the evaluation still involve some uncertainty. Some simple actions could be taken in order to improve knowledge on the site. This could probably lower the score of the range.

The first uncertainty concerns the quantity of contaminants in presence. In the present situation, nature and quantity of the contaminants are unknown. No register has been hold in the past when they started their activities at the beginning of the century. However, no highly explosive ordnance are used on this site because of the risks of ignition of a forest fire and of the presence of the nuclear power plant only 1.5 km north and the waste disposal site also north of the Impact Area A. This makes it difficult to estimate the importance of the contamination. Furthermore, because of this lack of information, contamination has been estimated with the area of the site, without knowing if contamination was effectively spread on the whole area. Knowing the exact impact or training locations when there were live-firing exercises (for example the locations of the targets used if so, would also help to estimate the real potentially contaminated area and to determine the direction followed by contaminants -this direction can vary depending on the part of the range where contamination occurs).

The other major point of uncertainty consists in the understanding of groundwater flow. It has been supposed that the aquifer lay in the quaternary deposits. Groundwater flow direction and hydraulic conductivity of the sediments should be established in order to have a precise view of the potential pathway of contaminants. That is why monitoring wells are necessary to determine these information and to observe the quality of groundwater throughout the time. While waiting for information, groundwater has been supposed to go towards south-east, i.e. towards Ottawa River and hydraulic conductivity of the sand has been estimated between 10^{-3} and 10^{-1} m/s (Freeze and Cherry, 1979). Hydraulic conductivity of sediments and hydraulic heads appear to be a key factor to localise the areas of recharge and discharge of the aquifer.

Finally, information on possibility of aerial transport of energetic materials and on flood potential would help to get a more precise idea of the risks of contamination on and off the site. It is important to specify that the odds of a major flood are low in part because of the higher level of the land compare to the water level. However, local flood may occur because of heavy rainfalls or snow melting. It is to be noted that a major cleaning of the site helps to prevent contamination of the area and of the surroundings.

3.5 Training Area B

3.5.1 Site characteristics

3.5.1.1 Geographic setting

The Impact Area B, now known as the Training Area B, is located on the eastern part of CFB Petawawa and especially, between the square by these co-ordinates: 5094900m N, 5100900m N, 317500m E and 323400m E in the UTM system (NAD 83). The site covers an area of approximately 14.6881 km^2. This value includes the area occupied by Mason Lake and Highview Lake. The range is characterised by flat terrain in its centre and southern parts. These areas are surrounded by mountains. Almost all the range is covered with trees. Some marshes can be find at different places such as 500m south of Highview Lake, approximately 300m north-west of Mason Lake and along a watercourse just north of Vaulin Creek.

3.5.1.2 Site boundaries

The Ottawa River constitutes the eastern limit. As for the northern end of the area, a cut line defines it. The southern border goes along the Chalk Bay. However, the western limit is not well defined. Its neighbouring site is Impact Area A.

3.5.1.3 Site history and activities

When CFB Petawawa started its activities at the beginning of the century, this area was used as an impact zone for artillery exercises. During the World War I, the Russian Army was testing the 100 mm shells on the eastern part of the base. The vocation of this site stood until a few years ago when it became a training area. Nowadays, no artillery exercise occurs in this area, but only troop manoeuvres.

3.5.1.4 Description of installations

There is not much installations on this site. Only gate B1 restrains the access to Chalk River Road and therefore, to northern part of the range. There is also a bivouac area located at these co-ordinates: 321950m E and 5095250m N. On Highview Tower Hill, there is a lookout that gives an overview of the area. Its location is 32250m E and 5097700m N. Every co-ordinates are based on the UTM (NAD 83) system.

3.5.1.5 Geological, hydrogeological and hydrological contexts

The geology of Training Area B is composed of limestone, minor dolostone, shale and sandstone. The bedrock is partly overlain by younger alluvium in terrace remnants and more precisely sand and gravely sand. This layer of sediments is commonly known as the Petawawa Sand Plain. This plain was formed during the Quaternary Period by a delta formed by Petawawa, Barron, Indian and Ottawa Rivers. At that time, the great Champlain Sea was covering the Saint-Lawrence Valley and the Ottawa River Valley. In the mountainous sections, there are more bedrock exposures that might have a thin drift cover.

The hydrogeological context is not well known due to the fact that no study was undertaken in the past. Hence, there are no monitoring well on the base. The only sampling campaigns were done few years ago by both provincial and federal governments. The observation wells were set at the end of the Petawawa River. The analysis of water samples did not concern energetic materials, but showed a high concentration of nitrates and metals.

According to the nature of surface deposits, it seems that the aquifer is unconfined. As for the bedrock, it may allows water to flow rapidly or not. The velocity of water depends on the hydraulic conductivity, porosity and hydraulic gradient. Numerous factors influence the hydraulic conductivity like the porosity, the grain size and the presence of fractures. In the case of Training Area B, the hydraulic conductivity of the bedrock has been neglected because of the lack of information and by comparison with the main material, which composed most of the surface deposits, i.e. the fine sand. The hydraulic conductivity of the sand has been estimated to vary between 10^{-06} m/s and 10^{-04} m/s because of its relatively porous nature (Freeze and Cherry, 1979).

The depth of the water table is another important information that is unknown. The closer it is of the surface, the more rapidly the contaminants can reach it. No estimate has been done for this criteria because the classification form do not consider it.

The groundwater flow direction is presumed to be towards south-west considering the Ottawa River and the Petawawa River as discharge zones. The Sand Plain itself constitutes a recharge zone of the aquifer due to its high permeability.

3.5.2 Risk identification

3.5.2.1 Potential or known sources of contamination

The potential sources of contaminant come from the use of explosive ammunitions, which contain energetic materials. The risk of threatening the environment occurs when these projectiles do not or partially explode. Once these duds are in the ground, there is a possibility that a leak occurs and then, cause some damages to the receptors located downstream.

3.5.2.2 Potential contaminants

The ammunitions used at Impact Area B are:

- BLANK AMMUNITION
- CS RIOT GAS
- CTG .38
- CTG .50mm
- CTG 5.56mm
- CTG 7.62mm
- CTG 9mm
- CTG 38mm SPEDEHETE CS
- CTG 38mm FLITERITE
- CTG 60mm MOR HE
- CTG 60mm MOR SMK WP
- CTG 60mm MOR III
- CTG 81mm MOR HE
- CTG 81mm MOR SMK WP
- CTG 81mm MOR III
- CTG 105mm HE M1
- CTG 105mm HE PD (HOW)
- CTG 105mm HE PLGD (HOW)
- CTG 105mm ILL (HOW)
- CTG 105mm SMK WP (HOW)
- CTG 105mm SMK (HOW)
- CTG 105mm SMK HCBE (TK)
- CTG 105mm SMK WP (TK)
- PROJ 155mm HE M107
- PROJ 155mm ILL
- PROJ 155mm SMK
- PROJ 155mm SMK WP
- RKT 21mm SUB-CAL(M72)
- PYROTECHNICS

This ammunition list can be found in appendix D (Training Area Authorisation Form). Heavy metals and energetic materials are contained in these ammunitions. The ratios and weights of these materials are unknown.

Ammunitions contain energetic materials that can decompose into numerous metabolites. These derivative products are sometimes more toxic and mobile than the original compound. TNT is a good example; there are approximately 21 metabolites. Some of these are even more soluble than the TNT itself.

3.5.2.3 Potential sources of contamination outside the site

According to topography and to direction flow of surface water, there is a risk of contamination by energetic materials coming from other sites. As for Training Area B, only the north-eastern part of impact Area A constitutes a potential source of contamination. Otherwise, the preferential pathway of surface water is towards east, i.e. towards the Ottawa River. Almost all the watercourses present in this area are tributary of the Ottawa River. However, surface water on the south-western part of the area flow towards Chalk Bay. Special considerations must be make on groundwater flow direction. In addition, the understanding of the role of watercourses in the base's area, i.e. whether or not there are recharge zones. And if so, the concentration of energetic materials in groundwater would increase and hence, constitutes a greater danger for receptors susceptible to be in contact with it.

3.5.2.4 Natural or human risks of increasing damages

Few factors could increase the potential damages caused by a contamination with energetic materials. A decrease in the quality of ammunitions would cause an increase of non-exploded projectiles, which could be dangerous. Moreover, an increase in precipitation or less frequent cleaning of the site (leading to a greater possibility of transfer of the energetic materials) could be harmful to the environment. Finally, levelling or bulldozing the soil could cause some duds to be buried in the ground, leading to a greater threat for the environment. Tanks or heavy vehicles movements can also be a cause of ground disturbance.

3.5.3 Hazard evaluation

3.5.3.1 Potential pathways for contaminants

Two pathways for transport of energetic materials are possible: aerial and aqueous. When a misfire occurs, the energetic materials present in the ammunition under a powdered form, can either be dissolve in water or be easily moved by the wind.

3.5.3.1.1 Groundwater

As known (see section 3.5.1.5), groundwater flow direction is not known due to the fact that no study on the hydrogeological context has been made. The hypothetical direction has been choose because of the sampling campaign done by both governments on the influence of military activities on the quality of water. In regard of the Training Area B, groundwater would flows into Chalk Bay or into the Ottawa River.

As for the depth of the water table, it is also unknown. Even if this criteria is not taken into account in the classification, it is important to consider it. If the aquifer has a shallow water table, the contaminants will reach the water table more easily and the contaminants can spread in the aquifer.

The energetic materials undergo biodegradation, so does the metabolites. Some of these, derived from TNT are highly soluble. However, they are also easily absorbed by organic matter and clay particles. This could explain why the lest soluble RDX can travel as fast or more then TNT if biodegradation is considered (Thiboutot et al., 1998).

3.5.3.1.2 Surface water

Surface water appears to be another pathway considering the runoff. The Training Area B is partly surrounded by Chalk Bay and the Ottawa River which define it as well drained. Surface water flows towards east. There are some lakes (Manson Lake and Highview Lake) which also act as watersheds. They are all tributary of the Ottawa River. The energetic materials might affect some wetlands located on the eastern part of the area.

3.5.3.1.3 Aerial transport

Explosive compounds such as RDX, TNT and HMX are not volatile. Furthermore, they are under a powder state when used in ammunitions. However, there is a possibility particles present at the surface of the ground undergo an aerial transport. What also happen is that these explosive materials can be absorbed by soil particles, which are also susceptible to aerial transport. It exists some ammunitions which contain energetic materials that release toxic fumes while burning. For example, the hexachloroethane (HC) fumes are harmful to the fauna and flora because of their toxicity and their persistence in the environment.

The wind has a relatively important influence on the Petawawa ranges. Western lands with their rocky composition are not influenced by the wind. As for the eastern lands, the sandy content in the surface materials are more propitious to be modified by the wind. Drift cover might undergo an aerial transport. For this reason, aerial transport can not be neglected. Impact Area B is a different case because of its highly dense wooded areas. In addition, this area is now use only for dry-firing exercises, i.e. there is no more explosive shells fired on this range. Predominant winds are usually coming from west, south-west and north-west. As for the velocity, ranges from 13 km/h to 17 km/h depending on its direction (Climatic atlas of Canada, 1988).

Wind appears to be a potential pathway for contaminants. However, the incidence on the Training Area B does not seem important due to the presence of vegetation.

3.5.3.2 Receptors

Receptors are those located downstream of the site potentially contaminated with energetic materials. As for CFB Petawawa, the groundwater flow direction is assumed to be the same that surface water. Receptors have been divided in two groups: humans and other receptors. This classification has been made to facilitate an overview of either living being or fragile areas that might be affected by a contamination with energetic materials. It does not suggest any value judgement. In fact, the same attention is provided to every receptors.

3.5.3.2.1 Humans

Although the Training Area B is quite far from the Town of Petawawa, the major city in the area, a potential contamination is still possible. Thus, there are some houses just across the Ottawa River. The probability that they might be affected is low but present. This is mostly due to the distance the contaminants would have to do. As for the population of Chalk River, it has not been considered because of its location upstream the site.

The CFB Petawawa is located in a remote area. The closest city is located south-east of the site. It is the city of Fort William on the border between the province of Quebec and the Ontario. Beside this small village, the Town of Petawawa (including the garrison) represent the other major land that might be influenced by the energetic materials.

People working on the site are mainly military personnel. Moreover, they are healthy and aware of hazards related to energetic materials.

3.5.3.2.2 Other receptors

This category contains both wildlife and vegetation. Large mammals such as White-tailed Deer, Moose and Black Bear can be found in this area. Other species living in this area include Red Fox, Beaver, Muskrat Grouse and Cottontail Rabbit.

As for marshes, they constitute fragile habitats that can easily be affected by any changes. Thus, there are some of these fragile areas along Vaulin Creek in the northern part of the range. A survey of the marshes did many years ago showed some high priority marshes north of Mason Lake and south of Highview Lake. The real influence of energetic materials coming from

Training Area B would have to be proved considering both groundwater flow direction and wind directions.

3.5.3.3 Known contamination cases

According to the *Environmental Impact Assessment of Military Training Activities at CFB Petawawa* and to Mr. Chris Hogan, B.Env.O., there is no known contamination case caused by the past activities on Training Area B at CFB Petawawa either in the past or nowadays. However, the presence of old unexploded shells in the ground always constitutes a threat for troops and a potential source of contamination.

3.5.3.4 Potential hazards inherent in site

The site presents a high risk of soil erosion especially because of its proximity to the Ottawa River and to Chalk Bay. However, the presence of vegetation lowers the sensitivity to erosion of this impact area. The southern part of the site is relatively lowland and flat terrain, which makes it sensible to flooding. If it occurs, energetic material particles would be in suspension and undergo an aquatic transport until they set in place downstream. Moreover, explosion risks related to duds are a constant threat to military personnel especially if clearance operations are not conducted frequently.

3.5.4 Prevention and emergency measures

To our knowledge, no emergency measures were ever taken on the site since it has been operated. Nevertheless, clearance operation are not conducted on a regular basis. The philosophy of CFB Petawawa regarding unexploded shells is to wait until there is one reported and then, taking care of it. The last major clearance operation occurred in the late 80's. However, newly constructed roads and installations have been clean in order to create a zone where there is no doubt about security.

There is still a possibility that duds located deep into the ground of the security area fired a long time ago come back to the surface because of the combining actions of thaw/frost.

The following table shows the different levels of clearance. Level 1 is the more frequently used. The only existing records of a level 2 clearance operation were for the construction of roads and other structures in the Impact Area 2. As for level 3, it is not often used mostly because of its important cost.

TABLE 6 – CLEARANCE LEVELS

Clearance level	Method
1	Clearing of surface duds by visual observation on the site.
2	Clearing of a soil layer (30-90 cm) from duds, with the help of a magnetic detector.
3	Complete clearing of the area of the site to any depth, until nothing is detected.

3.5.5 Site classification

The Impact Area B receives a score of 74.7 ± 4.3 /100 or ranging from 70.4 to 79 /100. This grade puts the site in class 1. The risk potential associated with this classification is high.

The higher grades were given for the groundwater, surface water, quantity of contaminants and the receptors (especially the environment). The map showing the surface deposits has no trace of any engineered or natural containment system. This is why the site got the highest number of points allowed for these criteria. The presence of the Ottawa River and Chalk Bay as borders of the site increased the scores related to the surface water. As for the environment, the marshes within the area, it contributes to raise the grade of potentially affected fragile sites. The accessibility to the site also got a high score mostly because of the civilians who are coming on the site by boat. The numerous "no trespassing" signs and warnings on the presence of unexploded shells are not enough to dissuade people. Finally, the quantity of contaminants has been estimate according to the area of the range because of the lack of information concerning the number of ordnance fired throughout the time. The facts that no register was hold in the past and that the quality of ammunition used was sensibly lower than nowadays, are a concern because of the potential contamination risks. Moreover, it appear to be a treat for the militaries who are walking in a "mine field".

The lower score have been given to the receptors (humans and others). The main reasons are that the water plant intake is located 7 km downstream and that people who are using the site are militaries. However, the facts that the Ottawa River and Chalk Bay are close to the site and are used for activities like fishing, swimming and sailing elevate the maximum amount of points allowed to the criteria of concern.

As shown in the special considerations of section IIA (groundwater), the adsorption of energetic materials on fine particles slows down the transfer from surface to the aquifer. This situation could facilitate an eventual cleanup and makes biodegradation possible to occur before contamination reaches the aquifer.

The hydraulic conductivity of the aquifer has been estimated in accordance with the nature of the surface deposits and with the chart of values (p.34 of the site classification worksheet).

The uncertainty associated to the total score originate from the lack of information regarding the availability of alternate drinking water supply, flood potential and aerial transport.

3.5.6 Recommendations and supplementary information required

Due to the lack of information, many parts of the evaluation still involve some uncertainty. Some simple actions could be taken in order to improve knowledge on the site. This could probably lower the score of the range.

The first uncertainty concerns the quantity of contaminants in presence. In the present situation, nature and quantity of the contaminants are unknown; this makes it difficult to estimate the importance of the contamination. Furthermore, because of this lack of information, contamination has been estimated with the area of the site, without knowing if contamination was effectively spread on the whole area. Consequently, it would be important to get further information on the nature and quantity of ammunition used. Even if no register was hold when the military exercises started on this site. Knowing the exact impact or training locations (for example the locations of the targets used if so, would also help to estimate the real potentially contaminated area and to determine the direction followed by contaminants - this direction can vary depending on the part of the range where contamination occurs).

The other major point of uncertainty consists in the understanding of groundwater flow. It has been supposed that the aquifer lay in the quaternary deposits. However, it stays a hypothesis due to the fact that no monitoring well has been installed. With these additions, groundwater flow direction and hydraulic conductivity of the sediments would be established. For this initial study, groundwater has been supposed to go towards south-east, i.e. towards the Ottawa River and hydraulic conductivity of the deposits has been estimated to vary from 10^{-5} and 10^{-2} m/s (Freeze and Cherry, 1979). Hydraulic conductivity of sediments and hydraulic heads appear to be a key factor to localise the areas of recharge and discharge of the aquifer.

Finally, information on possibility of aerial transport of energetic materials and on flood potential would help to get a more precise idea of the risks of contamination on and off the site. The flood potential appears to be low due to the fact that the level of the Ottawa River would have to raise of at least 10 m to get inland. However, local flood on the areas surrounding creeks and lakes are possible due to the snow melting. As for the influence of the wind, it is limited because there are plenty within the area but still present. Occasions like a leakage or the explosion of an unexploded shell are susceptible to aerial transport. It is to be noted that a major cleaning of the site helps to prevent contamination of the area and of the surroundings.

3.6 Petawawa Grenade Range

3.6.1 Site characteristics

3.6.1.1 Geographic setting

The Petawawa Grenade Range is located within Impact Area 2 on the eastern part of CFB Petawawa and especially, at these co-ordinates: 318800m E and 5088300m N in the UTM system (NAD 83). The site covers an area less than 1 km². The range is characterised by a flat terrain partially surrounded by trees. The soil is covered by either sand or grass. There are some fragile areas are in Training Area E and approximately 2.5 km south-west of the site. Jorgens Lake represents the closest basin and the Ottawa River, the closest watercourse.

3.6.1.2 Site boundaries

The Petawawa Grenade Range is located within the Area 2 and especially beside the eastern limit. The junction of Brindle Road and Road 17 at the north-eastern end of the area is the only well defined frontier. Elsewhere, there is no particular physical feature.

3.6.1.3 Site history and activities

When CFB Petawawa started its activities at the beginning of the century, this area was used as an impact zone for artillery exercises. During the World War I, the Russian Army was testing the 100 mm shells on the eastern part of the base. The vocation of this site stood until many years ago when it became a grenade range. Nowadays, the range is still in use and its vocation has not change.

3.6.1.4 Description of installations

The only way to get to the range is by taking Messer Trail that goes along the Canadian Pacific railroad and the Trans Canada Highway 17. Gates 2C and 2D give a direct access to the cart-tracks that directly go to the range. The site itself is simple. There is concrete "bunker" that protect the military personal from the grenade fragments. Otherwise, the impact zone is flat.

3.6.1.5 Geological, hydrogeological and hydrological contexts

The geology of Petawawa Grenade Range is composed of limestone, minor dolostone, shale and sandstone. The bedrock is overlain by sand deposits modified by wind. This layer of sediments is commonly known to be a part of the Petawawa Sand Plain. This plain was formed during the Quaternary Period by a delta formed by Petawawa, Barron, Indian and Ottawa Rivers. At that time, the great Champlain Sea was covering the Saint-Lawrence Valley and the Ottawa River Valley.

The hydrogeological context is not well known due to the fact that no study was undertaken in the past. Hence, there are no monitoring well on the base. The only sampling campaigns were done few years ago by both provincial and federal governments. The observation wells were set at the end of the Petawawa River. The analysis of water samples did not concern energetic materials, but showed a high concentration of nitrates and metals.

According to the nature of surface deposits, it seems that the aquifer is unconfined. As for the bedrock, it may allows water to flow rapidly or not. The velocity of water depends on the hydraulic conductivity, porosity and hydraulic gradient. Numerous factors influence the hydraulic conductivity like the porosity, the grain size and the presence of fractures. In the case of Petawawa Grenade Range, the hydraulic conductivity of the bedrock has been neglected because of the lack of information and by comparison with the main material, which composed most of the surface deposits, i.e. the sand. The hydraulic conductivity of the sand has been estimated to vary between 10^{-06} m/s and 10^{-03} m/s because of its porous nature (Freeze and Cherry, 1979).

The depth of the water table is another important information that is unknown. The closer it is of the surface, the more rapidly the contaminants can reach it. No estimate has been done for this criteria because the classification form do not consider it.

The groundwater flow direction is presumed to be towards south-west considering the Petawawa River as discharge zones. The Sand Plain itself constitutes a recharge zone of the aquifer due to its high permeability. However, without any geological assessment, these hypothesises stay questionable.

3.6.2 Risk identification

3.6.2.1 Potential or known sources of contamination

The potential sources of contaminant come from the use of explosive ammunitions, which contain energetic materials. The risk of threatening the environment occurs when these projectiles do not or partially explode. Once these duds are in the ground, there is a possibility that a leak occurs and then, cause some damages to the receptors located downstream.

3.6.2.2 Potential contaminants

The ammunitions used at Rocket Launcher Range are:

- GREN FRAG M67
- GREN FRAG M61
- PYROTECHNIVCS

This ammunition list can be found in appendix D (Training Area Authorisation Form). Heavy metals and energetic materials are contained in these ammunitions. The ratios and weights of these materials are unknown.

Ammunitions contain energetic materials that can decompose into numerous metabolites. These derivative products are sometimes more toxic and mobile than the original compound. TNT is a good example; there are approximately 21 metabolites. Some of these are even more soluble than the TNT itself.

3.6.2.3 Potential sources of contamination outside the site

According to topography and to the direction flow of surface water, there is a low risk of contamination by energetic materials coming from other sites. Preferential pathway of surface water is towards south and west. The most probable source of contamination is the DZ Anzio Area 1 to the north. Furthermore, other neighbouring sites are not even classified as danger area. Thus, the probability of finding any unexploded duds is low. Special considerations must be make on groundwater flow direction. In addition, the understanding of the role of watercourses in the base's area, i.e. whether or not they are recharge zones. If so, the concentration of energetic materials in groundwater would increases and hence, constitutes a greater danger for receptors susceptible to be in contact with it.

3.6.2.4 Natural or human risks of increasing damages

Few factors could increase the potential damages caused by a contamination with energetic materials. A decrease in the quality of ammunitions would cause an increase of non-exploded projectiles, which could be dangerous. Moreover, an increase in precipitation or less frequent cleaning of the site (leading to a greater possibility of transfer of the energetic materials) could be harmful to the environment. Finally, levelling or bulldozing the soil could cause some duds to be buried in the ground, leading to a greater threat for the environment. Tanks or heavy vehicles movements can also be a cause of ground disturbance.

3.6.3 Hazard evaluation

3.6.3.1 Potential pathways for contaminants

Two pathways for transport of energetic materials are possible: aerial and aqueous. When a misfire occurs, the energetic materials present in the ammunition under a powdered form, can either be dissolve in water or be easily moved by the wind.

3.6.3.1.1 Groundwater

As known (see section 3.6.1.5), groundwater flow direction is not known due to the fact that no study on the hydrogeological context has been made. The hypothetical direction has been choose because of the sampling campaign done by both governments on the influence of military activities on the quality of water. In regard of the Petawawa Grenade Range, groundwater would flows towards either Jorgens Lake or Petawawa River, i.e. towards south-east.

As for the depth of the water table, it is also unknown. Even if this criteria is not taken into account in the classification, it is important to consider it. If the aquifer has a shallow water table, the contaminants will reach the water table more easily and the contaminants can spread in the aquifer.

The energetic materials undergo biodegradation, so does the metabolites. Some of these, derived from TNT are highly soluble. However, they are also easily absorbed by organic matter and clay particles. This could explain why the lest soluble RDX can travel as fast or more then TNT if biodegradation is considered (Thiboutot et al., 1998).

3.6.3.1.2 Surface water

Surface water appears to be another pathway considering the runoff. The Petawawa Grenade Range is on the northern part of Jorgens plain. There is no precise border such as river, lake or pond. Duke Creek is the closest basin in the area. The rarity of watercourse indicates that the grenade area is poorly drained. According to the topography, surface water flows towards east. There are some wetlands along Duke Creek that might be affected by energetic materials.

3.6.3.1.3 Aerial transport

Explosive compounds such as RDX, TNT and HMX are not volatile. Furthermore, they are under a powder state when used in ammunitions. However, there is a possibility particles present at the surface of the ground undergo an aerial transport. What also happen is that these explosive materials can be absorbed by soil particles, which are also susceptible to aerial transport. It exists some ammunitions which contain energetic materials that release toxic fumes while burning. For example, the hexachloroethane (HC) fumes are harmful to the fauna and flora because of their toxicity and their persistence in the environment.

The direction of the wind varies a lot, but is more often towards east. If an aerial transport occurs due to the explosion of a grenade, the cities that is more likely to be affected is Petawawa (south-east). Otherwise, the others habitat possibly affected would be the wildlife, the aquatic fauna of the Ottawa River and the closest fragile areas, i.e. the marshes located along Duke Creek and Antler Lake.

3.6.3.2 Receptors

Receptors are those located downstream of the site potentially contaminated with energetic materials. As for CFB Petawawa, the groundwater flow direction is assumed to be the same that surface water. Receptors have been divided in two groups: humans and other receptors. This classification has been made to facilitate an overview of either living being or fragile areas that might be affected by a contamination with energetic materials. It does not suggest any value judgement. In fact, the same attention is provided to every receptors.

3.6.3.2.1 Humans

The closest city to the site, considering the direction flow of the river and the direction of the wind, is the Town of Petawawa located approximately 5 km south-east of the range, would be the most probable receptor affected by a contamination by energetic materials. As for the water plant intake or the residential wells, there is no proof of the presence of energetic materials coming from the grenade range because water has never been tested for that type of contaminants and there is barely no information on the groundwater context.

People working on the site are mainly military personnel. Moreover, they are healthy and aware of hazards related to energetic materials.

3.6.3.2.2 Other receptors

This category contains both wildlife and vegetation. Large mammals such as White-tailed Deer, Moose and Black Bear can be found in this area. Other species living in this area include Red Fox, Beaver, Muskrat Grouse and Cottontail Rabbit.

As for marshes, they constitute fragile habitats that can easily be affected by any changes. Thus, there are some of these fragile areas along Duke Creek and around Antler Lake respectively in the western and in the eastern parts of the range. A survey of the marshes did many years ago showed some high priority marshes in Training Areas E and G and within Impact area 2. The influence of energetic materials coming from Petawawa Grenade Range would have to be proved considering both groundwater flow direction and wind directions.

3.6.3.3 Known contamination cases

According to the *Environmental Impact Assessment of Military Training Activities at CFB Petawawa* and to Mr. Chris Hogan, B.Env.O., there is no known contamination case caused by the past activities on Petawawa Grenade Range at CFB Petawawa either in the past or nowadays. However, the presence of old unexploded shells in the ground always constitutes a threat for troops and a potential source of contamination.

3.6.3.4 Potential hazards inherent in site

The site presents a low risk of soil erosion especially because of the distance that separates it from the closest basins. However, the absence of vegetation and the type of surficial deposits, i.e. fine sand, constitute a propitious environment to aerial erosion and erosion caused by runoff water. Flooding in this area are not considered as a potential hazard due to the distance that separates it from the Ottawa River. Moreover, explosion risks related to duds are a constant threat to military personnel especially if clearance operations are not conducted frequently.

3.6.4 Prevention and emergency measures

To our knowledge, no emergency measures were ever taken on the site since it has been operated. Nevertheless, clearance operation are not conducted on a regular basis. The philosophy of CFB Petawawa regarding unexploded shells is to wait until there is one reported and then, taking care of it. However roads and areas that have an extensively use have been in part clean. There is still a possibility that duds located deep in the ground come back to the surface because of the combining actions of thaw/frost.

Since 1974, over 87.25 km² on the impact areas have been swept at a clearance level 1. As for the Grenade Range Area A, the records do not show that a clearance operation ever occurred. On the other hand, the construction of the concrete bunker needed a characterisation of the soil on which it would be constructed.

The following table shows the different levels of clearance. Level 1 is the more frequently used. Thus, the construction of roads or any other structures might need a level 2. As for level 3,it is not often used mostly because of its important cost.

TABLE 7 – CLEARANCE LEVELS

Clearance level	Method
1	Clearing of surface duds by visual observation on the site.
2	Clearing of a soil layer (30-45 cm) from duds, with the help of a magnetic detector.
3	Complete clearing of the area of the site to any depth, until nothing is detected.

3.6.5 Site classification

The Petawawa Grenade Range has received a score of 48.8 ± 4.3 /100 or ranging from 44.5 to 53.1 /100. This mark classified the site at the limit of classes 2 and 3. Thus, the risk potential vary from medium low to medium.

Higher marks were given to the groundwater as a potential pathway of contaminants. The lack of information on this issue leaves us no choice but to make few suppositions. A closer look to the surface deposits map showed that there were neither natural nor engineered containment layer. As for the hydraulic conductivity of the aquifer, it has been estimate in accordance with the nature of the surface deposits and to the chart on the range of values of hydraulic conductivity and permeability (p.34 of the site classification worksheet).

The relatively low grades of surface water are due to the fact that there is no major water course or basin close to the site. The remoteness also explains the low scores related to the receptors. The closest city is the Town of Petawawa approximately 5 km south-west.

The uncertainty associated to the total score originate from the lack of information regarding the availability of alternate drinking water supply, flood potential and aerial transport.

As shown in the special considerations of section IIA (groundwater), the adsorption of energetic materials on fine particles slows down the transfer from surface to the aquifer. This situation could facilitate an eventual cleanup and makes biodegradation possible to occur before contamination reaches the aquifer.

Even if the Petawawa Grenade Range had a low score, it does not mean that there is no chances of a contamination by energetic materials. It becomes important to consider the previous uses of the site and low order detonation in order to evaluate the potential of contamination. If traces of TNT, RDX or HMX are found in the water within Impact Area 2, it would be hard to determine the real influence of the grenade range. For this reason, it is important to see the global influence of the ranges upstream and see which sites had and still have an extensive use that could be directly related to the contamination.

3.6.6 Recommendations and supplementary information required

Due to the lack of information, many parts of the evaluation still involve some uncertainty. Some simple actions could be taken in order to improve knowledge on the site. This could probably lower the score of the range.

The first uncertainty concerns the quantity of contaminants in presence. In the present situation, nature and quantity of the contaminants are unknown; this makes it difficult to estimate the importance of the contamination. Furthermore, because of this lack of information, contamination has been estimated with the area of the site, without knowing if contamination was effectively spread on the whole area. Consequently, it would be important to get further information on the nature and quantity of ammunition used.

The other major point of uncertainty consists in the understanding of groundwater flow. It has been supposed that the aquifer lay in the sand that compose the surface deposits. Monitoring wells would be a good way to characterise the hydrogeological context, such as groundwater flow direction and hydraulic conductivity of the sediments, and to witness the quality of water in the future. While waiting for information, groundwater has been supposed to go towards south-east, i.e. towards Petawawa River and hydraulic conductivity of the sand has been estimated to vary between 10^{-06} and 10^{-03} m/s (Freeze and Cherry, 1979). Hydraulic conductivity of sediments and hydraulic heads appear to be a key factor to localise the areas of recharge and discharge of the aquifer.

The lack of information on possibility of aerial transport of energetic materials and on flood potential would help to get a more precise idea of the risks of contamination on and off the site. However, flood is not a major concern mostly because of the remoteness of the range from water courses or basins. Even local flood that could occur in the Jorgens Lake area due to the melting of snow would not affect the range. It is to be noted that a major cleaning of the site helps to prevent contamination of the area and of the surroundings.

3.7 Impact Areas 7 and 8

3.7.1 Site characteristics

3.7.1.1 Geographic setting

The Impact Areas 7 and 8 are located on the western part of CFB Petawawa and especially, in the square produced by the following co-ordinates: 301400m E, 308500m E, 5082000m N and 5092500m N in the UTM system (NAD 83). The site covers an area of more than 56 km^2. The areas are located in a part of the base characterised by important hills. There are many basins, but the more important are Centre Lake, Military Lake and the east end of Montgomery Lake. The major drainage feature is the Petawawa River which has as source the Montgomery Lake. Its direction flow is due east and it acts as a border between area 7 and area 8. These areas are mostly covered with grass and sand. There are many marshes especially in the northern part of area 8 and eastern part of area 7, along Centre Creek. These marshes are considered as fragile habitats.

3.7.1.2 Site boundaries

As said before, the impact areas 7 and 8 are located in the eastern part of CFB Petawawa. The areas are not well delimited, i.e. there is no particular physical feature. However, it is bordered by the Petawawa Range and Training Area to the north, the Training Areas P and Q to the west, the Impact Areas 5 and 6 to the east and finally by the Training Area R to the south.

3.7.1.3 Site history and activities

When CFB Petawawa started its activities at the beginning of the century, the eastern areas were used as impact zones for artillery exercises. During the World War I, the Russian Army was testing the 100 mm shells at Petawawa. Gradually, the government expropriated the lands located in the western part. Progressively, military exercises were undergoing in the western part of CFB Petawawa leaving the eastern areas as dry-firing ranges. Nowadays, the impact areas 7 and 8 are used for long range firing exercises. Targets are usually tops of hills, but sometimes duds are off target and hit roads, marshes or watercourses.

3.7.1.4 Description of installations

There is many access road to these sites. Most of them are relatively well maintained, but it happens that they are damaged by shells. Orange Road to the north, Race Horse Road to the east and Survey Lake Road to the south and west provide access to the multiple gates the control the access to the impact areas. Impact area 8 contains the Demolition Range which has been studied previously in this assessment. There are some bunkers where military personnel can witness the destruction of ammunition, explosives, etc. They also provided the location of unexploded ordnance.

3.7.1.5 Geological, hydrogeological and hydrological contexts

The geology of Demolition Range is composed of Precambrian rocks (metamorphic and intrusive: amphibolite, granulite, mafic, ultramafic and anorthositic rocks). That land is a part of the Canadian Shield. The bedrock is overlain by gravel, gravely sand, sand and by poorly sorted till.

The hydrogeological context is not well known due to the fact that no study was undertaken in the past. Hence, there are no monitoring well on the base. The only sampling campaigns were done few years ago by both provincial and federal governments. The observation wells were set at the mouth of the Petawawa River. The analysis of water samples did not concern energetic materials, but showed a high concentration of nitrates and metals.

According to the nature of surface deposits, it seems that the aquifer is unconfined. As for the bedrock, it may allows water to flow rapidly or not. The velocity of water depends on the hydraulic conductivity, porosity and hydraulic gradient. Numerous factors influence the hydraulic conductivity like the porosity, the grain size and the presence of fractures. In the case of the Impact Areas 7 and 8, the hydraulic conductivity of the bedrock has been neglected because of the lack of information and its nature. The hydraulic conductivity of the deposits has been estimated to vary between 10^{-12} m/s and 10^{-2} m/s depending of the material and its porous nature (Freeze and Cherry, 1979).

The depth of the water table is another important information that is unknown. The closer it is of the surface, the more rapidly the contaminants can reach it. No estimate has been done for this criteria because the classification form do not consider it.

The groundwater flow direction is presumed to be towards south-west for area 8 considering the Barron River as a discharge and towards south for area 7 considering Petawawa River as a discharge watercourse. As for the recharge areas, there is no information that specified where the aquifer recharges. However, mountains are usually known to be a recharge zone due to the contact between bedrock and permeable surface deposits. The influence of Biggar Lake is not well known. It could be either a discharge or a recharge zone.

3.7.2 Risk identification

3.7.2.1 Potential or known sources of contamination

The potential sources of contaminant come from the use of explosive ammunitions which contain energetic materials. The risk of threatening the environment occurs when these projectiles do not or partially explode. Once these duds are in the ground, there is a possibility that a leak occurs and then, cause some damages to the receptors located downstream.

3.7.2.2 Potential contaminants

No authorisation form was available. Hence, the nature of ammunitions used on these sites has to be determine in order to evaluate if there is a chance to find energetic materials in the ground.

Ammunitions contain energetic materials that can decompose into numerous metabolites. These derivative products are sometimes more toxic and mobile than the original compound. TNT is a good example; there are approximately 21 metabolites. Some of these are even more soluble than the TNT itself.

3.7.2.3 Potential sources of contamination outside the site

According to the flow direction of surface water and topography, there is a minimum risk of contamination by other sites. The reason is that artillery exercises are concentrated in areas 7 and 8. Otherwise, the neighbouring sites do not appear to be potential sources of contamination. Area P and Area Q are not classified as dangerous, which lower the possibility of finding duds in the ground. As for Impact Area 6, its location downstream of the Impact areas 7 and 8 classify this site as potentially contaminated. Finally, the fact that Petawawa River separates Impact Area 7 from Impact Area 8 implies that energetic materials would travel downstream. Considerations on the groundwater flow direction must be made to provide a good analysis of a particular site

3.7.2.4 Natural or human risks of increasing damages

Few factors could increase the potential damages caused by a contamination with energetic materials. A decrease in the quality of ammunitions would cause an increase of non-exploded projectiles, which could be dangerous. Moreover, an increase in precipitation or less frequent cleaning of the site (leading to a greater possibility of transfer of the energetic materials) could be harmful to the environment. Finally, levelling or bulldozing the soil could cause some duds to be buried in the ground, leading to a greater threat for the environment. Tanks or heavy vehicles movements can also be a cause of ground disturbance.

3.7.3 Hazard evaluation

3.7.3.1 Potential pathways for contaminants

Two pathways for transport of energetic materials are possible: aerial and aqueous. When a misfire occurs, the energetic materials present in the ammunition under a powdered form, can either be dissolve in water or be easily moved by the wind.

3.7.3.1.1 Groundwater

As known, groundwater flow direction is not known due to the fact that no study on the hydrogeological context has been made. The hypothetical direction has been choose because of the sampling campaign done by both governments on the influence of military activities on the quality of water. In regard of the Impact Areas 7 and 8, groundwater is taught to flow towards south and south-east.

As for the depth of the water table, it is also unknown. Even if this criteria is not taken into account in the classification, it is important to consider it. If the aquifer has a shallow water table, the contaminants will reach the water table more easily and the contaminants can spread in the aquifer.

The energetic materials undergo biodegradation, so does the metabolites. Some of these, derived from TNT are highly soluble. However, they are also easily absorbed by organic matter and clay particles. This could explain why the lest soluble RDX can travel as fast or more then TNT if biodegradation is considered (Thiboutot et al., 1998).

3.7.3.1.2 Surface water

Surface water appears to be another pathway considering the runoff. The Impact Areas 7 and 8 have well-defined border like river, pond or lake. Barron River and Petawawa River define the areas as well drained. According to the topography, surface water flows mostly towards the Petawawa River in either areas. There are some wetlands within these areas that might be affected by energetic materials.

3.7.3.1.3 Aerial transport

Explosive compounds such as RDX, TNT and HMX are not volatile. Furthermore, they are under a powder state when used in ammunitions. However, there is a possibility particles present at the surface of the ground undergo an aerial transport. What also happen is that these explosive materials can be absorbed by soil particles, which are also susceptible to aerial transport. It exists some ammunition, which contain energetic materials that release toxic fumes while burning. For example, the hexachloroethane (HC) fumes are harmful to the fauna and flora because of their toxicity and their persistence in the environment.

The wind has a relatively important influence on the Petawawa ranges. Eastern lands were in the past and nowadays influenced by the wind. As for the western lands, their rocky composition lowers the wind incidence. However, drift cover might undergo an aerial transport. For this reason, aerial transport cannot be neglected. Predominant winds are usually coming from west, south-west and north-west. As for the velocity, ranges from 13 km/h to 17 km/h depending on its direction (Climatic atlas of Canada, 1988).

The CFB Petawawa is located in a remote area. The closest city is located far east of the Impact Areas 7 and 8. Beside the Town of Petawawa (including the garrison), the lands that might be influenced by the energetic materials

3.7.3.2 Receptors

Receptors are those located downstream of the site potentially contaminated with energetic materials. As for CFB Petawawa, the groundwater flow direction is assumed to be the same that surface water. Receptors have been divided in two groups: humans and other receptors. This classification has been made to facilitate an overview of either living being or fragile areas that might be affected by a contamination with energetic materials. It does not suggest any value judgement. In fact, the same attention is provided to every receptors.

3.7.3.2.1 Humans

CFB Petawawa is located in a remote area of north-eastern Ontario. The cities surrounding the base have for the majority, a low population. If we consider the groundwater flow, the cities that is the more likely to be affected would be the garrison and the town of Petawawa and other municipalities that have its water supplies downstream into the Ottawa River. Otherwise, the remoteness of the range lower the risks that energetic materials that are undergoing an aerial transport affect the cities in the areas surrounding the base.

People working on the site are mainly military personnel. Moreover, they are healthy and aware of hazards related to energetic materials.

3.7.3.2.2 Other receptors

This category contains both wildlife and vegetation. Large mammals such as White-tailed Deer, Moose and Black Bear can be found in this area. Other species living in this area include Red Fox, Beaver, Muskrat Grouse and Cottontail Rabbit.

As for marshes, they constitute fragile habitats that can easily be affected by any changes. Thus, there are some of these fragile areas along Clement Creek in the northern part of the range. A survey of the marshes did many years ago showed some high priority marshes in Training Areas C and L. The influence of energetic coming from Training Area D would have to be proved considering both groundwater flow direction and wind directions.

3.7.3.3 Known contamination cases

According to the *Environmental Impact Assessment of Military Training Activities at CFB Petawawa* and to Mr. Chris Hogan, B.Env.O., there is no known contamination case caused by the past activities on Impact Areas 7 and 8 at CFB Petawawa either in the past or nowadays. However, the presence of old unexploded shells in the ground always constitutes a threat for troops and a potential source of contamination.

3.7.3.4 Potential hazards inherent in site

The site shows a high risk of soil erosion especially because of the presence of many lakes and watercourses within the area. However, the vegetation that partly surrounds the lakes lowers the sensitivity to both aerial and water erosion. The terrain just east of the lake is treeless which makes it propitious to both erosion and flooding. If these events occur, energetic material particles would be in suspension and undergo an aquatic transport until they set in place downstream. Moreover, explosion risks related to duds are a constant threat to military personnel especially if clearance operations are not conducted frequently.

3.7.4 Prevention and emergency measures

To our knowledge, no emergency measures were ever taken on the site since it has been operated. Nevertheless, clearance operation are not conducted on a regular basis. The philosophy of CFB Petawawa regarding unexploded shells is to wait until there is one reported and then, taking care of it. As for the Impact Areas 7 and 8, the presence of UXO in the ground is probable and might represent a major concern. Many years ago, an important forest fire took place on the western part of CFB Petawawa. Three cases of cooked off ordnance have been registered. Still, these cases are under investigation due to the fact that the shells can resist to high temperature. Nevertheless, the procedures concerning forest fire have been changed in order to prevent any accident.

There is still a possibility that duds located deep into the ground of the security area fired a long time ago come back to the surface because of the combining actions of thaw/frost.

The following table shows the different levels of clearance. Level 1 is the more frequently used. The only existing records of a level 2 clearance operation were for the construction of roads and other structures in the Impact Area 2. As for level 3, it is not often used mostly because of its important cost.

TABLE 8 – CLEARANCE LEVELS

Clearance level	Method
1	Clearing of surface duds by visual observation on the site.
2	Clearing of a soil layer (30-90 cm) from duds, with the help of a magnetic detector.
3	Complete clearing of the area of the site to any depth, until nothing is detected.

3.7.5 Site classification

The Demolition Range receives a score of 77.5 ± 4.3 /100 or ranging from 73.2 to 81.8 /100. This grade puts the site in class 1 and the risk potential associates with this classification is high.

Higher grades were given for contaminants characteristics, groundwater, surface water and the receptors. The lack of information concerning the geological, hydrogeological and hydrological contexts forced us to make some suppositions especially for the direction flow of water in and on the ground. The hydraulic conductivity of the aquifer was supposed to be in accordance with the nature of the surface deposits and with the chart of values (p.34 of the site classification worksheet). However, the map of the surface deposits was not precise enough to characterise the real nature of materials in place. That is why an interval of hydraulic conductivity was given. There was no trace of engineered or natural containment system. The presence of many lakes, marshes and rivers can not be neglected. In fact, we think it represents the main drainage systems and the potential pathways for the contaminants contained in runoff water by spreading down the slopes beside the hills. The marshes within the areas increase the score for the presence of fragile sites to its maximum value.

The receptors received a low grade concerning humans because of the remoteness of the site. The closest village is Black Bay located approximately 10 km east. Another reason is that the site is within the Impact Area 8 where ordnance land. Furthermore, only military personnel has an access to this part of the base. However, other receptors got a relatively high score due mostly to the presence of marshes and dense forests. As known, they constitute rich natural habitats.

The results clearly show that the impact areas have a high score. It does not mean that there is a contamination by energetic materials, but it indicates that further studies should be undergone. The fact that the impact zones are not well defined influences a lot the score concerning the estimate of contaminant. A more detailed study on the zones of interest, i.e. the targets, would facilitate future studies of these sites. If traces of TNT, RDX or HMX are in the water, it would be hard to determine the real influence of the Demolition Range. For this reason, it is important to see the global influence of the ranges upstream and see which sites had and still have an extensive use that could be directly related to the contamination.

As shown in the special considerations of section IIA (groundwater), the adsorption of energetic materials on fine particles slows down the transfer from surface to the aquifer. This situation could facilitate an eventual cleanup and makes biodegradation possible to occur before contamination reaches the aquifer.

The uncertainty associated to the total score originate from the lack of information regarding the availability of alternate drinking water supply, flood potential and aerial transport.

3.7.6 Recommendations and supplementary information required

Due to the lack of information, many parts of the evaluation still involve some uncertainty. Some simple actions could be taken in order to improve knowledge on the site. This could probably lower the score of the range.

The first uncertainty concerns the quantity of contaminants in presence. In the present situation, nature and quantity of the contaminants are unknown; this makes it difficult to estimate the importance of the contamination. Furthermore, because of this lack of information, contamination has been estimated with the area of the site, without knowing if it was effectively spread on the whole area. Consequently, it would be important to get further information on the nature and quantity of materials destroyed.

The other major point of uncertainty consists in the understanding of groundwater flow. It has been supposed that the aquifer lays in the Q uaternary deposits. Groundwater flow direction and hydraulic conductivity of the sediments should be established in order to obtain these data necessary to know the direction a potential contamination would follow. While waiting for information, groundwater has been supposed to go towards south and south-east, i.e. towards either Barron River or Petawawa River and hydraulic conductivity of the surface deposits has been estimated to range between 10^{-12} cm/s and 10^{-2} m/s (Freeze and Cherry, 1979). Hydraulic conductivity of sediments and hydraulic heads appear to be a key factor to localise the areas of recharge and discharge of the aquifer.

Finally, information on possibility of aerial transport of energetic materials and on flood potential would help to get a more precise idea of the risks of contamination on and off the site. It is to be noted that a major cleaning of the site helps to prevent contamination of the area and of the surroundings.

4. General conclusions and recommendations

The present report intended to evaluate sites potentially contaminated by energetic materials at CFB Petawawa. These evaluations are meant to facilitate management of each site and understanding of the global environmental situation at CFB Petawawa. Four evaluations were completed in this study, some of which including more than one range. Notably, the Rocket Launcher Range is located within the Impact Area A. The Demolition Range has been studied independently of the Impact Area 8 because of its specific use and area. Impact Areas 7 and 8 have been evaluate together because they are now the only impact zones during artillery exercises. As for the Impact Area A, Training Areas B and D, the evaluations were done on the base of their uses in the past. Nowadays, non explosives ordnance are used on these sites.

The scores resulting from the classification of the sites are showed in this table:

TABLE 9 – POTENTIAL RISK OF EVALUATED SITES

Site	Scores	Potential risk
Demolition Range	57.1 ± 4.3 /100	Medium
Impact Area 7,8	77.5 ± 4.3 /100	High
Training Area D	72.7 ± 4.3 /100	High
Training Area B	74.7 ± 4.3 /100	High
Petawawa Grenade Range	48.8 ± 4.3 /100	Medium
Impact Areas A	69.8 ± 4.3 /100	High
DZ Anzio Area 1	71.0 ± 4.3 /100	High

The evaluated sites got scores that indicated medium to high risk. The criteria that had a real influence on the results is the quantity of contaminants on the ranges. It has been evaluated in accordance with the area of the range. Consequently, it induces an error that can lead to either overvalue or to undervalue the real potential risk. In this way, the Petawawa Grenade Range got the lowest score because of its little area (less than 1 ha) and the Impact Areas 7 and 8 got the highest also because of the area they cover (56.3789 km^2). Moreover, the presence of several sensitive areas, lakes, wetland and groundwater resources within the site contribute to increase the score.

On the basis of these results, two hypothesis have to be considered: the first one is to suppose that the sites are indeed potentially dangerous. The other hypothesis, which is not necessary contradictory with the first one, is that the present form of evaluation tends to overestimate the contamination of the sites when the source of contaminants is unexploded ordnance. The estimation of the quantity of energetic materials should therefore be examined and possibly changed to take into consideration the punctual nature of this kind of contamination source. It is important to understand that this conclusion is not made to reduce the scores of the ranges; it has just been felt that the initial CCME's evaluation had not been conceived to be used for this sort of contamination. This is easily understood when looking at the limit of contamination classes in the section about contaminant quantity. A site where the area of impact is estimated to be greater than 10 ha gets the maximal score. This is not very useful to discriminate sites at CFB Petawawa, where area of the sites can reach 3017.15 ha.

History of the sites is generally not well known. This can be a problem if dangerous operations previously took place on a range and could still contaminate the environment. Furthermore, the danger caused by the presence of UXO in the ground prevent military personnel from passing through some part of the Training Area even if there is a low potential of contamination. Even within the garrison, there are possibilities to find unexploded shells fired at the opening of the base. No records on this exist, but the discovery of these duds beside a building happens occasionally.

The clearance reports from range control showed that compilation of fired and destroyed ordnance is already done. This should be continued, and cumulative balance sheets should be produced for each site, in order to control, evaluate and limit the quantity of duds potentially contaminating the environment. However, the cleaning of Danger and Training Areas, which are very large, require a lot of time, money and personnel. A level 1 clearance does not prevent duds in the ground from coming up to the surface. The result is that time and money will still have to be spent on a previously cleaned area.

Finally, this report is meant to help summarising the available information on potentially dangerous sites at CFB Petawawa, and to give a preliminary evaluation of the risk created by these sites. The sources of information were not numerous. This is why the evaluations should not be seen as a final step of environmental assessment of the base. The evaluations should be reviewed if felt necessary by personnel of the base; they should also be kept up to date regularly, in order to be used as a tool for the management of the ranges.

From this point of view, recommendations can be made to improve the accuracy of the evaluations:

1) Geological, hydrological and hydrogeological context

The important lack of information on the geological, hydrological and hydrogeological context did not facilitate the writing of this report. Many suppositions have been made in order to evaluate accurately the actual status of each sites. However, it is impossible to affirm that all the scores are close to the reality. It would be more than useful to do an assessment on the geological, hydrological and hydrogeological context.

2) Soil and groundwater sampling

Further assessment of the studied sites should be carried out in order to confirm or not the present report. This assessment should consist of soil sampling and analysis. If significant contamination is detected, installation of observation wells and analysis of groundwater samples should be conducted to assess potential contaminant impacts on local groundwater quality. As for CFB Petawawa, a monitoring campaign of groundwater in the north-eastern part of the base and in Impact Areas, especially areas 7 and 8 would help to prevent the deterioration of the quality of groundwater.

3) Compilation of existing data

Despite of the few documents available for this study, there will have surely other sources of information on the base in a near future. It is important to continue to collect information in order to build an environmental database for CFB Petawawa sites. This database should comprise a summary of the information available as well as a map for each site. Such a database will make environmental work more easier and useful that it has been in the past, because access to information would be easier and faster.

4) Study of aerial transport of contaminants

Unlike the groundwater or surface water migration of energetic materials, the mechanisms of aerial transport is poorly known. Some studies could be done in order to conclude on the real potential of such a pathway. Moreover, other studies on the mechanism of explosion (whether or not residues are loosen in the air)

5) Hydrogeological data

Hydrogeological context of the base is not precisely known. The installation of observation wells to know the depth and direction of groundwater flow in the aquifers could also be very significant. In addition, it would allow a better understanding of the migration of contaminants and a better knowledge of Quaternary deposits and bedrock.. Grain size curves and hydraulic conductivity of the Quaternary deposits would be interesting data, since there is come contradicting information about the permeability of deposits.

6) Compilation of the quantity of energetic materials

A compilation should be done on each site to determine the quantity of energetic materials released in the environment. This could be done in calculating the difference between the number of unexploded fired ammunitions and the number of destroyed duds (of corresponding calibre) on a same site for a given period. Information such as exact composition of ammunitions and nature of energetic materials comprised in each type of ammunitions which was not available should also be compiled and included in the database previously mentioned.

7) Identification of preferential pathways

Physical or virtual modelling of contamination should be done to determine their importance in the different media (groundwater, surface water, air) depending on topography and soil type. The wind is also an important factor, especially in treeless areas where the risks of aerial erosion are high. Adsorption and biodegradation processes could also be studied in the meantime.

8) Study of the global influence

The present study present the potential risk of contamination for a site. It would be also useful to know the combined influence of different sites that have a common preferential pathway (wind, groundwater or surface water).

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Appendix A – Evaluation procedure for sites potentially contaminated with energetic materials

Evaluation procedure for sites potentially contaminated with energetic materials

Introduction

Training on military bases often involves the use of dangerous materials. Energetic materials are considered to be dangerous; they must be handled with care because of their explosive characteristics and can also have toxic effects on humans and on the environment. Normally, there are no major problems associated with the use of ammunitions containing energetic materials, because they explode and the toxic substances are transformed in simpler and less toxic gases by the process. CO_2 and water can be produced this way. However, some ammunitions sometimes fail to explode. The duds then lie on the ground and could be a source of contamination if energetic materials leach out of the unexploded shell.

Over the last few years, the Canadian Forces have undertaken a plan of environmental conformation. It was thus suggested to list and evaluate all potentially contaminated training sites. This process would then facilitate the management of the ranges, notably helping to set a priority order of intervention between all those sites. The following text explains the recommended procedure for succint evaluation and classification of potentially contaminated military training sites.

Existing methods

Two existing methods of environmental risks evaluation have been particularly studied: the CCME's (Canadian Council of Ministers of the Environment, 1992) method and the BRGM's (Bureau de recherche géologique et minière, 1998). The procedure suggested by the EPA (Environmental Protection Agency) was also studied, but it appeared to need a lot of information to be completed. Because a simple method had to be used, the EPA's procedure was set aside. However, let's mention the impressing computerised system built by the EPA.

CCME's method

The CCME is a canadian organism regrouping the provincial and federal ministers of the environment. In 1992, the CCME published a succint method for evaluation of potentially contaminated sites. This method is quite simple and can evaluate either the potential or known risks related to a site.

BRGM's method

The BRGM, a French organism affiliated to the Ministère de l'Aménagement du Territoire et de l'Environnement français, has built a simplified method for risk evaluation of potentially contaminated sites. The method is more complex than the CCME's method; the potential and current risks are all evaluated. The only receptors considered, however, are humans. Another particularity is the fact that the weighting of the different section changes depending on the use of the site.

Selection of a method

Even if the two method are similar, many differences can be noted between them. First, the CCME's method appears to be much simpler than the other. Nevertheless, this does not necessarily imply a loss of accuracy for the evaluation. Indeed, the problems caused by such a simplification (comparatively to the BRGM's method) were judged insignificant. Two other points were also considered uninteresting in the BRGM's method: 1) the only receptors considered are humans, even if a disturbed environment will eventually have some effects on human life; 2) the use-depending weighting also seemed to be a problem, since the use of sites could eventually change.

It was thus concluded that the CCME's method was the most convenient for the classification of the sites of the Department of National Defence. However, some modifications were made to it in order to adapt it to contamination with energetic materials.

a) Modification made to the CCME' method

The first modification was to make a list of the possible contaminants. Such a list was presented with the BRGM's method and was adopted. However, because some contaminants, such as energetic materials, were not in the list, a literature review was done to find information on the characteristics of energetic materials and on related criteria. It is recommended that the list from the BRGM be used as reference; of course, missing information will have to be found and added to this list.

Another problem with the CCME's evaluation is that migration risks are evaluated depending only on the site, and not on the contaminant itself. For instance, potential groundwater migration is evaluated according to the permeability of the aquifer and the presence of a confining layer, but it does not take the solubility and mobility of the contaminants in account. These missing items were therefore put in the special considerations of the corresponding sections and are the following:

<u>Exposure pathways</u>

<u>Groundwater</u>
- Solubility of contaminants (Ratio solubility/criteria);
- Retardation factor;
- Bio-degradation.

<u>Surface water</u>
- Solubility of contaminants (Ratio solubility/criteria);
- Bio-degradation.

Direct contact

- Vapour pressure of contaminants;
- Powderiness of soil (based on BRGM criteria)

Receptors

Human and animal uses

- Number of people affected by contamination (inspired by BRGM criteria, but adapted for Canadian demography);
- Type of person using the site.

The special considerations are given the same weighting than in the original evaluation. Furthermore, in a given section, the special consideration cannot make the score exceed the minimum or maximum score for that section. This way, the modified classification method stays compatible with the original method.

b) Modifications made to the score calculation

The CCME states that the method can be used for calculating either potential or current risks related to sites. However, it was felt that both scores should be calculated, because they do not give the same information. Indeed, potential risks are linked to the estimated vulnerability of a site, and current risks are related to known contamination cases. Some sites can show a very high potential risk and still not be contaminated. This is the case at CFB Dundurn (Saskatchewan), where the high soil permeability raises the potential of contamination of the aquifer, but where no significant contamination was measured in spite of the intensive use of the detonation range. On the other hand, some ranges could also show a small potential risk and be highly contaminated. In fact, it seems that calculation of the two scores can limit the incorrect conclusions caused by an imperfect knowledge of a site.

This is why two scores are calculated: the "potential" and the "mixed" score. The "potential" score gives information on the potential risks. The "mixed" score gives information on the current risks, according to all available field data. The score is qualified of mixed because the information is seldom completely available. The missing information on current risk is replaced by information on potential risks. Ideally, the "mixed" score should be based only on field data.

To facilitate calculation of the scores, a site classification computerised sheet was created in Microsoft Excel™. The two scores are automatically calculated based on the site characteristics and on the other field data. It can be noted that the default value for all known contamination cases is -100. A default value had to be written to respect the programming procedure; -100 was chosen to avoid any confusion with a possible value. The presence of this number indicates that no contamination is known for the site.

Finally, according to the CCME's method, the incertitude on a site can never be higher than 15 points (on 100). No evaluation exceeding this limit will be considered valid. Further information will then have to be collected before performing the evaluation again.

The method in a context of global evaluation

The suggested method is based on the detailed evaluation from the CCME. However, it is suggested that this method be used in a more complete procedure. These are the steps to follow in order to perform an exhaustive evaluation of the sites (source documents are indicated in brackets:

1) Compilation and inventory of the available information;
2) Facility/Site Description (CCME)
3) National Classification System Process Checklist (CCME)
4) Short evaluation form (CCME)
5) **Site classification Worksheet (CCME&BRGM)**
6) Site classification computerised sheet (feuille Excel)
7) Final report (based on the BRGM report)

A final report will be presented for each selected base of the Canadian Forces (CFB). This report will help summarising the available information in one document. The report will give general information on the base (context, number and type of training sites, meteorological data, etc.) and specific information and classifications for all the evaluated sites. The plan of this report is inspired from that of the BRGM' method:

1) Introduction
    - Context
    - Evaluation method

2) Characteristics of the base :
    - Geographic and climatic background
    - Property's boundaries
    - Historical and actual activities
    - Information sources

3) Studied sites
    - Site characteristics
        - Geographic setting
        - Site boundaries
        - Site history and activities
        - Descrition of installations
        - Geological, hydrogeological and hydrological contexts

    - Risk identification
        - Potential or known sources of contamination
        - Potential contaminants
        - Potential sources of contamination outside of site
        - Natural or human risks of increasing damages

- Hazard evaluation
  - Potential pathways for contaminants
  - Receptors
  - Known contamination cases
  - Potential hazards inherent in site
- Prevention and emergency measures
- Site classification
- Recommendations and supplementary information required
-

4) General conclusion and recommendations

5) References

6) Appendixes

N.B.: Point 3) is done for each range where the use of energetic materials is possible.

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Appendix B – Evaluations of sites

Site classification computerised worksheet

Site: Training Area D   Date: 06-27-2000   User (s): Marc-André Lavigne

	Sections	Score for potential impacts	Known and/or potential impacts		?	Comments
	CONTAMINANT(S) CHARACTERISTICS					
A)	DEGREE OF HAZARD	11	11	/14	0	Energetic materials found in ordnances.
B)	CONTAMINANT QUANTITY	10	10	/10	0	Area = 8.78314 km^2, no register before 1995
C)	PHYSICAL STATE OF CONTAMINANTS	3	3	/9	0	TNT, RDX, HMX, etc
	Special considerations	0	0	/6		
	TOTAL	24	24	/33	0	N.B.: If the total is < 0 or > 33, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 33).
	EXPOSURE PATHWAYS					
A)	GROUNDWATER					
	~~Known contamination at or beyond property boundary~~		-100	/11		
	Engineered subsurface containment	4	4	/4	0	No engineered system.
	Thickness of confining layer over aquifer(s) of concern	1.5	1.5	/1,5	0	No confining layer.
	Hydraulic conductivity of the confining layer	1.5	1.5	/1,5	0	No confining layer.
	Annual rainfall	0.7	0.7	/1	0	700 mm between 1950 and 1981.
	Hydraulic conductivity of the aquifer(s) of concern	2.5	2.5	/3	0	From 10E-03 cm/s to 1 cm/s.
	Special considerations	0.8	0.8	/4		Solubility: 4/3, Retardation Factor: 0, Biodegradation: not observed
	TOTAL	11.0	11.0	/11	0.0	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
B)	SURFACE WATER					
	~~Observed or mesured contamination of water/effluent discharged from site~~		-100	/11		
	Surface containment	5	5	/5	0	Trees that border the northern part of the area.
	Distance to perennial surface water	3	3	/3	0	Chalk Bay, Clement Lake within the area and Ottawa River to the east.
	Topography	1	1	/1,5	0	Flat with steep slopes E and W, contaminants at or below ground level.
	Run-off potential (see nomograph)	0.31	0.31	/1	0	
	Flood potential	0.25	0.25	/0,5	0.25	No flood in the last 50 years but Chalk Bay increases the possibilities.
	Special considerations	1.4	1.4	/4		Solubility: 2
	TOTAL	11.0	11.0	/11	0.3	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
C)	DIRECT CONTACT					
	~~Known contamination of media off-site~~		-100	/11		
	Airborne emissions (gases, vapour, dust, etc.)	2.5	2.5	/5	2.5	Possible but unknown.
	Accessibility of site (ability to contact materials)	3.5	3.5	/4	0	People come by boat, contaminants not totally covered.
	Hazardous soil gas migration	0	0	/2	0	No putrescible contaminants.
	Special considerations	-1.3	-1.3	/4		Vapor pressure: -2, powderiness: 2/3
	TOTAL	4.7	4.7	/11	2.5	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
	RECEPTORS					
A)	HUMANS AND ANIMALS					
	~~Known adverse impact on living things as a result of the contaminated site~~		-100	/18		
	~~Known impact on drinking water supply~~		-100	/9		
	Proximity to drinking water supply	3	3	/6	0	Water plant intake approx. 5 km south.
	"Availability" of alternate drinking water supply	1.5	1.5	/3	1.5	Unknown but possible.
	~~Known impact on used water resource~~		-100	/4		
	Proximity to water resources used for activities	0.5	0.5	/2	0	Ottawa River and Chalk Bay.
	Use of water resources	2	2	/2	0	Fishing and swimming.
	~~Known contamination of land used by humans~~		-100	/5		
	Use of land at and surrounding site	3	3	/5	0	Houses approx. 5 km downstream.
	Special considerations	0.0	0.0	/5		People affected lower than 250, military people.
	TOTAL	10.0	10.0	/18	1.5	N.B.: If the total is < 0 or > 18, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 18).
B)	ENVIRONMENT					
	~~Known adverse impact on sensitive environment as a result of the contaminated site~~		-100	/16		
	Distance from site to nearest sensitive environment	6	6	/10	0	Some marshes within training areas C and L.
	Distance to important or susceptible groundwater resource(s)	6	6	/6	0	Chalk Bay and Ottawa River are discharge zones.
	Special considerations	0	0	/5		
	TOTAL	12	12	/16	0	N.B.: If the total is < 0 or > 16, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 16).

Total score (potential impacts)	71.8	+	0.9	/100	+/-	4.3
Total score (known impacts or potential impacts if the former is not known)	71.8	+	0.9	/100	+/-	4.3

Score	Class	Risk potential	Action required
70-100	1	High	Yes
50-69	2	Medium	Likely
38-49	3	Medium low	May be
<=37	N	Low	Not likely

N.B. : If the uncertainty exceeds 15, we consider that there if insufficient information to assign a significant score and the site is therefore classified in class I (for insufficient information).

N.B. : The number "-100" has been used as default when no information was available about the contamination of the site. This value (-100) was chosen to avoid any confusion with possible scores.

Appendix C

Facility/Site Description

FACILITY/SITE DESCRIPTION

Document site information as completely as possible:

Site No.: RA 683 *Site Name:* IMPACT AREA D *Province/Territory:* ONTARIO

Custodian Dept.: DND *Facility Name:* CFB PETAWAWA *Site Operator/Manager:* CFB PETAWAWA

Type of Site: MILITARY TRAINING *Site Owner:* DND

Zone: ______ *UTM Coordinates:* ________ *Easting* *Latitude:* ____ *deg.* ____ *min.* ____ *sec.*

________ *Northing* *Longitude:* ____ *deg.* ____ *min.* ____ *sec.*

Location: ______________________ *Legal Land Description:* ______________

Address ______________________ *Provincial Parcel No.:* ______________

Brief Description of Site: ______________________________________

Site Land Use: *Current:* MILITARY TRAINING *Proposed:* IDEM

Comments:

Summary of Site Classification Information:

Completed Evaluation Form: X *Detailed* X *Short*

Site Score: 72.7 *Total* ± 4.3 *Estimated Score*

Class: (1, 2, 3, N, or I) $\boxed{1}$ *Risk:* HIGH

Notes: ______________

Contact Name: CHRIS HOGAN / SEAN MOYLES

Position: ______________________

Address: ______________________

City: PETAWAWA *Prov./Terr.:* ONT. *Postal Code:* ______

Phone No.: ______ *Fax No.:* ______

Site Classified by above ______ *or* MARC-ANDRÉ LAVIGNE / KARINE CHAMPAGNE

Degree of Familiarity with Site: ____ *Very familiar* X *Moderately familiar* ____ *Indirectly familiar* ____ *Unfamiliar*

Visited site: X *Yes* ______ *No*

Position: RESEARCH ASSISTANT *Phone No.:* (418) 654-2647

Address: 880 CHEMIN STE-FOY, BUR 840 CP7500

City: QUEBEC *Prov./Terr.:* QUEBEC *Postal Code:* G1V 4C7 *Date of Completed Classification:* ______

Site Identification: ______

National Classification System Process Checklist

_____ USER'S GUIDE REVIEWED

__X__ MINIMUM DATA REQUIREMENTS MET

- __X__ Description of site location
- __X__ Type of contaminants or materials likely to be present at site (and/or description of historical activities)
- __✓__ Approximate size of site and quantity of contaminants
- _____ Approximate depth to water table
- __X__ Geologic map or survey information (soil, overburden, and bedrock information)
- __✓__ Annual rainfall data (can be inferred from rainfall map of Canada)
- __X__ Surface cover information
- __X__ Proximity to surface water
- __X__ Topographic information
- _____ Flood potential of site
- _____ Proximity to drinking water supply
- __X__ Uses of adjacent water resources
- __X__ Land use information (on-site and surrounding)

__X__ FACILITY/SITE DESCRIPTION COMPLETED

__X__ SITE CLASSIFICATION WORKSHEET COMPLETED

__X__ REFERENCES ATTACHED/CITED

__X__ EVALUATION FORM COMPLETED

__X__ Detailed Form __X__ Short Form

__X__ SCORE SHEET COMPLETED

__X__ SITE CLASSIFICATION

Class: __X__ 1 _____ 2 _____ 3 _____ N _____ I

Score: __72.7__ ± __4.3__
Total Estimated Score

_____ SITE INFORMATION ENTERED ON NCS COMPUTERIZED VERSION

Site Identification: ____________________

SHORT EVALUATION FORM

Instructions for Use

Answer Yes or No to questions 1 to 5 below. If the response to question 1a) or 1b) is Yes, automatically rate the site as Class 1 (C1). If the answers to any three of questions 2 to 5 are Yes, the site should also be rated as Class 1. For all Yes answers, supporting documentation and rationale must be referenced or attached.
To confirm Class 1 rating and/or if two or more No responses are given, the Detailed Evaluation Form should also be completed.

		No	Yes		Reference Attached
1	a) Is site contamination known to have caused adverse impacts on humans or sensitive environments? (see User's Guide)	☒	☐	→ Class 1	☐
	b) Is the site a fire or explosion hazard as it currently exists?	☒	☐	→ Class 1	☐
I	**Contaminant(s) Characteristics**				
	2 Are contaminants that can be classified as 'high concern' (as defined in the User's Guide) present at the site?	☐	☒		☐
	3 Are the high concern contaminants known to be present in large quantities? Answer yes if contaminant is: • liquid (as disposed/spilled) • in quantity >1,000 m^3 • in an area of contamination >10 ha • distributed or placed in such a manner as to have the potential to cause significant off-site contamination	☐	☒		☐
II	**Pathways**				
	4 Is the site known to have caused contamination (above national or applicable provincial/territorial guidelines or policies) of off-site groundwater, adjacent surface water, neighbouring surficial material (i.e., soil) or air? (see User's Guide)	☒	☐		☐
III	**Receptors**				
	5 Is the site contamination known to have a) impacted the quality of local drinking water or other water resources (i.e., exceeds Guidelines for Canadian Drinking Water and/or Canadian Water Quality Guidelines or applicable provincial/territorial guidelines or policies); b) contaminated lands used for agricultural, residential or parkland purposes (i.e., exceeds the AG or R/P values of Canadian Environmental Quality Criteria for Contaminated Sites or applicable provincial/territorial guidelines or policies); or c) caused vegetative stress or other known environmental impairment? (A Yes answer should be given if the impact has made the water, land, environment, or air unacceptable for use.)	☒	☐		☐

If 3 or more Yes answers are given in Sections I, II, and III above, rate site as Class 1. Check box if Class 1 rating. ☐

Site Identification:

Appendix D

User's Guide (even pages) and Site Classification Worksheet (odd pages)

USER'S GUIDE

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
I. Contaminant(s) Characteristics	A. Degree of hazard • High concern contaminants - high concentration • High concern contaminants - low concentration • Medium concern contaminants - high concentration • Medium concern contaminants - low concentration • Low concern contaminants	14 11 8 5 3	In determining the degree of hazard of a waste, it is recognized that a listed hazardous waste is generally of greater concern than a liquid or solid industrial waste. These are in turn of greater concern than other solid wastes. Municipal and organic wastes are considered medium concern contaminants due to their putrescible nature (production of methane and other landfill gases). Household wastes may contain hazardous materials (e.g., batteries, medical wastes, paints, etc).	Determine the level of hazard according to the following table of typical contaminants and definition of high concentrations: <u>High Concern Contaminants</u> • Materials defined as dangerous goods in the Transport of Dangerous Goods Act and Regulations • Materials identified by Province as hazardous waste (pesticides, herbicides, paint sludge, acid and alkaline solutions, solvents, etc.) • Materials regulated by the Canadian Environmental Protection Act (e.g., PCBs) • Institutional waste (lab, schools hospitals, etc.) • Pathological wastes and animal carcasses • Radioactive wastes <u>Medium Concern Contaminants</u> • Liquid waste not referred to in above, petroleum products septic tank pumpings, agricultural and chemical containers • Food processing wastes • Non-hazardous incinerator residues • Municipal solid (household) wastes • Organic and vegetable wastes • Mining residues <u>Low Concern Contaminants</u> • Industrial and commercial solid wastes, (e.g., construction materials such as wood, metal, hay, sand/silt piles, etc.) • Other nearly inert wastes (e.g., foundry sands) <u>High Concentration of Contaminants</u> • contaminant concentrations in soil, groundwater or surface water exceed Canadian Environmental Quality Criteria for Contaminated Sites (>2x commercial/industrial level); or material that was deposited in highly concentrated form (e.g., >5000 ppm)	Transport of Dangerous Goods Act; Provincial/Territorial Hazardous Wastes lists; regulations under Canadian Environmental Protection Act; Canadian Environmental Quality Criteria for Contaminated Sites; etc.
	B. Contaminant Quantity (area/volume of site contamination) • >10 ha, or >1000 m^3, or drums of liquid • 2 to 10 ha, or 100 to 1000 m^3 • <2 ha, or <100 m^3	10 6 2	Little information is known about the quantity of wastes at abandoned sites in Canada. Therefore, waste quantity estimates may be interpreted from area or quantity information.	Measure or estimate the area or quantity of potential contamination. Note: Any number of drums abandoned or disposed is considered a high concern.	
	C. Physical State of Contaminants • Liquid/gas • Sludge • Solid	9 7 3	Contaminants in liquid form are more mobile in the ground and water than solids. However, certain water-soluble solid wastes are more mobile than viscous liquids, and these should be evaluated on a case-by-case basis.	Determine the state of the contaminant when it was disposed or deposited.	
	Special Considerations	-6 to +6	(See 3.7.3 in text)	Technical judgment.	

SITE CLASSIFICATION WORKSHEET

(Instructions: Document site information, assign score, provide rationale behind score and indicate source of information in the spaces provided.)

I. CONTAMINANT(S) CHARACTERISTICS — SCORE

A. • Degree of Hazard

List possible contaminants and estimated concentrations: ENERGETIC MATERIALS FOUND IN AMMUNITION (TNT, HMX, RDX)

POSSIBILITY OF HEAVY METAL CONTAMINATION

Scoring Rationale & Information Source: ______ **11**

B. • Contaminant Quantity

Estimated or measured areal volume of contaminated zone: NO REGISTER OF UXO SHELLS BEFORE 1995

QUANTITY ESTIMATED WITH AREA OF THE RANGE

AREA : 8.78314 km^2

Scoring Rationale & Information Source: ______ **10**

C. • Physical State of Contaminant

Does the site contain:

a) Predominantly liquids/gases ______

b) Primarily sludges ______

c) Primarily solids ENERGETIC MATERIALS (TNT, RDX, HMX)

Scoring Rationale & Information Source: ______ **3**

• Special Considerations

Document any other important contaminant characteristics not addressed above: ______

Scoring Rationale & Information Source: ______ **—**

Site Identification: ______

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways	A. Groundwater 1. Known contamination at or beyond property boundary • Groundwater significantly exceeds Canadian Drinking Water Guidelines (CDWG) by >2x or known contact of contaminants with groundwater • Between 1 and 2x CDWG or probable contact with groundwater • Meets Canadian Drinking Water Guidelines	 11 6 0	The legislative basis for most jurisdictions is to prevent off-site migration of contamination.	Review chemical data and evaluate groundwater quality. If contamination at or beyond the property boundary exceeds Canadian Drinking Water Guidelines (CDWG) or applicable provincial/territorial guidelines or policies, or if contaminants are known to be in contact with groundwater, then evaluate the site as high.	Canadian Water Quality Guidelines; Provincial/ Territorial Water Quality Guidelines or policies; Guidelines for Canadian Drinking Water Quality.
	2. Potential for groundwater contamination (a) Engineered subsurface containment • No containment • Partial containment • Full containment	 4 2 0	Well contained sites have minimal potential for pollution. Potential for pollution decreases with increasing containment.	Review the existing engineered systems and relate these structures to hydrogeology of the site and determine if full containment is achieved. Full containment is defined as an engineered system, monitored as being effective, which provides for the capture and treatment of contaminants. If there is no system, this factor is evaluated high. If there is less than full containment or if uncertain then evaluate as medium. Typical engineered systems include leachate collection systems and low permeability liners.	
	(b) Thickness of confining layer over aquifer(s) of concern • 3 m or less • 3 to 10 m • >10 m	 1.5 1 0	The thickness of a confining layer (e.g., clay, shale, etc.) between contaminants and any aquifers of concern will affect the attenuation of contaminants and hence the quantity and quality of contaminants reaching the aquifers.	Measure or estimate thickness of any confining layer (e.g., clay, shale, etc.) over all aquifers of concern from existing well records or from a general knowledge of local conditions. If possible, an estimate of the continuity of the confining layer should be made from borehole well record information. Note: an aquifer is defined as a geologic material that will yield groundwater in usable quantities.	Historical geologic maps, well records, government hydrogeologist or local consultants.
	(c) Hydraulic conductivity of the confining layer • $>10^{-4}$ cm/sec • 10^{-4} to 10^{-6} cm/sec • $<10^{-6}$ cm/sec	 1.5 1 0.5	The rate at which contaminants migrate through the confining layer will affect attenuation and the contaminant loading to the aquifers.	Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Apppendix D). Clays, granite, shales should be scored low. Silts etc. should be scored medium. Sand, gravel, and limestone should be scored high.	Freeze and Cherry, 1979, and other groundwater texts.

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS **SCORE**

A. Groundwater

1. • Known Groundwater Contamination

Document information on known groundwater contamination: NO RECORD

Scoring Rationale & Information Source: —

2.a • Engineered Subsurface Containment

Document engineered systems protecting groundwater: NO ENGINEERED SYSTEM

Scoring Rationale & Information Source: 4

2.b • Thickness of Confining Layer Over Aquifer(s) of Concern

Document local geological conditions: BEDROCK (PRECAMBRIAN ROCKS - INTRUSIVE AND METAMORPHIC) OVERLAIN BY OLDER ALLUVIUM IN TERRACE REMNANTS : SAND,

Identify water-bearing zones used for water supply: GRAVELLY SAND, MODERN ALLUVIUM : CLAY, SAND, SILT, GRAVEL AND TILL (POORLY SORTED DIAMICTON)

Scoring Rationale & Information Source: 1.5

2.c • Hydraulic Conductivity of the Confining Layer

Estimate hydraulic conductivity of any confining layer: IT RANGES FROM 10^{-3} TO 1

Scoring Rationale & Information Source: 1.5

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	A.2. (d) Annual Rainfall • >1000 mm • 600 mm • 400 mm • 200 mm	 1 0.7 0.6 0.4 0.2	The quantity of rainfall affects the quantity of leachate produced. Higher leachate quantities have a higher impact on the environment.	Refer to Environment Canada rainfall records for relevant areas. Use 30-year average rainfall for evaluation purposes. Divide rainfall by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score)	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	(e) Hydraulic conductivity of aquifer(s) of concern • $>10^{-2}$ cm/sec • 10^{-2}-10^{-4} cm/sec • $<10^{-4}$ cm/sec	 3 0.5 1.5 0.5	Aquifers with high hydraulic conductivity can transport contaminants at high velocity over great distances, e.g., solution limestones, highly fractured rocks or gravel deposits.	Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Appendix D).	Freeze and Cherry, 1979.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) :			
Solubility (S) :			
• low (S/standard ≈ 10^1)	-4/3*	* The weighting suggested is valid if there are no points affected to other special considerations.	
• medium (S/standard ≈ 10^2)	0		
• high (S/standard ≈ 10^3)	4/3*		
Retardation factor (R) :		N.B. : the R calculation was done using n = 0,33 et ρ_b = 1,75 g/cm^3 ; if the studied soil is neither sand, silt or clay, the R factor must be recalculated because n et ρ_b change. (R_{Cl} ≈ 1)	
• important delay (R / R_{Cl} ≈ 10^2) or (K_d ≈ 12,51)	-4/3* 0.5		
• delayed (R / R_{Cl} ≈ 10^1) or (K_d ≈ 1,14)	0		
• little or no delay (R / R_{Cl} ≈ 10^0) or (K_d ≈ 0)	4/3*		
Biodegradation (µ) :			
• observed	-4/3*		
• non observed	0		
• non biodegradable	4/3*		
Other special considerations	(-4 à 4)	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	

II. EXPOSURE PATHWAYS (cont'd) **SCORE**

A. <u>Groundwater</u> (cont'd)

2.d • Annual Rainfall

Document rainfall data: BETWEEN 1951 AND 1980 -> ≃ 700mm

Scoring Rationale & Information Source: CLIMATIC ATLAS - CANADA — 0.7

2.e • Hydraulic Conductivity of Aquifer(s) of Concern

Estimate hydraulic conductivity of relevant aquifer(s): IT RANGES FROM 10^{-3} TO 1

Scoring Rationale & Information Source: ______ — 2.5

3. • Special Considerations

Document any other important ground water issues not addressed above:
SOLUBILITY (130/0.12 = 5/STANDARD) => 4/3
RETARDATION FACTOR => -0.5
BIODEGRADATION (NOT OBSERVED) => 0

Scoring Rationale & Information Source: ARBITRARY SCORE FOR RETARDATION FACTOR — 5/6

Site Identification: ______

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	B. Surface Water 1. Observed or measured contamination of water/effluent discharged from site • Known or strongly suspected to exceed Canadian Water Quality Guidelines (CWQG) by >2x • Known or strongly suspected to be between 1 - 2x CWQG • Meets Canadian Water Quality Guidelines	 11 6 0	The legislative basis in all jurisdictions is not to contaminate surface water beyond established limits.	Collect all available information on quality of surface water near to site. Evaluate available data against Canadian Water Quality Guidelines (select appropriate guidelines based on local water use, e.g., recreational, irrigation, freshwater aquatic life, etc.) and relevant provincial/territorial water quality objectives.	CCME Canadian Water Quality Guidelines; Relevant provincial /territorial and federal legislation and regulations.
	2. Potential for surface water contamination a) Surface Containment • No containment • Partial containment • Full containment	 5 3 0.5	The level and type of engineered containment will affect the potential for contaminants to be released to surface water.	Review the existing engineered systems and relate these structures to site conditions and proximity to surface water and determine if full containment is achieved; e.g., evaluate low if there is full containment such as capping, berms, dikes; evaluate medium if there is partial containment such as natural barriers, trees, ditches, sedimentation ponds; evaluate high if there are no intervening barriers between the site and nearby surface water.	Site inspection reports, air photos, etc.
	b) Distance to perennial surface water • 0 to <100 m • 100 to 300 m • >300 m	 3 2 0.5	The distance to surface water will affect the probability of contaminants reaching the watercourse. The Ontario Ministry of the Environment has established a classification for immediate impact zone at 50 m. For conservatism, this zone has been broadened to 100 m.	Review available mapping and survey data to determine distance to nearest surface water bodies.	
	c) Topography • Contaminants above ground level and slope is steep • Contaminants at or below ground level and slope is steep • Contaminants above ground level and slope is flat • Contaminants at or below ground level and slope is flat	 1.5 1.2 0.8 0.6 0	Water can run off (and therefore potentially contaminate surface water) with greater ease from elevated sites on slopes.	Review engineering documents on the topography of the site and the slope of surrounding terrain. • steep slope = >50% • flat slope = <5% Note: Type of fill placement (e.g., trench, above ground, etc.)	

II. EXPOSURE PATHWAYS (cont'd)

SCORE

B. Surface Water

1. • Observed or Measured Contamination

Document information on surface water contamination: NO RECORD

Scoring Rationale & Information Source: —

2.a • Surface Containment

Review and document engineered or natural systems protecting surface water: NO SURFACE CONTAINMENT

Scoring Rationale & Information Source: 5

2.b • Distance to Perennial Surface Water

Estimate distance from site to nearest stream or other water body: CHALK BAY AND OTTAWA RIVER TO THE EAST

Scoring Rationale & Information Source: 3

2.c • Topography

Document terrain conditions: RELATIVELY FLAT TERRAIN WITH STEEP SLOPES TO THE WEST AND TO THE EAST

Document position of contaminants (are they above ground or buried?) CONTAMINANTS AT AND UNDER GROUND LEVEL

Scoring Rationale & Information Source: 0.6

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	B. 2. d) Run-off potential (see nomograph, end of Appendix D) • >1000 mm rainfall and low permeability surface material • 500 to 1000 mm rainfall and moderately permeable surface material • <500 mm rainfall and highly permeable surface material	 1 0.6 0.2	Run-off transports contaminants into water bodies. Water run-off is a function of precipitation and the rate of infiltration (less permeable soils will allow greater run-off).	Refer to Environment Canada precipitation records for relevant areas. Use 30-year average precipitation for evaluation purposes. Determine factor score using "Run-Off Potential Nomograph" figure at end of Appendix D.	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	e) Flood potential • 1 in 2 years • 1 in 10 years • 1 in 50 years	 0.5 0.3 0.1	The potential for large quantities and concentrations of contaminants to be released to surface water courses over a short period of time will be affected by the flood potential of a water course near the site.	Review published data such as flood plain mapping or flood potential (e.g., spring or mountain run-off) and Conservation Authority records to evaluate flood potential of nearby water courses both up and down gradient. Rate zero if site not in flood plain.	Established flood plain guidelines/ maps; provincial/ territorial soil survey maps.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) : Solubility (S) : • low (S/standard ≈ 10^1) • medium (S/standard ≈ 10^2) • high (S/standard ≈ 10^3)	 -2* 0 2*	* The weighting suggested is valid if there are no points affected to other special considerations.	
Biodegradation (µ) : • observed • non observed • non biodegradable Other special considerations	 -2* 0 2* (-4 à 4)	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	

II. EXPOSURE PATHWAYS (cont'd) **SCORE**

B. Surface Water (cont'd)

2.d • **Run-off Potential**

Document geological and rainfall conditions: PRECIPITATION ≈ 700 mm + PERMEABLE SURFACE MATERIALS

Scoring Rationale & Information Source: ______ 0.31

2.e • **Flood Potential**

Estimate flood frequency of nearby water courses or water bodies: UNKNOWN
ACCORDING TO CHRIS HOGAN NO FLOOD HAPPENS IN THE LAST 50 YEARS

Scoring Rationale & Information Source: ______ 0.25 ?

3. • **Special Considerations**

Document any other important surface water conditions not addressed above: SOLUBILITY (S/STANDARD ≈ 130/0.12) => 2
BIODEGRADATION (NOT OBSERVED) => 0

Scoring Rationale & Information Source: ______ 2

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	C. Direct Contact 1. Known contamination of media off-site • Known contamination of soil, sediment or air off-site due to contact with contaminated soil, dust, air, etc. (vector transported should also be considered). • Strongly suspected contamination of media off-site • No contamination of media off-site	 11 6 0	Known or measured contamination off-site is an important consideration for determining impact of contaminants.	Record known or measured contamination of soil, sediment or air on or off-site. Note any presence of soil gas, such as methane, associated with site.	
	2. Potential for direct human and/or animal contact a) Airborne Emissions (gases, vapours, dust, etc.) • Known or suspected airborne emissions impacting on neighbouring properties • Airborne emissions generally restricted to site • No airborne emissions	 5 3 1.5 0	If air emissions are evident off-site, there is a great hazard for direct contamination of neighbouring biota and/or resources.	Review available site information to determine if there have been complaints off-site (due to vapours, gas, dust, etc). Reports for these problems are not likely available for most abandoned sites. Review regulatory site inspection reports. If airborne emissions are known to be impacting neighbouring properties and possibly endangering the public, some immediate action (including characterization of emissions) should be initiated to curtail hazardous emissions or otherwise reduce or eliminate exposure.	Site inspection reports, etc.
	b) Accessibility of Site (ability to contact materials) • Limited or no barriers to prevent site access; contaminants not covered • Moderate accessibility or intervening barriers; contaminants are covered • Controlled access or remote location and contaminants are covered	 4 3 0	The greater the accessibility to a site and to contaminants, the greater the chance for contamination of human and animal life by direct contact.	Review location and engineering of the site and determine if there are intervening barriers between the site and humans or animals. A low rating should be assigned to a (covered) site surrounded by a locked chain link fence or in a remote location, whereas a high score should be assigned to a site that has no cover, fence, natural barriers or buffer.	
	c) Hazardous soil gas migration • Contaminants are putrescible and soil permeability is high • Soil contaminants are putrescible but soil permeability is low and/or groundwater is <2 m from surface • No putrescible contaminants at the site.	 2 1 0	Methane gas migration has been known to cause explosions adjacent to abandoned landfills.	Consider presence of organic material on site, the depth to water table, soil hydraulic conductivity, vegetative stress, odours, etc.	
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	
	3. Special considerations (detailed) : Vapor pressure : • < 0,1 kPa • 0,1 à 0,5 kPa • 0,5 à 1,5 kPa • > 1,5 kPa Powderiness : • < 0,1 % • 0,1 à 1 % • 1 à 10 % • > 10 % Other special considerations	 -2* -2/3* 2/3* 2* -2* -2/3* 2/3* 2* -4 à 4	(N.B. : vapor pressure limits are valid at a 20°C temperature) * The weighting suggested is valid if there are no points affected to other special considerations. (i.e. the sample % with a grain size ≤ 45 µm) N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must n[illegible]ed th[illegible]ibed l[illegible]		

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS (cont'd) **SCORE**

C. Direct Contact

1. • Known Contamination Off-site:

Document reports of off-site contamination due to contact with contaminated soil, dust, air, etc.: NO RECORD

Scoring Rationale & Information Source: —

2.a • Airborne Emissions

Document incidents or complaints about fumes, gases, dust, odours, etc.: UNKNOWN, BUT POSSIBLE

Scoring Rationale & Information Source: 3 ?

2.b • Accessibility of Site

Review and document avenues of site access by humans and animals: THE ACCESS IS CONTROLED BUT THERE ARE PEOPLE WHO NEGLECT THE "NO TRESPASSING" RULE

Scoring Rationale & Information Source: SEAN MOYLES 3

2.c • Hazardous Soil Gas Migration

Review potential for hazardous soil gas production and migration from site: NO PUTRESCIBLE CONTAMINANTS

Scoring Rationale & Information Source: 0

3. • Special Considerations

Document any other conditions whereby humans/animals could contact contamination: VAPOR PRESSURE ($\simeq 1.49 \times 10^{-9}$ atm) POWDERINESS = 2/3

Scoring Rationale & Information Source: -2

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors	A. Human and Animal Uses 1. Known adverse impact on humans or domestic animals as a result of the contaminated site • Known adverse effect on humans or domestic animals • Strongly suspected adverse effect on humans or domestic animals	 18 15	Contamination from a site that causes a measurable impact on humans is a great concern.	Review and evaluate reports of impact(s) of site contamination (e.g., increased heavy metal levels measured in blood of nearby residents as a result of site contamination). Any site assigned 15 or more points for this factor should automatically be classified as Class 1. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980)	
	2. Potential for impact on humans or animals a) Drinking water supply i) Known impact on drinking water supply Drinking water supply is known to be adversely affected as a result of site contamination • Known contamination of drinking water supply to levels above CDWG • Strongly suspected contamination of drinking water supply • Drinking water supply is known not to be contaminated	 9 7 0	Water used for drinking should be protected against contamination from any site.	Review available site data (inspection reports, assessment documentation) to determine if drinking water (groundwater, surface water, private, commercial or municipal supply) is known or suspected to be contaminated above Guidelines for Canadian Drinking Water Quality or applicable provincial/territorial guidelines or policies. If drinking water supply is known to be contaminated above these guidelines, some immediate action (e.g., provision of alternate drinking water supply) should be initiated to reduce or eliminate exposure.	Guidelines for Canadian Drinking Water Quality; other drinking water guidelines developed by recognized agencies (e.g., other Health and Welfare Canada guidelines, U.S. EPA, etc.).
	ii) Potential for impact on drinking water supply • Proximity to drinking water supply • 0 to <100 m • 100 to <300 m • 300 m to <1 km • 1 to 5 km	 6 5 4 3	The nearer a drinking water well is to a contaminant source, the greater the potential for contamination. Well water used for irrigation/agricultural purposes should also be included as it may be used for human consumption.	Review provincial/territorial base mapping or air photos and measure the distance to the nearest resident or drinking water supply. Judge whether the water is being used as a drinking water source. Commonly rural areas use groundwater for drinking purposes. For urban sites, contact the local Public Utilities Commission to determine water source and location.	
	• "Availability" of alternate drinking water supply • Alternate drinking water supply is not available • Alternate drinking water supply would be difficult to obtain • Alternate drinking water supply available	 3 2 0.5	This factor takes into account the availability of replacement water supplies, and is used in the technical sense as a factor to indicate the degree of urgency, not as a sociopolitical consideration.	Determine availability of alternate drinking water supply or distance to alternate source.	

SITE CLASSIFICATION WORKSHEET - cont'd

III. RECEPTORS

SCORE

A. Human and Animal Uses

1. • Known Adverse Impact on Humans or Domestic Animals

Record known or suspected adverse effects on humans or domestic animals: NO RECORD

Scoring Rationale & Information Source:

Score: –

2.a.i • Known Contamination of Drinking Water Supply

Record known or suspected incidents of contamination of drinking water: NO RECORD

Scoring Rationale & Information Source:

Score: –

2.a.ii.°• Distance to Nearest Drinking Water Supply(s)

Identify nearest drinking water well and measure distance to site: PETAWAWA'S WATER WELL IS LOCATED 5 Km SOUTH FROM THE SITE

Scoring Rationale & Information Source:

Score: 3

2.a.ii.°°•Availability of Alternate Drinking Water Supply

Document availability of alternate sources of drinking water and ease of implementation: OTHER WATER SUPPLIES WOULD BE DIFFICULT TO OBTAIN (PEMBROKE, DEEP RIVER)

Scoring Rationale & Information Source:

Score: 3

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	A.2. b) Other Water Resources i) Known impact on used water resource Water resource (used for recreational purposes, commercial food preparation, livestock watering, irrigation or other food chain uses) is known to be adversely affected as a result of site contamination		The water used for these purposes (groundwater or surface water) should be protected against contamination.	Review documentation for reported or suspected contamination of water used for recreation or food chain uses, and refer to Canadian Water Quality Guidelines or other relevant guidelines (select appropriate guidelines based on local water use) to determine if supply is considered contaminated.	CCME Canadian Water Quality Guidelines; provincial/territorial water quality guidelines and objectives; etc.
	• Water resource is known to be contaminated above CWQG	4			
	• Water resource is strongly suspected to be contaminated above CWQG	3			
	• Water resource is known not to be contaminated	0			
	ii) Potential for impact on water resources • Proximity to water resources used for activities listed above		The nearer a water resource is to a site, the greater the risk of contamination.	Determine distance from the site to the nearest recreational or food chain used water resource.	
	• 0 to <100 m	2			
	• 100 to <300 m	1.5			
	• 300 m to <1 km	1			
	• 1 to 5 km	0.5			
	• Use of water resources - if multiple uses, give highest score (use following table)	0.2 - 2	Potential for impact due to use of water resource is related to the type and frequency of use. Human uses are of the highest concern.	Assess water users adjacent to the site from maps and directories.	

Water Use	Frequency of Use: Frequent	Frequency of Use: Occasional
Recreational (swimming, fishing)	2	1
Commercial food preparation	1.5	0.8
Livestock watering	1	0.5
Irrigation	1	0.5
Other domestic or food chain uses	0.5	0.3
Not currently used but likely future use	0.5	0.2

III. RECEPTORS (cont'd) SCORE

A. Human and Animal Uses (cont'd)

2.b.i • Known Impact on Used Water Resource

Record information on water resource that is or is potentially affected by site contamination: NO RECORD

Scoring Rationale & Information Source: -

2.b.ii.°• Proximity of Water Resources to Site

Locate and measure nearest water resource areas to site: CHALK BAY AND ALLUMETTE LAKE / OTTAWA RIVER TO THE EAST

Scoring Rationale & Information Source: 2

2.b.ii.°°• Water Uses

Record uses of nearby water resources: RECREATIONAL SWIMMING AND FISHING

Scoring Rationale & Information Source: 2

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	A. 2. c) Direct human exposure i) Known contamination of land used by humans • Known contamination of land used for agricultural or residential/parkland/school purposes above AG or R/P EQC values • Known contamination of land used for commercial or industrial purposes above C/I EQC values • Land is known not to be contaminated	 5 3.5 0	Hazards associated with soil contamination are directly related to land use.	Review zoning and land use maps for lands adjacent the site. Evaluate levels of soil contamination against Canadian Environmental Quality Criteria (EQC) for Contaminated Sites (AG = agricultural level; R/P = residential/parkland level; C/I = commercial/industrial level). If soil is known to be contaminated above these levels and possibly endangering public health, some immediate action (e.g., fencing the area, limiting public access, etc.) should be initiated to reduce or eliminate the exposure.	CCMB Canadian Environmental Quality Criteria for Contaminated Sites.
	ii) Potential human exposure through land use • Use of land at and surrounding site (use following table; give highest score to worst case scenario) Distance from Site Land Use (current or future) — 0 - 300m — 300m - 1km — 1 - 5km Residential — 5 — 4.5 — 3 Agricultural — 5 — 4 — 2.5 Parkland/School — 4 — 3 — 1.5 Commercial/Industrial — 3 — 1 — 0.5	0.5 - 5 3	Hazards associated with soil contamination are directly related to land use and distance of the used land from the site. Residential and agricultural land uses are of highest concern because humans are situated at these locations for longer periods.	Review zoning and land use maps over the distances indicated. If the proposed future land use is more "sensitive" than the current land use, evaluate this factor assuming the proposed future use is in place (indicate in the worksheet that future land use is the consideration). Agricultural land use is defined as uses of land where the activities are related to the productive capability of the land or facility (e.g., greenhouse) and are agricultural in nature, or activities related to the feeding and housing of animals as livestock. Residential/Parkland land uses are defined as uses of land on which dwelling on a permanent, temporary, or seasonal basis is the activity (residential), as well as uses on which the activities are recreational in nature and require the natural or human designed capability of the land to sustain that activity (parkland). Commercial/Industrial land uses are defined as land on which the activities are related to the buying, selling, or trading of merchandise or services (commercial), as well as land uses which are related to the production, manufacture, or storage of materials (industrial).	
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	
	3. Special considerations (detailed) : People affected by contamination : • ≤ 250 • 250 à 1000 • > 1000	 0 1 1,5* 3*	* The weighting suggested is valid if there are no points affected to other special considerations.		
	Type of person using the site : • Workers • Adults • Children and seniors Other special considerations	0 1* 2* (-5 à 5)	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.		

III. RECEPTORS (cont'd) SCORE

A. Human and Animal Uses (cont'd)

2.c.i • **Known Contamination of Land Used by Humans**

Record land use type (current or proposed) and level of contamination for land known to be contaminated due to site: NO RECORD

Scoring Rationale & Information Source:

Score: –

2.c.ii • **Land Use at and Adjacent to the Site**

Document land uses (current and proposed) for up to 5 km from the site: IMPAC AREA A | ALLUMETTE LAKE OTTAWA RIVER CHALK BAY | GARRISON AREA | TRAINING AREAS C & L

	N	E	S	W
0 - <300 m				
300 m - <1 km	THERE ARE RESIDENCES LOCATED 1-5 KM DOWNSTREAM			
1 km - 5 km				

Scoring Rationale & Information Source:

Score: 3

3. • **Special Considerations**

Document any other important human or animal use information, including details of air contamination if known:

PEOPLE AFFECTED (POTENTIALLY) > 250 => 1

THE SITE IS USED BY MILITARY PEOPLE

Scoring Rationale & Information Source:

Score: 1

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	B. Environment 1. Known adverse impact on a sensitive environment as a result of the contaminated site • Known adverse impact on sensitive environment • Evidence of stress on aquatic species or vegetative stress on trees, crops or plant life located on properties neighbouring the site • Strongly suspected adverse impact on sensitive environment	 16 14 12	The environment should be protected against site contamination. Evidence of impact(s) shows that protection is lacking.	Review records for evidence of vegetative stress or impairment of any nearby sensitive environments. A sensitive environment is defined as a sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980).	
	2. Potential for impact on sensitive environments a) Distance from site to nearest sensitive environment (e.g., sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc.) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km	 10 6 2 0.5	It is considered that within approximately 1 km of the site there is immediate concern for contamination. Therefore, an environmentally sensitive area located within this area of the site will be subject to concern. It is also generally considered that any sensitive area located greater than 10 km from the site will not be impacted.	Review Conservation Authority mapping and literature. Also review Ministry of Natural Resources records and Federal Land Capability maps. Identify provincial/territorial and federal designated environmentally sensitive areas.	Relevant provincial /territorial and federal maps of sensitive environments.
	b) Groundwater - distance to important or susceptible groundwater resource(s) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km	 6 4 2 1	The closer a site is to a discharge or recharge area, the greater the potential for contamination of a groundwater or surface water resource.	Review groundwater contour maps, if available, and other available reports. Otherwise use established hydrogeologic principles.	Local groundwater maps, etc.
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	

SITE CLASSIFICATION WORKSHEET - cont'd

III. RECEPTORS (cont'd) SCORE

B. Environment

1. • Known Adverse Impact(s) on Sensitive Environment

Record known impact(s) on any sensitive biological environment at and/or around the site: NO RECORD

Scoring Rationale & Information Source: —

2.a • Distance from Site to Nearest Sensitive Environment

Document location, distance, type and details of any nearby sensitive environments or habitats: SOME MARSHES WITHIN TRAINING AREAS C AND L

Scoring Rationale & Information Source: 6

2.b • Groundwater

Measure distance to major recharge or discharge area: SOME BEDROCK EXPOSURES AND OUTCROP WITHIN THE AREA.

Scoring Rationale & Information Source: 6

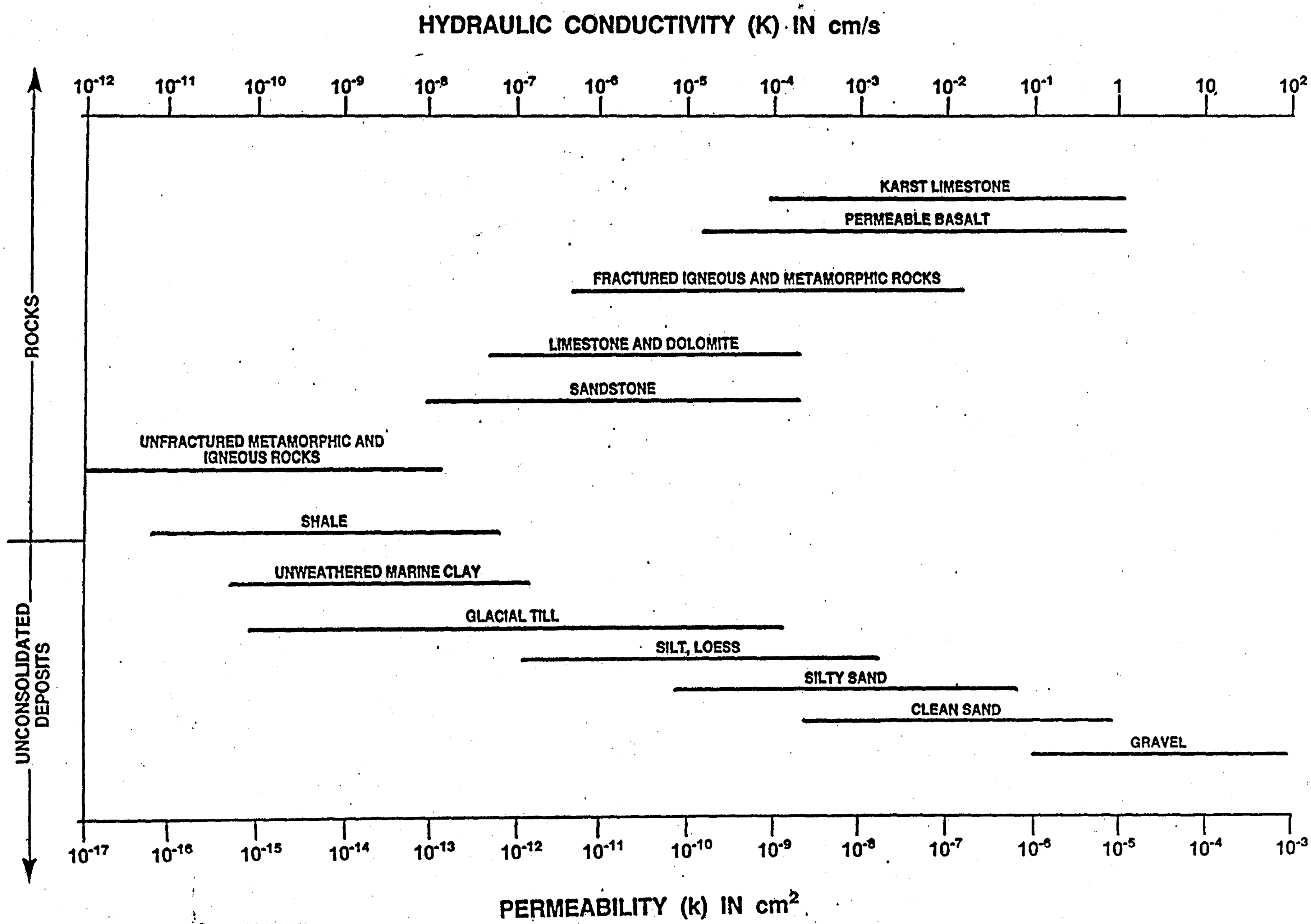
3. • Special Considerations

Document any other important impacts on the environment not addressed above:

Scoring Rationale & Information Source: —

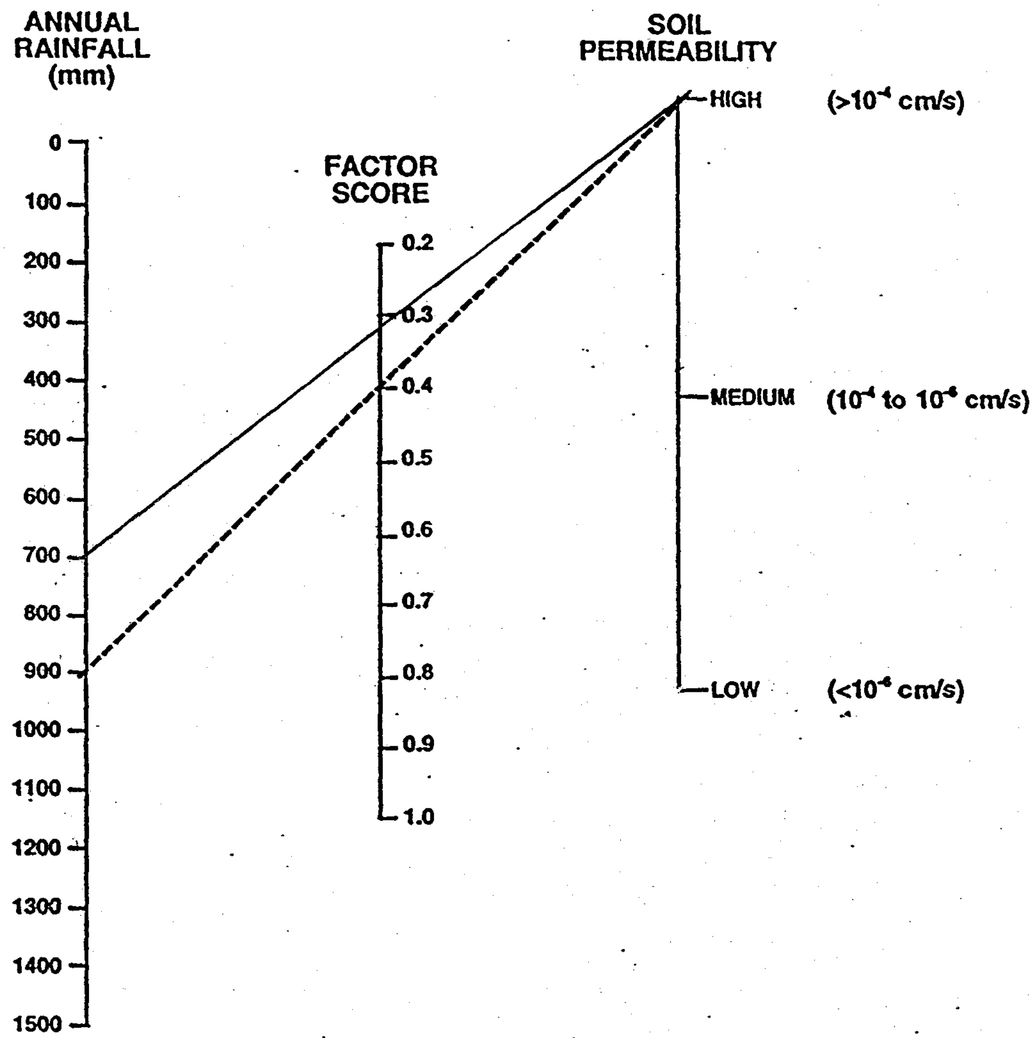
Site Identification:

RANGE OF VALUES OF HYDRAULIC CONDUCTIVITY AND PERMEABILITY



MODIFIED FROM FREEZE AND CHERRY, 1979 AND TODD, 1959

RUN-OFF POTENTIAL NOMOGRAPH
(FACTOR II B 2 d)



To determine the factor score, use a ruler and join the annual rainfall value (mm) with the soil permeability data; take the factor score from the middle line.

For example, if rainfall is 900 mm and soil permeability is high, the score would be 0.4.

Compounds	Abbreviations	Solubility	T	Vapour pressure	T	Degradation	Degradation constants (mu)			Kd	Toxicity	"EPA drinking water standard"	MEF water quality criteria	Drinkability standard	Danger criteria (Daniels)	Danger criteria (Rouisse)	References
							Sand	Silt	Clay								
Units		(mg/L)	(C)	(atm)	(C)		(/hr)	(/hr)	(/hr)	(L/kg)		(mg/L)	(mg/L)	(ppb-ug/L)	(mg/K)	(mg/Kg)	
2,4,6 trinitrotoluene	2,4,6 TNT	150	25	7,25E-09	25	Mostly anaerobic					Possibly toxic	0,02					(1)
		130	20	1,45E-09	20									1	0,3	0,024	(2)
		150	25	9,49E-09	25												(3)
		130	20	4,61E-09	20												(3)
				1,66E-09	20												(4)
							3,20E-03	1,40E-01	8,30E-02								(5)
										Ottawa sand: 1,5							(6)
										Silt: 4,5							(6)
										Clay: 10							(6)
													0,12*				(7)
2,4 dinitrotoluene	2,4 DNT	280	25	2,86E-07	25	Aerobic and anaerobic					Possibly carconogenous						(1)
		270	22	2,89E-07	20									5			(2)
				3,17E-08	25												(3)
		270	20	1,61E-08	20												(3)
													1,10E-04				(7)
2,6 dinitrotoluene	2,6 DNT	208	25	7,46E-07	25	Aerobic and anaerobic											(1)
		206	25	7,46E-07	20									5			(2)
													0,93*				(7)
cyclo - 1,3,5 - triméthylene - 2,4,6 - trinitramine	RDX	45	25	5,30E-12	25	Anaerobique					Possibly carconogenous	0,1					(1)
		42	20	5,53E-12	20									2	0,3	0,00024	(2)
(or hexahydro - 1,3,5 - trinitro - 1,3,5 - triazine, or		50	20	2,56E-12	20												(3)
							0	6,50E-03	1,40E-02								(5)
										0,1 à 13,26							(6)
cyclo - 1,3,5,7 - tetramethylene - 2,4,6,8 - tetranitramine	HMX	5	25	4,38E-17	25	Anaerobique						nd		400	1,7	2,2	(1)
(or octahydro - 1,3,5,7 - tetranitro - 1,3,5,7 - tetrazocine)		5	25	4,34E-17	20												(2)
										0,2 à 4,2							(6)
							0	3,60E-03	3,20E-02								(5)

(1) McGrath, 1995
(2) Thiboutot *et al*, 1998
(3) Pheelan and Webb, 1997
(4) Hayes, 1992
(5) Myers *et al*, 1996
(6) Townsend *et al*, 1996
(7) http://www.mef.gouv.qc.ca/fr/environn/criteres_eau

* Provisory criteria for aquatic life (surface water)

Conversion table for pressure units

	atm	mm Hg	torr	kPa	bar
1 atm =	1	760	760	101,3	1,013250274
1 mm Hg =	0,00131579	1	1	0,13328947	0,001333224
1 torr =	0,00131579	1	1	0,13328947	0,001333224
1 kPa =	0,00987167	7,50246792	7,50246792	1	0,010002471
1 bar =	0,986923	750,06148	750,06148	99,9752999	1

MINISTERE DE LA DEFENSE NATIONALE
DEPARTMENT OF NATIONAL DEFENCE
Gouvernement du Canada / Government of Canada

SISEFC CFRIS

FORMULAIRE D'AUTORISATION DE SECTEUR
RANGE / TRAINING AREA AUTHORIZATION FORM

Code de secteur: / Range Id: **RA700** Nom de secteur: / Range Name: **FIBUA RGE**

Locale / Location:	CFB PETAWAWA	Type / Type:	FIBUA
Base / Base:	CFB PETAWAWA		
Commandement / Command:	Director Land Forces Readiness		
État / Status:	Actif Active	Grandeur / Size:	500.00 Metres
Feuille de carte / Map Sheet:	MCE132 TR 89 ED 7 GR187914	Allées / Lanes:	0

ARMES WEAPONS	MUNITIONS AMMUNITION
RIOT GUN 38mm	CN Riot M7 (MIL & CIV)
PYROTECHNICS	CTG 38mm SPEDEHETE CS
PISTOL M85	CTG 38mm FLITERITE CS
	PYROTECHNICS
	CS Riot Gas
	GELATIN CAPSULES M85

RESTREINTS: RESTRICTIONS

Sécurité / Safety:
1. No CS/Tear gas in sewer lines.
2. No live ammo to be used in or on FIBUA site.

Autre / Other: None

Date autorisé / Authorized Date:	18/06/1998	Autorisé par:	MWO G.H. BERGERON
Commandement / Command:	Director Land Forces Readiness	Authorized By:	DLFR6-6-3
Date inspectée / Inspected Date:	18/11/1997 Central Area	Par / By:	LFCA MWO RD

Site classification computerised worksheet

Site: Demolition Range   Date: 06-27-2000   User (s): Marc-André Lavigne

Sections	Score for potential impacts	Known and/or potential impacts		?	Comments
CONTAMINANT(S) CHARACTERISTICS					
A) DEGREE OF HAZARD	11	11	/14	0	Energetic materials found in ordnances.
B) CONTAMINANT QUANTITY	2	2	/10	0	Area < 1 km², no register before 1995
C) PHYSICAL STATE OF CONTAMINANTS	3	3	/9	0	TNT, RDX, HMX, etc
Special considerations	0	0	/6		
TOTAL	16	16	/33	0	N.B.: If the total is < 0 or > 33, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 33)
EXPOSURE PATHWAYS					
A) GROUNDWATER					
Known contamination at or beyond property boundary		-100	/11		
Engineered subsurface containment	4	4	/4	0	No engineered system.
Thickness of confining layer over aquifer(s) of concern	1.5	1.5	/1,5	0	No confining layer.
Hydraulic conductivity of the *confining* layer	1.5	1.5	/1,5	0	No confining layer.
Annual rainfall	0.7	0.7	/1	0	700 mm between 1950 and 1981.
Hydraulic conductivity of the aquifer(s) of concern	0.5	0.5	/3	0	From 10E-10 cm/s to 10E-04 cm/s, average value.
Special considerations	0.8	0.8	/4		Solubility: 4/3, Retardation Factor: -1/2, Biodegradation: not observed
TOTAL	9.0	9.0	/11	0.0	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
B) SURFACE WATER					
Observed or mesured contamination of water/effluent discharged from site		-100	/11		
Surface containment	5	5	/5	0	Trees all over the area but no particular surface containment.
Distance to perennial surface water	2	2	/3	0	Biggar Lake beside the area, Barron River to the south.
Topography	0	0	/1,5	0	Flat area, contaminants at or below ground level.
Run-off potential (see nomograph)	0.52	0.52	/1	0	Average value.
Flood potential	0.25	0.25	/0,5	0.25	No flood in the last 50 years but Sturgeon Lake increases the possibility.
Special considerations	2.0	2.0	/4		Solubility: 2
TOTAL	9.8	9.8	/11	0.3	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
C) DIRECT CONTACT					
Known contamination of media off-site		-100	/11		
Airborne emissions (gases, vapour, dust, etc.)	2.5	2.5	/5	2.5	Possible but unknown.
Accessibility of site (ability to contact materials)	2	2	/4	0	Remote area but contaminants are not covered.
Hazardous soil gas migration	0	0	/2	0	No putrescible contaminants.
Special considerations	-1.3	-1.3	/4		Vapor pressure: -2, powderiness: 2/3
TOTAL	3.2	3.2	/11	2.5	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11)
RECEPTORS					
A) HUMANS AND ANIMALS					
Known adverse impact on living things as a result of the contaminated site		-100	/18		
Known impact on drinking water supply		-100	/9		
Proximity to drinking water supply	3	3	/6	0	Some cabins beside Barron River.
"Availability" of alternate drinking water supply	1.5	1.5	/3	1.5	Other water supply available (lakes, rivers, etc), but quality not known.
Known impact on used water resource		-100	/4		
Proximity to water resources used for activities	0.5	0.5	/2	0	Barron River
Use of water resources	2	2	/2	0	Fishing, swimming
Known contamination of land used by humans		-100	/5		
Use of land at and surrounding site	0	0	/5	0	Military exercises.
Special considerations	0.0	0.0	/5		People affected lower than 250, military people.
TOTAL	7.0	7.0	/18	1.5	N.B.: If the total is < 0 or > 18, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 18).
B) ENVIRONMENT					
Known adverse impact on sensitive environment as a result of the contaminated site		-100	/16		
Distance from site to nearest sensitive environment	10	10	/10	0	Some marshes within the area 8.
Distance to important or susceptible groundwater resource(s)	6	6	/6	0	Biggar Lake act as either a recharge or discharge area.
Special considerations	0	0	/5		
TOTAL	16	16	/16	0	N.B.: If the total is < 0 or > 16, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 16)

Total score (potential impacts)	59.5	+	1.5	/100	+/-	4.3
Total score (known impacts or potential impacts if the former is not known)	59.5	+	1.5	/100	+/-	4.3

N.B. : If the uncertainty exceeds 15, we consider that there if insufficient information to assign a significant score and the site is therefore classified in class I (for insufficient information).

Score	Class	Risk potential	Action required
70-100	1	High	Yes
50-69	2	Medium	Likely
38-49	3	Medium low	May be
<=37	N	Low	Not likely

N.B. : The number "-100" has been used as default when no information was available about the contamination of the site. This value (-100) was chosen to avoid any confusion with possible scores.

Appendix C

Facility/Site Description

FACILITY/SITE DESCRIPTION

Document site information as completely as possible:

Site No.: RA 720 *Site Name:* DEMOLITION RANGE *Province/Territory:* ONTARIO

Custodian Dept.: DND *Facility Name:* CFB PETAWAWA *Site Operator/Manager:* CFB PETAWAWA

Type of Site: DEMOLITION *Site Owner:* DND

Zone: ______ *UTM Coordinates:* 3057000 *Easting* 5083300 *Northing*

Latitude: ____ *deg.* ____ *min.* ____ *sec.*
Longitude: ____ *deg.* ____ *min.* ____ *sec.*

Location: ______
Address ______
Legal Land Description: ______
Provincial Parcel No.: ______

Brief Description of Site: ______

Site Land Use: *Current:* PETAWAWA *Proposed:* IDEM

Comments:

12

Summary of Site Classification Information:

Completed Evaluation Form: x *Detailed* X *Short*

Site Score: 61 *Total* ± 4.3 *Estimated Score*

Class: (1, 2, 3, N, or I) 2 *Risk:* MEDIUM

Notes: ______

Contact Name: CHRIS HOGAN /SEAN MOYLES

Position: ______

Address: ______

City: PETAWAWA *Prov./Terr.:* ONT. *Postal Code:* ______

Phone No.: ______ *Fax No.:* ______

Site Classified by above ______ *or* MARC-ANDRÉ LAVIGNE / KARINE CHAMPAGNE

Degree of Familiarity with Site: ____ *Very familiar* ____ *Moderately familiar* X *Indirectly familiar* ____ *Unfamiliar*
Visited site: ____ *Yes* x *No*

Position: RESEARCH ASSISTANT *Phone No.:* (418) 654-2647
Address: 880 CHEMIN Ste-FOY, BUR. 840 CP 7500
City: QUEBEC *Prov./Terr.:* QUEBEC *Postal Code:* G1V 4C7 *Date of Completed Classification:* ______
Site Identification: ______

National Classification System Process Checklist

_____ USER'S GUIDE REVIEWED

__X__ MINIMUM DATA REQUIREMENTS MET

- __X__ Description of site location
- __X__ Type of contaminants or materials likely to be present at site (and/or description of historical activities)
- __X__ Approximate size of site and quantity of contaminants
- _____ Approximate depth to water table
- __X__ Geologic map or survey information (soil, overburden, and bedrock information)
- __X__ Annual rainfall data (can be inferred from rainfall map of Canada)
- __X__ Surface cover information
- __X__ Proximity to surface water
- __X__ Topographic information
- _____ Flood potential of site
- __X__ Proximity to drinking water supply
- __X__ Uses of adjacent water resources
- __X__ Land use information (on-site and surrounding)

__X__ FACILITY/SITE DESCRIPTION COMPLETED

__X__ SITE CLASSIFICATION WORKSHEET COMPLETED

__X__ REFERENCES ATTACHED/CITED

__X__ EVALUATION FORM COMPLETED

__X__ Detailed Form __X__ Short Form

__X__ SCORE SHEET COMPLETED

__X__ SITE CLASSIFICATION

Class: _____ 1 __X__ 2 _____ 3 _____ N _____ I

Score: __61__ ± __4.3__
Total Estimated Score

_____ SITE INFORMATION ENTERED ON NCS COMPUTERIZED VERSION

Site Identification: ____________________

SHORT EVALUATION FORM

Instructions for Use

Answer Yes or No to questions 1 to 5 below. If the response to question 1a) or 1b) is Yes, automatically rate the site as Class 1 (C1). If the answers to any three of questions 2 to 5 are Yes, the site should also be rated as Class 1. For all Yes answers, supporting documentation and rationale must be referenced or attached.
To confirm Class 1 rating and/or if two or more No responses are given, the Detailed Evaluation Form should also be completed.

			No	Yes		Reference Attached
1	a)	Is site contamination known to have caused adverse impacts on humans or sensitive environments? (see User's Guide)	☒	☐	→ Class 1	☐
	b)	Is the site a fire or explosion hazard as it currently exists?	☒	☐	→ Class 1	☐
I		**Contaminant(s) Characteristics**				
	2	Are contaminants that can be classified as 'high concern' (as defined in the User's Guide) present at the site?	☐	☒		☐
	3	Are the high concern contaminants known to be present in large quantities? Answer yes if contaminant is: • liquid (as disposed/spilled) • in quantity >1,000 m^3 • in an area of contamination >10 ha • distributed or placed in such a manner as to have the potential to cause significant off-site contamination	☐	☒		☐
II		**Pathways**				
	4	Is the site known to have caused contamination (above national or applicable provincial/territorial guidelines or policies) of off-site groundwater, adjacent surface water, neighbouring surficial material (i.e., soil) or air? (see User's Guide)	☒	☐		☐
III		**Receptors**				
	5	Is the site contamination known to have a) impacted the quality of local drinking water or other water resources (i.e., exceeds Guidelines for Canadian Drinking Water and/or Canadian Water Quality Guidelines or applicable provincial/territorial guidelines or policies); b) contaminated lands used for agricultural, residential or parkland purposes (i.e., exceeds the AG or R/P values of Canadian Environmental Quality Criteria for Contaminated Sites or applicable provincial/territorial guidelines or policies); or c) caused vegetative stress or other known environmental impairment? (A Yes answer should be given if the impact has made the water, land, environment, or air unacceptable for use.)	☒	☐		☐

If 3 or more Yes answers are given in Sections I, II, and III above, rate site as Class 1. Check box if Class 1 rating. ☐

Appendix D

User's Guide (even pages) and Site Classification Worksheet (odd pages)

USER'S GUIDE

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
I. Contaminant(s) Characteristics	A. Degree of hazard • High concern contaminants - high concentration • High concern contaminants - low concentration • Medium concern contaminants - high concentration • Medium concern contaminants - low concentration • Low concern contaminants	14 11 8 5 3	In determining the degree of hazard of a waste, it is recognized that a listed hazardous waste is generally of greater concern than a liquid or solid industrial waste. These are in turn of greater concern than other solid wastes. Municipal and organic wastes are considered medium concern contaminants due to their putrescible nature (production of methane and other landfill gases). Household wastes may contain hazardous materials (e.g., batteries, medical wastes, paints, etc).	Determine the level of hazard according to the following table of typical contaminants and definition of high concentrations: High Concern Contaminants • Materials defined as dangerous goods in the Transport of Dangerous Goods Act and Regulations • Materials identified by Province as hazardous waste (pesticides, herbicides, paint sludge, acid and alkaline solutions, solvents, etc.) • Materials regulated by the Canadian Environmental Protection Act (e.g., PCBs) • Institutional waste (lab, schools hospitals, etc.) • Pathological wastes and animal carcasses • Radioactive wastes Medium Concern Contaminants • Liquid waste not referred to in above, petroleum products septic tank pumpings, agricultural and chemical containers • Food processing wastes • Non-hazardous incinerator residues • Municipal solid (household) wastes • Organic and vegetable wastes • Mining residues Low Concern Contaminants • Industrial and commercial solid wastes, (e.g., construction materials such as wood, metal, hay, sand/silt piles, etc.) • Other nearly inert wastes (e.g., foundry sands) High Concentration of Contaminants • contaminant concentrations in soil, groundwater or surface water exceed Canadian Environmental Quality Criteria for Contaminated Sites (>2x commercial/ industrial level); or material that was deposited in highly concentrated form (e.g., >5000 ppm)	Transport of Dangerous Goods Act; Provincial/ Territorial Hazardous Wastes lists; regulations under Canadian Environmental Protection Act; Canadian Environmental Quality Criteria for Contaminated Sites; etc.
	B. Contaminant Quantity (area/volume of site contamination) • >10 ha, or >1000 m^3, or drums of liquid • 2 to 10 ha, or 100 to 1000 m^3 • <2 ha, or <100 m^3	10 6 2	Little information is known about the quantity of wastes at abandoned sites in Canada. Therefore, waste quantity estimates may be interpreted from area or quantity information.	Measure or estimate the area or quantity of potential contamination. Note: Any number of drums abandoned or disposed is considered a high concern.	
	C. Physical State of Contaminants • Liquid/gas • Sludge • Solid	9 7 3	Contaminants in liquid form are more mobile in the ground and water than solids. However, certain water-soluble solid wastes are more mobile than viscous liquids, and these should be evaluated on a case-by-case basis.	Determine the state of the contaminant when it was disposed or deposited.	
	Special Considerations	-6 to +6	(See 3.7.3 in text)	Technical judgment.	

SITE CLASSIFICATION WORKSHEET

(Instructions: Document site information, assign score, provide rationale behind score and indicate source of information in the spaces provided.)

I. CONTAMINANT(S) CHARACTERISTICS — SCORE

A. • Degree of Hazard

List possible contaminants and estimated concentrations: ENERGETIC MATERIALS FOUND IN AMMUNITION (TNT, HMX, RDX)
POSSIBILITY OF HEAVY METAL CONTAMINATION

Scoring Rationale & Information Source: ______ **11**

B. • Contaminant Quantity

Estimated or measured areal volume of contaminated zone: NO REGISTER OF UNEXPLODED SHELLS BEFORE 1995
AREA < 1 Km²
QUANTITY ESTIMATED WITH AREA OF THE RANGE

Scoring Rationale & Information Source: CHRIS HOGAN / SEAN MOYLES **10**

15

C. • Physical State of Contaminant

Does the site contain:
a) Predominantly liquids/gases ______
b) Primarily sludges ______
c) Primarily solids ENERGETIC MATERIALS (TNT, RDX, HMX)

Scoring Rationale & Information Source: ______ **3**

• Special Considerations

Document any other important contaminant characteristics not addressed above: ______

Scoring Rationale & Information Source: ______ **—**

Site Identification: ______

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways	A. Groundwater 1. Known contamination at or beyond property boundary • Groundwater significantly exceeds Canadian Drinking Water Guidelines (CDWG) by >2x or known contact of contaminants with groundwater • Between 1 and 2x CDWG or probable contact with groundwater • Meets Canadian Drinking Water Guidelines	 11 6 0	The legislative basis for most jurisdictions is to prevent off-site migration of contamination.	Review chemical data and evaluate groundwater quality. If contamination at or beyond the property boundary exceeds Canadian Drinking Water Guidelines (CDWG) or applicable provincial/territorial guidelines or policies, or if contaminants are known to be in contact with groundwater, then evaluate the site as high.	Canadian Water Quality Guidelines; Provincial/ Territorial Water Quality Guidelines or policies; Guidelines for Canadian Drinking Water Quality.
	2. Potential for groundwater contamination (a) Engineered subsurface containment • No containment • Partial containment • Full containment	 4 2 0	Well contained sites have minimal potential for pollution. Potential for pollution decreases with increasing containment.	Review the existing engineered systems and relate these structures to hydrogeology of the site and determine if full containment is achieved. Full containment is defined as an engineered system, monitored as being effective, which provides for the capture and treatment of contaminants. If there is no system, this factor is evaluated high. If there is less than full containment or if uncertain then evaluate as medium. Typical engineered systems include leachate collection systems and low permeability liners.	
	(b) Thickness of confining layer over aquifer(s) of concern • 3 m or less • 3 to 10 m • >10 m	 1.5 1 0	The thickness of a confining layer (e.g., clay, shale, etc.) between contaminants and any aquifers of concern will affect the attenuation of contaminants and hence the quantity and quality of contaminants reaching the aquifers.	Measure or estimate thickness of any confining layer (e.g., clay, shale, etc.) over all aquifers of concern from existing well records or from a general knowledge of local conditions. If possible, an estimate of the continuity of the confining layer should be made from borehole well record information. Note: an aquifer is defined as a geologic material that will yield groundwater in usable quantities.	Historical geologic maps, well records, government hydrogeologist or local consultants.
	(c) Hydraulic conductivity of the confining layer • $>10^{-4}$ cm/sec • 10^{-4} to 10^{-6} cm/sec • $<10^{-6}$ cm/sec	 1.5 1 0.76 0.5	The rate at which contaminants migrate through the confining layer will affect attenuation and the contaminant loading to the aquifers.	Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Apppendix D). Clays, granite, shales should be scored low. Silts etc. should be scored medium. Sand, gravel, and limestone should be scored high.	Freeze and Cherry, 1979, and other groundwater texts.

II. EXPOSURE PATHWAYS

SCORE

A. Groundwater

1. • Known Groundwater Contamination

Document information on known groundwater contamination: NO RECORD

Scoring Rationale & Information Source: [–]

2.a • Engineered Subsurface Containment

Document engineered systems protecting groundwater: NO ENGINEERED SYSTEM

Scoring Rationale & Information Source: [4]

2.b • Thickness of Confining Layer Over Aquifer(s) of Concern

Document local geological conditions: BEDROCK (LIMESTONE, DOLOSTONE, SHALE, SANDSTONE, MINOR DRIFT COVER) OVERLAIN BY TILL (POORLY SORTED DIAMICTON)

Identify water-bearing zones used for water supply: NO CONFINING LAYER

Scoring Rationale & Information Source: [1.5]

2.c • Hydraulic Conductivity of the Confining Layer

Estimate hydraulic conductivity of any confining layer: NO CONFINING LAYER

Scoring Rationale & Information Source: [1.5]

3. Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	A.2. (d) Annual Rainfall • >1000 mm • 600 mm • 400 mm • 200 mm	 1 0.7 0.6 0.4 0.2	The quantity of rainfall affects the quantity of leachate produced. Higher leachate quantities have a higher impact on the environment.	Refer to Environment Canada rainfall records for relevant areas. Use 30-year average rainfall for evaluation purposes. Divide rainfall by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score)	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	(e) Hydraulic conductivity of aquifer(s) of concern • $>10^{-2}$ cm/sec • 10^{-2}-10^{-4} cm/sec • $<10^{-4}$ cm/sec	 3 1.5 0.5	Aquifers with high hydraulic conductivity can transport contaminants at high velocity over great distances, e.g., solution limestones, highly fractured rocks or gravel deposits.	Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Appendix D).	Freeze and Cherry, 1979.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	
	3. Special considerations (detailed) : Solubility (S) : • low (S/standard ≈ 10^1) • medium (S/standard ≈ 10^2) • high (S/standard ≈ 10^3)	 -4/3* 0 4/3*	* The weighting suggested is valid if there are no points affected to other special considerations.		
	Retardation factor (R) : • important delay ($R / R_{Cl} \approx 10^2$) or ($K_d \approx 12{,}51$) • delayed ($R / R_{Cl} \approx 10^1$) or ($K_d \approx 1{,}14$) • little or no delay ($R / R_{Cl} \approx 10^0$) or ($K_d \approx 0$)	 -4/3* 0 4/3*	N.B. : the R calculation was done using n = 0,33 et ρ_b = 1,75 g/cm^3 ; if the studied soil is neither sand, silt or clay, the R factor must be recalculated because n et ρ_b change. ($R_{Cl} \approx 1$)		
	Biodegradation (μ) : • observed • non observed • non biodegradable	 -4/3* 0 4/3*			
	Other special considerations	(-4 à 4)	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.		

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS (cont'd) **SCORE**

A. Groundwater (cont'd)

2.d • Annual Rainfall

Document rainfall data: BETWEEN 1951 AND 1980 —> ≐ 700 mm

Scoring Rationale & Information Source: CLIMATIC ATLAS - CANADA 0.2

2.e • Hydraulic Conductivity of Aquifer(s) of Concern

Estimate hydraulic conductivity of relevant aquifer(s): TILL HAS A HYDROLIC CONDUCTIVITY RANGING FROM 10^{-10} TO 10^{-4} cm/s

Scoring Rationale & Information Source: 0.5

3. • Special Considerations

Document any other important ground water issues not addressed above: SOLUBILITY (S/STANDARD = 130/0.12) => 4/3
RETARDATION FACTOR (Kd ≐ 4.5) => -0.5
BIODEGRADATION (NOT OBSERVED) => 0

Scoring Rationale & Information Source: ARBITARY SCORE FOR RETARDATION FACTOR 5/6

Site Identification: __________

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	B. Surface Water 1. Observed or measured contamination of water/effluent discharged from site • Known or strongly suspected to exceed Canadian Water Quality Guidelines (CWQG) by >2x • Known or strongly suspected to be between 1 - 2x CWQG • Meets Canadian Water Quality Guidelines	 11 6 0	The legislative basis in all jurisdictions is not to contaminate surface water beyond established limits.	Collect all available information on quality of surface water near to site. Evaluate available data against Canadian Water Quality Guidelines (select appropriate guidelines based on local water use, e.g., recreational, irrigation, freshwater aquatic life, etc.) and relevant provincial/territorial water quality objectives.	CCMB Canadian Water Quality Guidelines; Relevant provincial /territorial and federal legislation and regulations.
	2. Potential for surface water contamination a) Surface Containment • No containment • Partial containment • Full containment	 5 3 0.5	The level and type of engineered containment will affect the potential for contaminants to be released to surface water.	Review the existing engineered systems and relate these structures to site conditions and proximity to surface water and determine if full containment is achieved; e.g., evaluate low if there is full containment such as capping, berms, dikes; evaluate medium if there is partial containment such as natural barriers, trees, ditches, sedimentation ponds; evaluate high if there are no intervening barriers between the site and nearby surface water.	Site inspection reports, air photos, etc.
	b) Distance to perennial surface water • 0 to <100 m • 100 to 300 m • >300 m	 3 2 0.5	The distance to surface water will affect the probability of contaminants reaching the watercourse. The Ontario Ministry of the Environment has established a classification for immediate impact zone at 50 m. For conservatism, this zone has been broadened to 100 m.	Review available mapping and survey data to determine distance to nearest surface water bodies.	
	c) Topography • Contaminants above ground level and slope is steep • Contaminants at or below ground level and slope is steep • Contaminants above ground level and slope is flat • Contaminants at or below ground level and slope is flat	 1.5 1.2 0.8 0	Water can run off (and therefore potentially contaminate surface water) with greater ease from elevated sites on slopes.	Review engineering documents on the topography of the site and the slope of surrounding terrain. • steep slope = >50% • flat slope = <5% Note: Type of fill placement (e.g., trench, above ground, etc.)	

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS (cont'd) **SCORE**

B. Surface Water

1. • Observed or Measured Contamination

Document information on surface water contamination: NO RECORD

Scoring Rationale & Information Source: [—]

2.a • Surface Containment

Review and document engineered or natural systems protecting surface water: NO SURFACE CONTAINMENT

Scoring Rationale & Information Source: [5]

2.b • Distance to Perennial Surface Water

Estimate distance from site to nearest stream or other water body: BIGGAR LAKE BESIDE THE AREA, BARON RIVER TO THE SOUTH

Scoring Rationale & Information Source: [3]

2.c • Topography

Document terrain conditions: FLAT SLOPE

Document position of contaminants (are they above ground or buried?) CONTAMINANTS AT OR BELOW GROUND LEVEL

Scoring Rationale & Information Source: MAP MCE 132 E/ 8 TR 99 [0]

Site Identification: ______________

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	B. 2. d) Run-off potential (see nomograph, end of Appendix D) • >1000 mm rainfall and low permeability surface material • 500 to 1000 mm rainfall and moderately permeable surface material • <500 mm rainfall and highly permeable surface material	1 0.7 0.6 0.2	Run-off transports contaminants into water bodies. Water run-off is a function of precipitation and the rate of infiltration (less permeable soils will allow greater run-off).	Refer to Environment Canada precipitation records for relevant areas. Use 30-year average precipitation for evaluation purposes. Determine factor score using "Run-Off Potential Nomograph" figure at end of Appendix D.	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	e) Flood potential • 1 in 2 years • 1 in 10 years • 1 in 50 years	0.5 0.3 0.35 0.1	The potential for large quantities and concentrations of contaminants to be released to surface water courses over a short period of time will be affected by the flood potential of a water course near the site.	Review published data such as flood plain mapping or flood potential (e.g., spring or mountain run-off) and Conservation Authority records to evaluate flood potential of nearby water courses both up and down gradient. Rate zero if site not in flood plain.	Established flood plain guidelines/ maps; provincial/ territorial soil survey maps.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) :			
Solubility (S) :			
• low (S/standard ≈ 10^1)	-2*	* The weighting suggested is valid if there are no points affected to other special considerations.	
• medium (S/standard ≈ 10^2)	0		
• high (S/standard ≈ 10^3)	2*		
Biodegradation (μ) :			
• observed	-2*		
• non observed	0	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	
• non biodegradable	2*		
Other special considerations	(-4 à 4)		

II. EXPOSURE PATHWAYS (cont'd) **SCORE**

B. Surface Water (cont'd)

2.d • Run-off Potential

Document geological and rainfall conditions: ANNUAL RAINFALL ≈ 700 mm
PERMEABILITY RANGING FROM 10^{-10} cm² TO 10^{-4} cm²

Scoring Rationale & Information Source: AVERAGE VALUE 0.52

2.e • Flood Potential

Estimate flood frequency of nearby water courses or water bodies: UNKNOWN

Scoring Rationale & Information Source: ARBITRARY SCORE 0.25 ?

3. • Special Considerations

Document any other important surface water conditions not addressed above: SOLUBILITY (S/STANDARD ≈ 10^3) ⇒ 2
BIODEGRADATION (NON OBSERVED) ⇒ 0

Scoring Rationale & Information Source: 2

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	C. Direct Contact 1. Known contamination of media off-site • Known contamination of soil, sediment or air off-site due to contact with contaminated soil, dust, air, etc. (vector transported should also be considered). • Strongly suspected contamination of media off-site • No contamination of media off-site	 11 6 0	Known or measured contamination off-site is an important consideration for determining impact of contaminants.	Record known or measured contamination of soil, sediment or air on or off-site. Note any presence of soil gas, such as methane, associated with site.	
	2. Potential for direct human and/or animal contact a) Airborne Emissions (gases, vapours, dust, etc.) • Known or suspected airborne emissions impacting on neighbouring properties • Airborne emissions generally restricted to site • No airborne emissions	 5 3 5.5 0	If air emissions are evident off-site, there is a great hazard for direct contamination of neighbouring biota and/or resources.	Review available site information to determine if there have been complaints off-site (due to vapours, gas, dust, etc). Reports for these problems are not likely available for most abandoned sites. Review regulatory site inspection reports. If airborne emissions are known to be impacting neighbouring properties and possibly endangering the public, some immediate action (including characterization of emissions) should be initiated to curtail hazardous emissions or otherwise reduce or eliminate exposure.	Site inspection reports, etc.
	b) Accessibility of Site (ability to contact materials) • Limited or no barriers to prevent site access; contaminants not covered • Moderate accessibility or intervening barriers; contaminants are covered • Controlled access or remote location and contaminants are covered	 4 3 2 0	The greater the accessibility to a site and to contaminants, the greater the chance for contamination of human and animal life by direct contact.	Review location and engineering of the site and determine if there are intervening barriers between the site and humans or animals. A low rating should be assigned to a (covered) site surrounded by a locked chain link fence or in a remote location, whereas a high score should be assigned to a site that has no cover, fence, natural barriers or buffer.	
	c) Hazardous soil gas migration • Contaminants are putrescible and soil permeability is high • Soil contaminants are putrescible but soil permeability is low and/or groundwater is <2 m from surface • No putrescible contaminants at the site.	 2 1 0	Methane gas migration has been known to cause explosions adjacent to abandoned landfills.	Consider presence of organic material on site, the depth to water table, soil hydraulic conductivity, vegetative stress, odours, etc.	
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	
	3. Special considerations (detailed) :				
	Vapor pressure : • < 0,1 kPa • 0,1 à 0,5 kPa • 0,5 à 1,5 kPa • > 1,5 kPa	 -2* -2/3* 2/3* 2*	(N.B. : vapor pressure limits are valid at a 20°C temperature) * The weighting suggested is valid if there are no points affected to other special considerations.		
	Powderiness : • < 0,1 % • 0,1 à 1 % • 1 à 10 % • > 10 %	 -2* -2/3* 2/3* 2*	(i.e. the sample % with a grain size ≤ 45 µm) N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.		
	Other special considerations	(-4 à 4)			

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS (cont'd) — SCORE

C. Direct Contact

1. • **Known Contamination Off-site:**

Document reports of off-site contamination due to contact with contaminated soil, dust, air, etc.: NO RECORD

Scoring Rationale & Information Source: ______ Score: —

2.a • **Airborne Emissions**

Document incidents or complaints about fumes, gases, dust, odours, etc.: POSSIBLE BUT UNKNOWN

Scoring Rationale & Information Source: ______ Score: 25 ?

2.b • **Accessibility of Site**

Review and document avenues of site access by humans and animals: REMOTE LOCATION AND CONTAMINANTS NOT COVERED

Scoring Rationale & Information Source: ______ Score: 2

2.c • **Hazardous Soil Gas Migration**

Review potential for hazardous soil gas production and migration from site: NO PUTRESCIBLE CONTAMINANTS

Scoring Rationale & Information Source: ______ Score: 0

3. • **Special Considerations**

Document any other conditions whereby humans/animals could contact contamination: VAPOR PRESSURE ($\sim 1.49 \times 10^{-9}$ atm)
POWDERINESS => 2/3 ARBITRARY VALUE

Scoring Rationale & Information Source: SEE p. 36 Score: -4/3

Site Identification: ______

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors	A. Human and Animal Uses 1. Known adverse impact on humans or domestic animals as a result of the contaminated site • Known adverse effect on humans or domestic animals • Strongly suspected adverse effect on humans or domestic animals	 18 15	Contamination from a site that causes a measurable impact on humans is a great concern.	Review and evaluate reports of impact(s) of site contamination (e.g., increased heavy metal levels measured in blood of nearby residents as a result of site contamination). Any site assigned 15 or more points for this factor should automatically be classified as Class 1. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980)	
	2. Potential for impact on humans or animals a) Drinking water supply i) Known impact on drinking water supply Drinking water supply is known to be adversely affected as a result of site contamination • Known contamination of drinking water supply to levels above CDWG • Strongly suspected contamination of drinking water supply • Drinking water supply is known not to be contaminated	 9 7 0	Water used for drinking should be protected against contamination from any site.	Review available site data (inspection reports, assessment documentation) to determine if drinking water (groundwater, surface water, private, commercial or municipal supply) is known or suspected to be contaminated above Guidelines for Canadian Drinking Water Quality or applicable provincial/territorial guidelines or policies. If drinking water supply is known to be contaminated above these guidelines, some immediate action (e.g., provision of alternate drinking water supply) should be initiated to reduce or eliminate exposure.	Guidelines for Canadian Drinking Water Quality; other drinking water guidelines developed by recognized agencies (e.g., other Health and Welfare Canada guidelines, U.S. EPA, etc.).
	ii) Potential for impact on drinking water supply • Proximity to drinking water supply • 0 to <100 m • 100 to <300 m • 300 m to <1 km • 1 to 5 km	 6 5 4 3	The nearer a drinking water well is to a contaminant source, the greater the potential for contamination. Well water used for irrigation/agricultural purposes should also be included as it may be used for human consumption.	Review provincial/territorial base mapping or air photos and measure the distance to the nearest resident or drinking water supply. Judge whether the water is being used as a drinking water source. Commonly rural areas use groundwater for drinking purposes. For urban sites, contact the local Public Utilities Commission to determine water source and location.	
	• "Availability" of alternate drinking water supply • Alternate drinking water supply is not available • Alternate drinking water supply would be difficult to obtain • Alternate drinking water supply available	 3 2 1.5 0.5	This factor takes into account the availability of replacement water supplies, and is used in the technical sense as a factor to indicate the degree of urgency, not as a sociopolitical consideration.	Determine availability of alternate drinking water supply or distance to alternate source.	

III. RECEPTORS — SCORE

A. Human and Animal Uses

1. • Known Adverse Impact on Humans or Domestic Animals

Record known or suspected adverse effects on humans or domestic animals: NO RECORD

Scoring Rationale & Information Source: —

2.a.i • Known Contamination of Drinking Water Supply

Record known or suspected incidents of contamination of drinking water: UNKNOWN

Scoring Rationale & Information Source: —

27

2.a.ii.°• Distance to Nearest Drinking Water Supply(s)

Identify nearest drinking water well and measure distance to site: SOME CABINS BESIDE BARRON RIVER

Scoring Rationale & Information Source: 3

2.a.ii.°°•Availability of Alternate Drinking Water Supply

Document availability of alternate sources of drinking water and ease of implementation: OTHER WATER SUPPLY WOULD BE AVAILABLE (LAKES, STREAMS AND RIVERS) BUT THE QUALITY IS NOT KNOWN

Scoring Rationale & Information Source: 1.5

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	A.2. b) Other Water Resources i) Known impact on used water resource Water resource (used for recreational purposes, commercial food preparation, livestock watering, irrigation or other food chain uses) is known to be adversely affected as a result of site contamination		The water used for these purposes (groundwater or surface water) should be protected against contamination.	Review documentation for reported or suspected contamination of water used for recreation or food chain uses, and refer to Canadian Water Quality Guidelines or other relevant guidelines (select appropriate guidelines based on local water use) to determine if supply is considered contaminated.	CCME Canadian Water Quality Guidelines; provincial/ territorial water quality guidelines and objectives; etc.
	• Water resource is known to be contaminated above CWQG	4			
	• Water resource is strongly suspected to be contaminated above CWQG	3			
	• Water resource is known not to be contaminated	0			
	ii) Potential for impact on water resources • Proximity to water resources used for activities listed above		The nearer a water resource is to a site, the greater the risk of contamination.	Determine distance from the site to the nearest recreational or food chain used water resource.	
	• 0 to <100 m	2			
	• 100 to <300 m	1.5			
	• 300 m to <1 km	1			
	• 1 to 5 km	0.5			
	• Use of water resources - if multiple uses, give highest score (use following table)	0.2 2	Potential for impact due to use of water resource is related to the type and frequency of use. Human uses are of the highest concern.	Assess water users adjacent to the site from maps and directories.	

Water Use	Frequency of Use: Frequent	Frequency of Use: Occasional
Recreational (swimming, fishing)	2	1
Commercial food preparation	1.5	0.8
Livestock watering	1	0.5
Irrigation	1	0.5
Other domestic or food chain uses	0.5	0.3
Not currently used but likely future use	0.5	0.2

III. RECEPTORS (cont'd) SCORE

A. Human and Animal Uses (cont'd)

2.b.i • Known Impact on Used Water Resource

Record information on water resource that is or is potentially affected by site contamination: NO RECORD

Scoring Rationale & Information Source: –

Score: –

2.b.ii.°• Proximity of Water Resources to Site

Locate and measure nearest water resource areas to site: BARRON RIVER 1.5 Km SOUTH

Scoring Rationale & Information Source:

Score: 0.5

2.b.ii.°°• Water Uses

Record uses of nearby water resources: FISHING
SWIMMING ?

Scoring Rationale & Information Source:

Score: 2

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	A. 2. c) Direct human exposure i) Known contamination of land used by humans • Known contamination of land used for agricultural or residential/parkland/school purposes above AG or R/P EQC values • Known contamination of land used for commercial or industrial purposes above C/I EQC values • Land is known not to be contaminated	5 3.5 0	Hazards associated with soil contamination are directly related to land use.	Review zoning and land use maps for lands adjacent the site. Evaluate levels of soil contamination against Canadian Environmental Quality Criteria (EQC) for Contaminated Sites (AG = agricultural level; R/P = residential/parkland level; C/I = commercial/industrial level). If soil is known to be contaminated above these levels and possibly endangering public health, some immediate action (e.g., fencing the area, limiting public access, etc.) should be initiated to reduce or eliminate the exposure.	CCME Canadian Environmental Quality Criteria for Contaminated Sites.
	ii) Potential human exposure through land use • Use of land at and surrounding site (use following table; give highest score to worst case scenario) Distance from Site Land Use (current or future) — 0 - 300m — 300m - 1km — 1 - 5km Residential — 5 — 4.5 — 3 Agricultural — 5 — 4 — 2.5 Parkland/School — 4 — 3 — 1.5 Commercial/Industrial — 3 — 1 — 0.5	0.5 - 5 0	Hazards associated with soil contamination are directly related to land use and distance of the used land from the site. Residential and agricultural land uses are of highest concern because humans are situated at these locations for longer periods.	Review zoning and land use maps over the distances indicated. If the proposed future land use is more "sensitive" than the current land use, evaluate this factor assuming the proposed future use is in place (indicate in the worksheet that future land use is the consideration). Agricultural land use is defined as uses of land where the activities are related to the productive capability of the land or facility (e.g., greenhouse) and are agricultural in nature, or activities related to the feeding and housing of animals as livestock. Residential/Parkland land uses are defined as uses of land on which dwelling on a permanent, temporary, or seasonal basis is the activity (residential), as well as uses on which the activities are recreational in nature and require the natural or human designed capability of the land to sustain that activity (parkland). Commercial/Industrial land uses are defined as land on which the activities are related to the buying, selling, or trading of merchandise or services (commercial), as well as land uses which are related to the production, manufacture, or storage of materials (industrial).	
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	

	3. Special considerations (detailed) : People affected by contamination : • ≤ 250 • 250 à 1000 • > 1000 Type of person using the site : • Workers • Adults • Children and seniors Other special considerations	 0 1,5* 3* 0 1* 2* (-5 à 5)	* The weighting suggested is valid if there are no points affected to other special considerations. N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	

III. RECEPTORS (cont'd) SCORE

A. Human and Animal Uses (cont'd)

2.c.i • Known Contamination of Land Used by Humans

Record land use type (current or proposed) and level of contamination for land known to be contaminated due to site: NO RECORD

Scoring Rationale & Information Source:

Score: —

2.c.ii • Land Use at and Adjacent to the Site

Document land uses (current and proposed) for up to 5 km from the site: MILITARY EXERCISES

	N	E	S	W
0 - <300 m	IMPACT AREA 8	IMPACT AREA 8	IMPACT AREA 8	IMPACT AREA 8
300 m - <1 km	SITE IS WITHIN THIS AREA			
1 km - 5 km				

Scoring Rationale & Information Source:

Score: 0

3. • Special Considerations

Document any other important human or animal use information, including details of air contamination if known: PEOPLE AFFECTED => < 250 => 0

THE SITE IS USED BY MILITARY PEOPLE

Scoring Rationale & Information Source:

Score: 0

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	B. Environment 1. Known adverse impact on a sensitive environment as a result of the contaminated site • Known adverse impact on sensitive environment • Evidence of stress on aquatic species or vegetative stress on trees, crops or plant life located on properties neighbouring the site • Strongly suspected adverse impact on sensitive environment	 16 14 12	The environment should be protected against site contamination. Evidence of impact(s) shows that protection is lacking.	Review records for evidence of vegetative stress or impairment of any nearby sensitive environments. A sensitive environment is defined as a sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980).	
	2. Potential for impact on sensitive environments a) Distance from site to nearest sensitive environment (e.g., sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc.) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km	 10 6 2 0.5	It is considered that within approximately 1 km of the site there is immediate concern for contamination. Therefore, an environmentally sensitive area located within this area of the site will be subject to concern. It is also generally considered that any sensitive area located greater than 10 km from the site will not be impacted.	Review Conservation Authority mapping and literature. Also review Ministry of Natural Resources records and Federal Land Capability maps. Identify provincial/territorial and federal designated environmentally sensitive areas.	Relevant provincial /territorial and federal maps of sensitive environments.
	b) Groundwater - distance to important or susceptible groundwater resource(s) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km	 6 4 2 1	The closer a site is to a discharge or recharge area, the greater the potential for contamination of a groundwater or surface water resource.	Review groundwater contour maps, if available, and other available reports. Otherwise use established hydrogeologic principles.	Local groundwater maps, etc.
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	

III. RECEPTORS (cont'd) SCORE

B. <u>Environment</u>

1. • **Known Adverse Impact(s) on Sensitive Environment**

Record known impact(s) on any sensitive biological environment at and/or around the site: NO RECORD

Scoring Rationale & Information Source: —

2.a • **Distance from Site to Nearest Sensitive Environment**

Document location, distance, type and details of any nearby sensitive environments or habitats: SOME MARSHES WITHIN THE AREA #8

Scoring Rationale & Information Source: 10

2.b • **Groundwater**

Measure distance to major recharge or discharge area: RECHARGE WITHIN THE AREA (MOUNTAINS, OUTCROPS)

Scoring Rationale & Information Source: 6

3. • **Special Considerations**

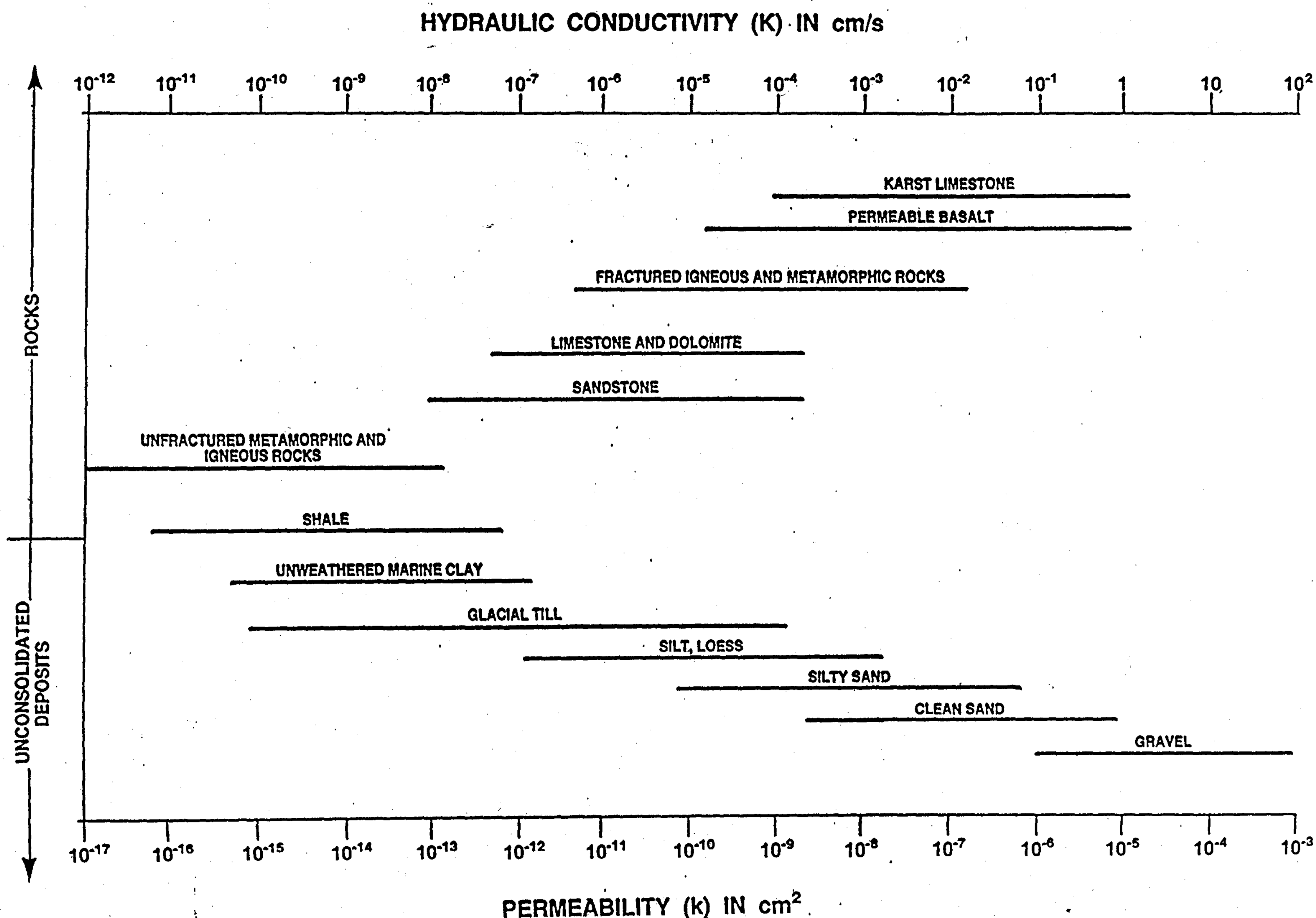
Document any other important impacts on the environment not addressed above:

Scoring Rationale & Information Source: —

Site Identification:

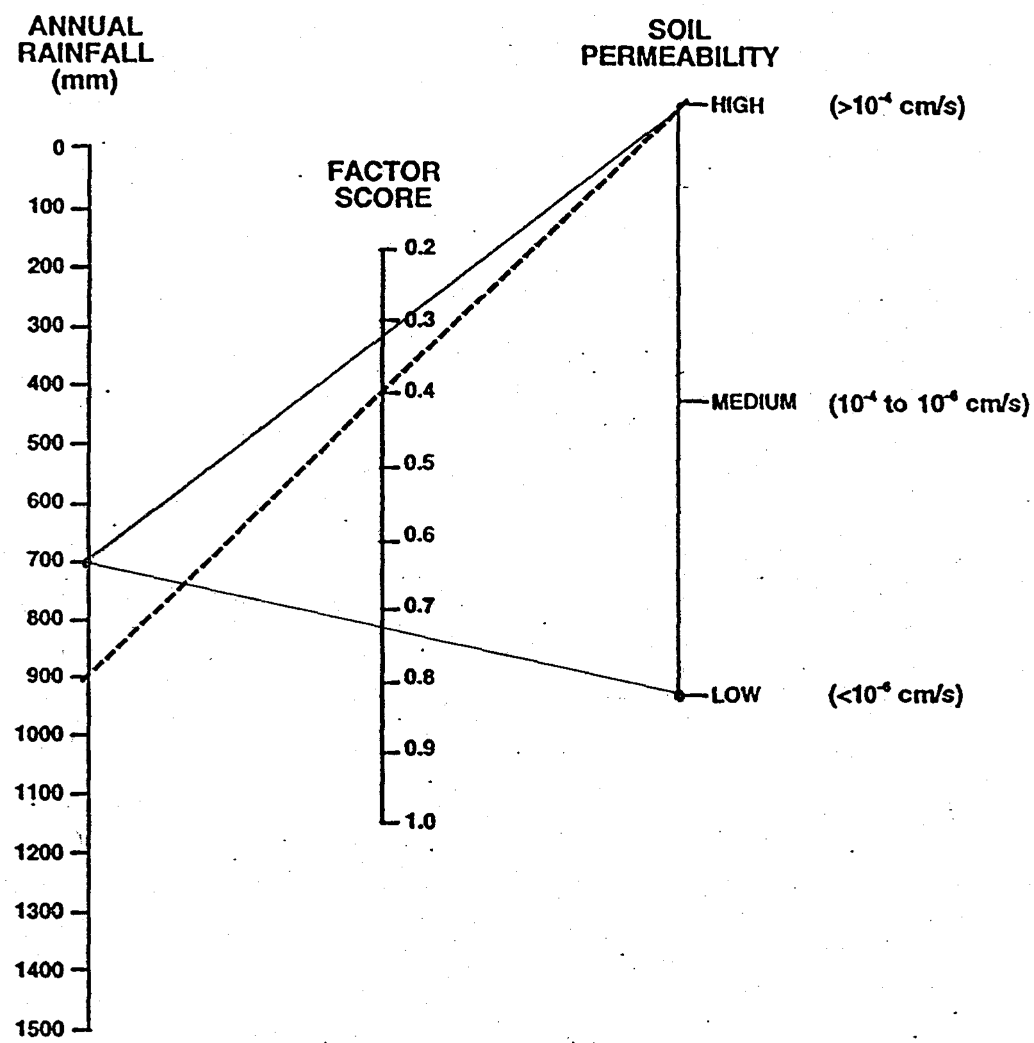
33

RANGE OF VALUES OF HYDRAULIC CONDUCTIVITY AND PERMEABILITY



MODIFIED FROM FREEZE AND CHERRY, 1979 AND TODD, 1959

RUN-OFF POTENTIAL NOMOGRAPH
(FACTOR II B 2 d)



To determine the factor score, use a ruler and join the annual rainfall value (mm) with the soil permeability data; take the factor score from the middle line.

For example, if rainfall is 900 mm and soil permeability is high, the score would be 0.4.

Compounds	Abbreviations	Solubility	T	Vapour pressure	T	Degradation	Degradation constants (mu)			Kd	Toxicity	'EPA drinking water standard"	MEF water quality criteria	Drinkability standard	Danger criteria (Daniels)	Danger criteria (Rouisse)	References
							Sand	Silt	Clay								
Units		(mg/L)	(C)	(atm)	(C)		(/hr)	(/hr)	(/hr)	(L/kg)		(mg/L)	(mg/L)	(ppb-ug/L)	(mg/K)	(mg/Kg)	
2,4,6 trinitrotoluene	2,4,6 TNT	150	25	7,25E-09	25	Mostly anaerobic					Possibly toxic	0,02					(1)
		130	20	1,45E-09	20									1	0,3	0,024	(2)
		150	25	9,49E-09	25												(3)
		130	20	4,61E-09	20												(3)
				1,66E-09	20												(4)
							3,20E-03	1,40E-01	8,30E-02								(5)
										Ottawa sand: 1,5							(6)
										Silt: 4,5							(6)
										Clay: 10							(6)
													0,12*				(7)
2,4 dinitrotoluene	2,4 DNT	280	25	2,86E-07	25	Aerobic and anaerobic					Possibly carconogenous						(1)
		270	22	2,89E-07	20									5			(2)
				3,17E-08	25												(3)
		270	20	1,61E-08	20												(3)
													1,10E-04				(7)
2,6 dinitrotoluene	2,6 DNT	208	25	7,46E-07	25	Aerobic and anaerobic											(1)
		206	25	7,46E-07	20									5			(2)
													0,93*				(7)
cyclo - 1,3,5 - triméthylene - 2,4,6 - trinitramine	RDX	45	25	5,30E-12	25	Anaerobique					Possibly carconogenous	0,1					(1)
		42	20	5,53E-12	20									2	0,3	0,00024	(2)
(or hexahydro - 1,3,5 - trinitro - 1,3,5 - triazine, or		50	20	2,56E-12	20												(3)
							0	6,50E-03	1,40E-02								(5)
										0,1 à 13,26							(6)
cyclo - 1,3,5,7 - tetramethylene - 2,4,6,8 - tetranitramine	HMX	5	25	4,38E-17	25	Anaerobique						nd		400	1,7	2,2	(1)
(or octahydro - 1,3,5,7 - tetranitro - 1,3,5,7 - tetrazocine)		5	25	4,34E-17	20												(2)
										0,2 à 4,2							(6)
							0	3,60E-03	3,20E-02								(5)

(1) McGrath, 1995
(2) Thiboutot *et al*, 1998
(3) Pheelan and Webb, 1997
(4) Hayes, 1992
(5) Myers *et al*, 1996
(6) Townsend *et al*, 1996
(7) http://www.mef.gouv.qc.ca/fr/environn/criteres_eau

* Provisory criteria for aquatic life (surface water)

Conversion table for pressure units

	atm	mm Hg	torr	kPa	bar
1 atm =	1	760	760	101,3	1,013250274
1 mm Hg =	0,00131579	1	1	0,13328947	0,001333224
1 torr =	0,00131579	1	1	0,13328947	0,001333224
1 kPa =	0,00987167	7,50246792	7,50246792	1	0,010002471
1 bar =	0,986923	750,06148	750,06148	99,9752999	1

Site classification computerised worksheet

Site: Impact Areas N, 2, 3, 4, 5 and 6 Date: 06-27-2000 User (s): Marc-André Lavigne

	Sections	Score for potential impacts	known and/or potential impacts		?	Comments
	CONTAMINANT(S) CHARACTERISTICS					
A)	DEGREE OF HAZARD	11	11	/14	0	Energetic materials found in ordnances.
B)	CONTAMINANT QUANTITY	10	10	/10	0	All areas: 77,99877 km², no register before 1995
C)	PHYSICAL STATE OF CONTAMINANTS	3	3	/9	0	Energetic materials.
	Special considerations	0	0	/6		
	TOTAL	24	24	/33	0	N.B.: If the total is < 0 or > 33, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e. between 0 and 33).
	EXPOSURE PATHWAYS					
A)	GROUNDWATER					
	Known contamination at or beyond property boundary		-100	/11		
	Engineered subsurface containment	4	4	/4	0	No engineered system.
	Thickness of confining layer over aquifer(s) of concern	1,5	1,5	/1,5	0	No confining layer.
	Hydraulic conductivity of the confining layer	1,5	1,5	/1,5	0	No confining layer.
	Annual rainfall	0,7	0,7	/1	0	700 mm between 1950 and 1981.
	Hydraulic conductivity of the aquifer(s) of concern	1,5	1,5	/3	1,5	Ranging from 10E-08 cm/s to 10E02 cm/s.
	Special considerations	1,3	1,3	/4		Solubility: 4/3, Retardation Factor: 0, Biodegradation: not observed
	TOTAL	10,5	10,5	/11	1,5	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e. between 0 and 11).
B)	SURFACE WATER					
	Observed or mesured contamination of water/effluent discharged from site		-100	/11		
	Surface containment	4	4	/5	0	No surface containment.
	Distance to perennial surface water	3	3	/3	0	Petawawa River, Barron River, Montgomery Lake, etc.
	Topography	1,2	1,2	/1,5	0	Mostly flat with some hills, contaminants are at or below ground level.
	Run-off potential (see nomograph)	0,52	0,52	/1	0	Average value.
	Flood potential	0,25	0,25	/0,5	0,25	No flood in the last 50 years but local floods might occur.
	Special considerations	2,0	2,0	/4		Solubility: 2
	TOTAL	11,0	11,0	/11	0,3	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e. between 0 and 11).
C)	DIRECT CONTACT					
	Known contamination of media off-site		-100	/11		
	Airborne emissions (gases, vapour, dust, etc.)	2,5	2,5	/5	2,5	Possible but unknown.
	Accessibility of site (ability to contact materials)	3	3	/4	0	Moderate access by boat, contaminants not totally covered.
	Hazardous soil gas migration	0	0	/2	0	No putrescible contaminants.
	Special considerations	-1,3	-1,3	/4		Vapor pressure: -2, powderiness: 2/3
	TOTAL	4,2	4,2	/11	2,5	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e. between 0 and 11).
	RECEPTORS					
A)	HUMANS AND ANIMALS					
	Known adverse impact on living things as a result of the contaminated site		-100	/18		
	Known impact on drinking water supply		-100	/9		
	Proximity to drinking water supply	4	4	/6	0	Houses south of area 3 <1km south and intake of water plant 3 km east.
	"Availability" of alternate drinking water supply	1,5	1,5	/3	1,5	Unknown but possible.
	Known impact on used water resource		-100	/4		
	Proximity to water resources used for activities	1	1	/2	0	Petawawa River between areas 3, 4, 5 and 6.
	Use of water resources	2	2	/2	0	Boating, fishing and swimming.
	Known contamination of land used by humans		-100	/5		
	Use of land at and surrounding site	4,5	4,5	/5	0	Military exercises, residential uses.
	Special considerations	0,0	0,0	/5		People affected lower than 250, military people.
	TOTAL	13,0	13,0	/18	1,5	N.B.: If the total is < 0 or > 18, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e. between 0 and 18).
B)	ENVIRONMENT					
	Known adverse impact on sensitive environment as a result of the contaminated site		-100	/16		
	Distance from site to nearest sensitive environment	10	10	/10	0	Some marshes within areas 2, 4, 5 and 6.
	Distance to important or susceptible groundwater resource(s)	6	6	/6	0	Hills within areas, outcrops: recharge areas, watercourses: discharge areas.
	Special considerations	0	0	/5		
	TOTAL	16	16	/16	0	N.B.: If the total is < 0 or > 16, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e. between 0 and 16).

Total score (potential impacts)	76,7	+	2,0	/100	+/-	5,8
Total score (known impacts or potential impacts if the former is not known)	76,7	+	2,0	/100	+/-	5,8

N.B. : If the uncertainty exceeds 15, we consider that there if insufficient information to assign a significant score and the site is therefore classified in class I (for insufficient information).

Score	Class	Risk potential	Action required
70-100	1	High	Yes
50-69	2	Medium	Likely
38-49	3	Medium low	May be
<=37	N	Low	Not likely

N.B. : The number "-100" has been used as default when no information was available about the contamination of the site. This value (-100) was chosen to avoid any confusion with possible scores.

Site classification computerised worksheet

Site: DZ Anzio Area 1 Date: 06-27-2000 User (s): Marc-André Lavigne

	Sections	Score for potential impacts	Known and/or potential impacts		?	Comments
	CONTAMINANT(S) CHARACTERISTICS					
A)	DEGREE OF HAZARD	11	11	/14	0	Energetic materials found in ordnances.
B)	CONTAMINANT QUANTITY	10	10	/10	0	Area = 5.44656 km², no register before 1995
C)	PHYSICAL STATE OF CONTAMINANTS	3	3	/9	0	Energetic materials.
	Special considerations	0	0	/6		
	TOTAL	24	24	/33	0	N.B.: If the total is < 0 or > 33, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 33)
	EXPOSURE PATHWAYS					
A)	GROUNDWATER					
	Known contamination at or beyond property boundary		-100	/11		
	Engineered subsurface containment	4	4	/4	0	No engineered system.
	Thickness of confining layer over aquifer(s) of concern	1.5	1.5	/1,5	0	No confining layer.
	Hydraulic conductivity of the confining layer	1.5	1.5	/1,5	0	No confining layer.
	Annual rainfall	0.7	0.7	/1	0	700 mm between 1950 and 1981.
	Hydraulic conductivity of the aquifer(s) of concern	1.5	1.5	/3	0	Fine sand: from 10E-02 cm/s to 10E-04 cm/s.
	Special considerations	0.8	0.8	/4		Solubility: 4/3, Retardation Factor: -1/2, Biodegradation: not observed
	TOTAL	10.0	10.0	/11	0.0	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
B)	SURFACE WATER					
	Observed or mesured contamination of water/effluent discharged from site		-100	/11		
	Surface containment	5	5	/5	0	No surface containment.
	Distance to perennial surface water	2	2	/3	0	Tucker Creek approx. 250 m west of the site.
	Topography	1	1	/1,5	0	Mostly flat with some hills, contaminants are at or below ground level.
	Run-off potential (see nomograph)	0.73	0.73	/1	0	
	Flood potential	0.1	0.1	/0,5	0.1	No flood in tha last 50 years.
	Special considerations	2.0	2.0	/4		Solubility: 2
	TOTAL	10.8	10.8	/11	0.1	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
C)	DIRECT CONTACT					
	Known contamination of media off-site		-100	/11		
	Airborne emissions (gases, vapour, dust, etc.)	2.5	2.5	/5	2.5	Possible but unknown.
	Accessibility of site (ability to contact materials)	2	2	/4	0	There is a fence, contaminants not totally covered.
	Hazardous soil gas migration	0	0	/2	0	No putrescible contaminants.
	Special considerations	-1.3	-1.3	/4		Vapor pressure: -2, powderiness: 2/3
	TOTAL	3.2	3.2	/11	2.5	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11)
	RECEPTORS					
A)	HUMANS AND ANIMALS					
	Known adverse impact on living things as a result of the contaminated site		-100	/18		
	Known impact on drinking water supply		-100	/9		
	Proximity to drinking water supply	3	3	/6	0	Water plant southwest of the site.
	"Availability" of alternate drinking water supply	1.5	1.5	/3	1.5	Unknown but possible.
	Known impact on used water resource		-100	/4		
	Proximity to water resources used for activities	0.5	0.5	/2	0	Ottawa River 3 km west.
	Use of water resources	2	2	/2	0	Boating, fishing and swimming.
	Known contamination of land used by humans		-100	/5		
	Use of land at and surrounding site	0	0	/5	0	Military exercises.
	Special considerations	0.0	0.0	/5		People affected lower than 250, military people.
	TOTAL	7.0	7.0	/18	1.5	N.B.: If the total is < 0 or > 18, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 18).
B)	ENVIRONMENT					
	Known adverse impact on sensitive environment as a result of the contaminated site		-100	/16		
	Distance from site to nearest sensitive environment	10	10	/10	0	Some marshes along Tucker Creek.
	Distance to important or susceptible groundwater resource(s)	6	6	/6	0	250m to Tucker Creek.
	Special considerations	0	0	/5		
	TOTAL	16	16	/16	0	N.B.: If the total is < 0 or > 16, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 16)

Total score (potential impacts)	69.5	+	1.5	/100	+/-	4.1
Total score (known impacts or potential impacts if the former is not known)	69.5	+	1.5	/100	+/-	4.1

N.B. : If the uncertainty exceeds 15, we consider that there if insufficient information to assign a significant score and the site is therefore classified in class I (for insufficient information).

Score	Class	Risk potential	Action required
70-100	1	High	Yes
50-69	2	Medium	Likely
38-49	3	Medium low	May be
<=37	N	Low	Not likely

N.B. : The number "-100" has been used as default when no information was available about the contamination of the site. This value (-100) was chosen to avoid any confusion with possible scores.

Appendix C

Facility/Site Description

FACILITY/SITE DESCRIPTION

Document site information as completely as possible:

Site No.: RA 681 Site Name: DZ ANZIO AREA 1 Province/Territory: ONTARIO

Custodian Dept.: DND Facility Name: CFB PETAWAWA Site Operator/Manager: CFB PETAWAWA

Type of Site: IMPACT AREA Site Owner: DND

Zone: ________ UTM Coordinates: ________ Easting ________ Northing

Latitude: ____ deg. ____ min. ____ sec.

Longitude: ____ deg. ____ min. ____ sec.

Location: ________ Legal Land Description: ________

Address ________ Provincial Parcel No.: ________

Brief Description of Site: SANDY AREA, FLAT WITH SOME HILLS

Site Land Use: Current: MILITARY TRAINING Proposed: IDEM

Comments:

Summary of Site Classification Information:

Completed Evaluation Form: X Detailed X Short

Site Score: 71.3 Total ± 4.3 Estimated Score

Class: (1, 2, 3, N, or I) 1 Risk: HIGH

Notes:

12

Contact Name: CHRIS HOGAN / SEAN HOYLES

Position: ________

Address: ________

City: PETAWAWA Prov./Terr.: ONT. Postal Code: ________

Phone No.: ________ Fax No.: ________

Site Classified by above ________ or MARC-ANDRÉ LAVIGNE / KARINE CHAMPAGNE

Degree of Familiarity with Site: ____ Very familiar X Moderately familiar ____ Indirectly familiar ____ Unfamiliar

Visited site: X Yes ____ No

Position: RESEARCH ASSISTANT Phone No.: (418) 654-2647

Address: 880 CHEMIN STE-FOY, BUR 840, CP 7500

City: QUÉBEC Prov./Terr.: QUÉBEC Postal Code: G1V 4C7 Date of Completed Classification: ________

Site Identification: ________

National Classification System Process Checklist

_____ USER'S GUIDE REVIEWED

__✓__ MINIMUM DATA REQUIREMENTS MET

- __✓__ Description of site location
- __✓__ Type of contaminants or materials likely to be present at site (and/or description of historical activities)
- __✓__ Approximate size of site and quantity of contaminants
- _____ Approximate depth to water table
- __✓__ Geologic map or survey information (soil, overburden, and bedrock information)
- __✓__ Annual rainfall data (can be inferred from rainfall map of Canada)
- __✓__ Surface cover information
- __✓__ Proximity to surface water
- __✓__ Topographic information
- _____ Flood potential of site
- _____ Proximity to drinking water supply
- __✓__ Uses of adjacent water resources
- __✓__ Land use information (on-site and surrounding)

__✓__ FACILITY/SITE DESCRIPTION COMPLETED

__✓__ SITE CLASSIFICATION WORKSHEET COMPLETED

__✓__ REFERENCES ATTACHED/CITED

__✓__ EVALUATION FORM COMPLETED

__✓__ Detailed Form __✓__ Short Form

__✓__ SCORE SHEET COMPLETED

__✓__ SITE CLASSIFICATION

Class: __✓__ 1 _____ 2 _____ 3 _____ N _____ I

Score: __71.3__ ± __4.3__
Total Estimated Score

_____ SITE INFORMATION ENTERED ON NCS COMPUTERIZED VERSION

Site Identification: ______________________________

SHORT EVALUATION FORM

Instructions for Use

Answer Yes or No to questions 1 to 5 below. If the response to question 1a) or 1b) is Yes, automatically rate the site as Class 1 (C1). If the answers to any three of questions 2 to 5 are Yes, the site should also be rated as Class 1. For all Yes answers, supporting documentation and rationale must be referenced or attached.

To confirm Class 1 rating and/or if two or more No responses are given, the Detailed Evaluation Form should also be completed.

		No	Yes		Reference Attached
1	a) Is site contamination known to have caused adverse impacts on humans or sensitive environments? (see User's Guide)	☐	☐	→ Class 1	☐
	b) Is the site a fire or explosion hazard as it currently exists?	☐	☐	→ Class 1	☐
I	**Contaminant(s) Characteristics**				
	2 Are contaminants that can be classified as 'high concern' (as defined in the User's Guide) present at the site?	☐	☐		☐
	3 Are the high concern contaminants known to be present in large quantities? Answer yes if contaminant is: • liquid (as disposed/spilled) • in quantity >1,000 m³ • in an area of contamination >10 ha • distributed or placed in such a manner as to have the potential to cause significant off-site contamination	☐	☐		☐
II	**Pathways**				
	4 Is the site known to have caused contamination (above national or applicable provincial/territorial guidelines or policies) of off-site groundwater, adjacent surface water, neighbouring surficial material (i.e., soil) or air? (see User's Guide)	☐	☐		☐
III	**Receptors**				
	5 Is the site contamination known to have a) impacted the quality of local drinking water or other water resources (i.e., exceeds Guidelines for Canadian Drinking Water and/or Canadian Water Quality Guidelines or applicable provincial/territorial guidelines or policies); b) contaminated lands used for agricultural, residential or parkland purposes (i.e., exceeds the AG or R/P values of Canadian Environmental Quality Criteria for Contaminated Sites or applicable provincial/territorial guidelines or policies); or c) caused vegetative stress or other known environmental impairment? (A Yes answer should be given if the impact has made the water, land, environment, or air unacceptable for use.)	☐	☐		☐

If 3 or more Yes answers are given in Sections I, II, and III above, rate site as Class 1. Check box if Class 1 rating. ☐

Site Identification:

Appendix D

User's Guide (even pages) and Site Classification Worksheet (odd pages)

USER'S GUIDE

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
1. Contaminant(s) Characteristics	A. Degree of hazard • High concern contaminants - high concentration • High concern contaminants - low concentration • Medium concern contaminants - high concentration • Medium concern contaminants - low concentration • Low concern contaminants	14 11 8 5 3	In determining the degree of hazard of a waste, it is recognized that a listed hazardous waste is generally of greater concern than a liquid or solid industrial waste. These are in turn of greater concern than other solid wastes. Municipal and organic wastes are considered medium concern contaminants due to their putrescible nature (production of methane and other landfill gases). Household wastes may contain hazardous materials (e.g., batteries, medical wastes, paints, etc).	Determine the level of hazard according to the following table of typical contaminants and definition of high concentrations: High Concern Contaminants • Materials defined as dangerous goods in the Transport of Dangerous Goods Act and Regulations • Materials identified by Province as hazardous waste (pesticides, herbicides, paint sludge, acid and alkaline solutions, solvents, etc.) • Materials regulated by the Canadian Environmental Protection Act (e.g., PCBs) • Institutional waste (lab, schools hospitals, etc.) • Pathological wastes and animal carcasses • Radioactive wastes Medium Concern Contaminants • Liquid waste not referred to in above, petroleum products septic tank pumpings, agricultural and chemical containers • Food processing wastes • Non-hazardous incinerator residues • Municipal solid (household) wastes • Organic and vegetable wastes • Mining residues Low Concern Contaminants • Industrial and commercial solid wastes, (e.g., construction materials such as wood, metal, hay, sand/silt piles, etc.) • Other nearly inert wastes (e.g., foundry sands) High Concentration of Contaminants • contaminant concentrations in soil, groundwater or surface water exceed Canadian Environmental Quality Criteria for Contaminated Sites (>2x commercial/industrial level); or material that was deposited in highly concentrated form (e.g., >5000 ppm)	Transport of Dangerous Goods Act; Provincial/Territorial Hazardous Wastes lists; regulations under Canadian Environmental Protection Act; Canadian Environmental Quality Criteria for Contaminated Sites; etc.
	B. Contaminant Quantity (area/volume of site contamination) • >10 ha, or >1000 m^3, or drums of liquid • 2 to 10 ha, or 100 to 1000 m^3 • <2 ha, or <100 m^3	10 6 2	Little information is known about the quantity of wastes at abandoned sites in Canada. Therefore, waste quantity estimates may be interpreted from area or quantity information.	Measure or estimate the area or quantity of potential contamination. Note: Any number of drums abandoned or disposed is considered a high concern.	
	C. Physical State of Contaminants • Liquid/gas • Sludge • Solid	9 7 3	Contaminants in liquid form are more mobile in the ground and water than solids. However, certain water-soluble solid wastes are more mobile than viscous liquids, and these should be evaluated on a case-by-case basis.	Determine the state of the contaminant when it was disposed or deposited.	
	Special Considerations	-6 to +6	(See 3.7.3 in text)	Technical judgment.	

SITE CLASSIFICATION WORKSHEET

(Instructions: Document site information, assign score, provide rationale behind score and indicate source of information in the spaces provided.)

I. CONTAMINANT(S) CHARACTERISTICS

SCORE

A. • **Degree of Hazard**

List possible contaminants and estimated concentrations: ENERGETIC MATERIALS FOUND IN AMMUNITION (TNT, RDX, HMX)
POSSIBILITY OF CONTAMINATION BY HEAVY METAL

Scoring Rationale & Information Source: ______ 11

B. • **Contaminant Quantity**

Estimated or measured areal volume of contaminated zone: NO RECORD OF UXO AND ORDNANCE FIRED BEFORE 1995
AREA = 5.44656 Km^2
CONTAMINATION ESTIMATED WITH THE AREA OF THE SITE

Scoring Rationale & Information Source: ______ 10

C. • **Physical State of Contaminant**

Does the site contain:
a) Predominantly liquids/gases ______
b) Primarily sludges ______
c) Primarily solids TNT, RDX, HMX

Scoring Rationale & Information Source: ______ 3

• **Special Considerations**

Document any other important contaminant characteristics not addressed above: ______

Scoring Rationale & Information Source: ______ –

Site Identification: ______

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways	A. Groundwater 1. Known contamination at or beyond property boundary • Groundwater significantly exceeds Canadian Drinking Water Guidelines (CDWG) by >2x or known contact of contaminants with groundwater • Between 1 and 2x CDWG or probable contact with groundwater • Meets Canadian Drinking Water Guidelines	 11 6 0	The legislative basis for most jurisdictions is to prevent off-site migration of contamination.	Review chemical data and evaluate groundwater quality. If contamination at or beyond the property boundary exceeds Canadian Drinking Water Guidelines (CDWG) or applicable provincial/territorial guidelines or policies, or if contaminants are known to be in contact with groundwater, then evaluate the site as high.	Canadian Water Quality Guidelines; Provincial/ Territorial Water Quality Guidelines or policies; Guidelines for Canadian Drinking Water Quality.
	2. Potential for groundwater contamination (a) Engineered subsurface containment • No containment • Partial containment • Full containment	 4 2 0	Well contained sites have minimal potential for pollution. Potential for pollution decreases with increasing containment.	Review the existing engineered systems and relate these structures to hydrogeology of the site and determine if full containment is achieved. Full containment is defined as an engineered system, monitored as being effective, which provides for the capture and treatment of contaminants. If there is no system, this factor is evaluated high. If there is less than full containment or if uncertain then evaluate as medium. Typical engineered systems include leachate collection systems and low permeability liners.	
	(b) Thickness of confining layer over aquifer(s) of concern • 3 m or less • 3 to 10 m • >10 m	 1.5 1 0	The thickness of a confining layer (e.g., clay, shale, etc.) between contaminants and any aquifers of concern will affect the attenuation of contaminants and hence the quantity and quality of contaminants reaching the aquifers.	Measure or estimate thickness of any confining layer (e.g., clay, shale, etc.) over all aquifers of concern from existing well records or from a general knowledge of local conditions. If possible, an estimate of the continuity of the confining layer should be made from borehole well record information. Note: an aquifer is defined as a geologic material that will yield groundwater in usable quantities.	Historical geologic maps, well records, government hydrogeologist or local consultants.
	(c) Hydraulic conductivity of the confining layer • $>10^{-4}$ cm/sec • 10^{-4} to 10^{-6} cm/sec • $<10^{-6}$ cm/sec	 1.5 1 0.5	The rate at which contaminants migrate through the confining layer will affect attenuation and the contaminant loading to the aquifers.	Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Apppendix D). Clays, granite, shales should be scored low. Silts etc. should be scored medium. Sand, gravel, and limestone should be scored high.	Freeze and Cherry, 1979, and other groundwater texts.

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS **SCORE**

A. Groundwater

1. • Known Groundwater Contamination

Document information on known groundwater contamination: NO RECORD

Scoring Rationale & Information Source: —

2.a • Engineered Subsurface Containment

Document engineered systems protecting groundwater: NO ENGINEERED SYSTEM

Scoring Rationale & Information Source: 4

2.b • Thickness of Confining Layer Over Aquifer(s) of Concern

Document local geological conditions: BEDROCK (LIMESTONE, DOLOSTONE, SHALE, SANDSTONE, MINOR DRIFT COVER) OVERLAIN BY FINE SAND

Identify water-bearing zones used for water supply: NO CONFINING LAYER

Scoring Rationale & Information Source: 1.5

2.c • Hydraulic Conductivity of the Confining Layer

Estimate hydraulic conductivity of any confining layer: NO CONFINING LAYER

Scoring Rationale & Information Source: 1.5

Site Identification: ______

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	A.2. (d) Annual Rainfall • >1000 mm • 600 mm • 400 mm • 200 mm	 1 0.7 0.6 0.4 0.2	The quantity of rainfall affects the quantity of leachate produced. Higher leachate quantities have a higher impact on the environment.	Refer to Environment Canada rainfall records for relevant areas. Use 30-year average rainfall for evaluation purposes. Divide rainfall by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score)	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	(e) Hydraulic conductivity of aquifer(s) of concern • >10^{-2} cm/sec • 10^{-2}-10^{-4} cm/sec • <10^{-4} cm/sec	 3 1.5 0.5	Aquifers with high hydraulic conductivity can transport contaminants at high velocity over great distances, e.g., solution limestones, highly fractured rocks or gravel deposits.	Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Appendix D).	Freeze and Cherry, 1979.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) :			
Solubility (S) : • low (S/standard ≈ 10^1) • medium (S/standard ≈ 10^2) • high (S/standard ≈ 10^3)	 -4/3* 0 4/3*	* The weighting suggested is valid if there are no points affected to other special considerations.	
Retardation factor (R) : • important delay (R / R_{Cl} ≈ 10^2) or (K_d ≈ 12,51) • delayed (R / R_{Cl} ≈ 10^1) or (K_d ≈ 1,14) • little or no delay (R / R_{Cl} ≈ 10^0) or (K_d ≈ 0)	 -4/3* 0 4/3*	N.B. : the R calculation was done using n = 0,33 et ρ_b = 1,75 g/cm^3 ; if the studied soil is neither sand, silt or clay, the R factor must be recalculated because n et ρ_b change. (R_{Cl} ≈ 1)	
Biodegradation (µ) : • observed • non observed • non biodegradable	 -4/3* 0 4/3*		
Other special considerations	(-4 à 4)	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	

II. EXPOSURE PATHWAYS (cont'd) SCORE

A. Groundwater (cont'd)

2.d • **Annual Rainfall**

Document rainfall data: BETWEEN 1950 AND 1981 ≃ 700 mm

Scoring Rationale & Information Source: CLIMATIC ATLAS - CANADA 0.7

2.e • **Hydraulic Conductivity of Aquifer(s) of Concern**

Estimate hydraulic conductivity of relevant aquifer(s): HYDRAULIC CONDUCTIVITY OF FINE SAND VARIES FROM 1×10^{-2} TO 1×10^{-4}

Scoring Rationale & Information Source: 1.5

3. • **Special Considerations**

Document any other important ground water issues not addressed above: SOLUBILITY (S/STANDARD = 130/0.12) => 4/3
RETARDATION FACTOR => -1/2 Kd ≤ 4.5
BIODEGRADATION (NON OBSERVED) => 0

Scoring Rationale & Information Source: ARBITRARY VALUE FOR RETARDATION FACTOR 5/6

Site Identification: ____

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	B. Surface Water 1. Observed or measured contamination of water/effluent discharged from site • Known or strongly suspected to exceed Canadian Water Quality Guidelines (CWQG) by >2x • Known or strongly suspected to be between 1 - 2x CWQG • Meets Canadian Water Quality Guidelines	 11 6 0	The legislative basis in all jurisdictions is not to contaminate surface water beyond established limits.	Collect all available information on quality of surface water near to site. Evaluate available data against Canadian Water Quality Guidelines (select appropriate guidelines based on local water use, e.g., recreational, irrigation, freshwater aquatic life, etc.) and relevant provincial/territorial water quality objectives.	CCME Canadian Water Quality Guidelines; Relevant provincial /territorial and federal legislation and regulations.
	2. Potential for surface water contamination a) Surface Containment • No containment • Partial containment • Full containment	 6 3 0.5	The level and type of engineered containment will affect the potential for contaminants to be released to surface water.	Review the existing engineered systems and relate these structures to site conditions and proximity to surface water and determine if full containment is achieved; e.g., evaluate low if there is full containment such as capping, berms, dikes; evaluate medium if there is partial containment such as natural barriers, trees, ditches, sedimentation ponds; evaluate high if there are no intervening barriers between the site and nearby surface water.	Site inspection reports, air photos, etc.
	b) Distance to perennial surface water • 0 to <100 m • 100 to 300 m • >300 m	 3 2 0.5	The distance to surface water will affect the probability of contaminants reaching the watercourse. The Ontario Ministry of the Environment has established a classification for immediate impact zone at 50 m. For conservatism, this zone has been broadened to 100 m.	Review available mapping and survey data to determine distance to nearest surface water bodies.	
	c) Topography • Contaminants above ground level and slope is steep • Contaminants at or below ground level and slope is steep • Contaminants above ground level and slope is flat • Contaminants at or below ground level and slope is flat	 1.5 1.2 1 0.8 0	Water can run off (and therefore potentially contaminate surface water) with greater ease from elevated sites on slopes.	Review engineering documents on the topography of the site and the slope of surrounding terrain. • steep slope = >50% • flat slope = <5% Note: Type of fill placement (e.g., trench, above ground, etc.)	

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS (cont'd)

SCORE

B. Surface Water

1. • Observed or Measured Contamination

Document information on surface water contamination: NO RECORD

Scoring Rationale & Information Source: —

2.a • Surface Containment

Review and document engineered or natural systems protecting surface water: NO SURFACE CONTAINMENT

21

Scoring Rationale & Information Source: 5

2.b • Distance to Perennial Surface Water

Estimate distance from site to nearest stream or other water body: TUCKER STREAM 250 M WEST OF THE SITE

Scoring Rationale & Information Source: 2

2.c • Topography

Document terrain conditions: MOSTLY FLAT WITH SOME HILLS

Document position of contaminants (are they above ground or buried?) AT OR BELOW GROUND LEVEL

Scoring Rationale & Information Source: 1

Site Identification: ____________

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	B. 2. d) Run-off potential (see nomograph, end of Appendix D) • >1000 mm rainfall and low permeability surface material • 500 to 1000 mm rainfall and moderately permeable surface material • <500 mm rainfall and highly permeable surface material	 1 0.6 0.2	Run-off transports contaminants into water bodies. Water run-off is a function of precipitation and the rate of infiltration (less permeable soils will allow greater run-off).	Refer to Environment Canada precipitation records for relevant areas. Use 30-year average precipitation for evaluation purposes. Determine factor score using "Run-Off Potential Nomograph" figure at end of Appendix D.	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	e) Flood potential • 1 in 2 years • 1 in 10 years • 1 in 50 years	 0.5 0.3 0.1	The potential for large quantities and concentrations of contaminants to be released to surface water courses over a short period of time will be affected by the flood potential of a water course near the site.	Review published data such as flood plain mapping or flood potential (e.g., spring or mountain run-off) and Conservation Authority records to evaluate flood potential of nearby water courses both up and down gradient. Rate zero if site not in flood plain.	Established flood plain guidelines/ maps; provincial/ territorial soil survey maps.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) : Solubility (S) : • low (S/standard ≈ 10¹) • medium (S/standard ≈ 10²) • high (S/standard ≈ 10³)	 -2* 0 2	* The weighting suggested is valid if there are no points affected to other special considerations.	
Biodegradation (µ) : • observed • non observed • non biodegradable Other special considerations	 -2* 0 2* (-4 à 4)	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	

II. EXPOSURE PATHWAYS (cont'd) **SCORE**

B. Surface Water (cont'd)

2.d • Run-off Potential

Document geological and rainfall conditions: RAINFALLS ≃ 700 mm
PERMEABILITY VARIE FROM 10^{-4} cm/s TO 10^{-2} cm/s

Scoring Rationale & Information Source: SEE P. 35 0.31

2.e • Flood Potential

Estimate flood frequency of nearby water courses or water bodies: NO FLOOD OCCURS IN THE LAST 50 YEARS

Scoring Rationale & Information Source: CHRIS HOGAN 0.25 ?

3. • Special Considerations

Document any other important surface water conditions not addressed above: SOLUBILITY (S/STANDARD > 10^3) => 2
BIODEGRADATION (NON OBSERVED) => 0

Scoring Rationale & Information Source: SEE P. 36 2

Site Identification: ______

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	C. Direct Contact 1. Known contamination of media off-site • Known contamination of soil, sediment or air off-site due to contact with contaminated soil, dust, air, etc. (vector transported should also be considered). • Strongly suspected contamination of media off-site • No contamination of media off-site	 11 6 0	Known or measured contamination off-site is an important consideration for determining impact of contaminants.	Record known or measured contamination of soil, sediment or air on or off-site. Note any presence of soil gas, such as methane, associated with site.	
	2. Potential for direct human and/or animal contact a) Airborne Emissions (gases, vapours, dust, etc.) • Known or suspected airborne emissions impacting on neighbouring properties • Airborne emissions generally restricted to site • No airborne emissions	 5 3 (1.5) 0	If air emissions are evident off-site, there is a great hazard for direct contamination of neighbouring biota and/or resources.	Review available site information to determine if there have been complaints off-site (due to vapours, gas, dust, etc). Reports for these problems are not likely available for most abandoned sites. Review regulatory site inspection reports. If airborne emissions are known to be impacting neighbouring properties and possibly endangering the public, some immediate action (including characterization of emissions) should be initiated to curtail hazardous emissions or otherwise reduce or eliminate exposure.	Site inspection reports, etc.
	b) Accessibility of Site (ability to contact materials) • Limited or no barriers to prevent site access; contaminants not covered • Moderate accessibility or intervening barriers; contaminants are covered • Controlled access or remote location and contaminants are covered	 4 3 (2) 0	The greater the accessibility to a site and to contaminants, the greater the chance for contamination of human and animal life by direct contact.	Review location and engineering of the site and determine if there are intervening barriers between the site and humans or animals. A low rating should be assigned to a (covered) site surrounded by a locked chain link fence or in a remote location, whereas a high score should be assigned to a site that has no cover, fence, natural barriers or buffer.	
	c) Hazardous soil gas migration • Contaminants are putrescible and soil permeability is high • Soil contaminants are putrescible but soil permeability is low and/or groundwater is <2 m from surface • No putrescible contaminants at the site.	 2 1 0	Methane gas migration has been known to cause explosions adjacent to abandoned landfills.	Consider presence of organic material on site, the depth to water table, soil hydraulic conductivity, vegetative stress, odours, etc.	
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	
	3. Special considerations (detailed) : Vapor pressure : • < 0,1 kPa • 0,1 à 0,5 kPa • 0,5 à 1,5 kPa • > 1,5 kPa Powderiness : • < 0,1 % • 0,1 à 1 % • 1 à 10 % • > 10 % Other special considerations	 -2* -2/3* 2/3* 2* -2* -2/3* 2/3* 2* (-4 à 4)	(N.B. : vapor pressure limits are valid at a 20°C temperature) * The weighting suggested is valid if there are no points affected to other special considerations. (i.e. the sample % with a grain size ≤ 45 µm) N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.		

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS (cont'd) **SCORE**

C. Direct Contact

1. • Known Contamination Off-site:

Document reports of off-site contamination due to contact with contaminated soil, dust, air, etc.: NO RECORD

Scoring Rationale & Information Source:

Score: —

2.a • Airborne Emissions

Document incidents or complaints about fumes, gases, dust, odours, etc.: POSSIBLE BUT UNKNOWN

Scoring Rationale & Information Source:

Score: 2.5 ?

2.b • Accessibility of Site

Review and document avenues of site access by humans and animals: THERE A FENCE WHICH RESTRAINS THE ACCESS BUT CONTAMINANTS ARE NOT TOTALLY COVERED

Scoring Rationale & Information Source:

Score: 2

2.c • Hazardous Soil Gas Migration

Review potential for hazardous soil gas production and migration from site: NO PUTRESCIBLE CONTAMINANTS

Scoring Rationale & Information Source:

Score: 0

3. • Special Considerations

Document any other conditions whereby humans/animals could contact contamination: VAPOR PRESSURE : 1.45×10^{-9} atm AT 30°C => -2
POWDERINESS : SOIL IS MOSTLY SAND => 2/3 ?
=> ARBITRARY VALUE

Scoring Rationale & Information Source: SEE P. 36

Score: 4/3 ?

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors	A. Human and Animal Uses 1. Known adverse impact on humans or domestic animals as a result of the contaminated site • Known adverse effect on humans or domestic animals • Strongly suspected adverse effect on humans or domestic animals	 18 15	Contamination from a site that causes a measurable impact on humans is a great concern.	Review and evaluate reports of impact(s) of site contamination (e.g., increased heavy metal levels measured in blood of nearby residents as a result of site contamination). Any site assigned 15 or more points for this factor should automatically be classified as Class 1. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980)	
	2. Potential for impact on humans or animals a) Drinking water supply i) Known impact on drinking water supply Drinking water supply is known to be adversely affected as a result of site contamination • Known contamination of drinking water supply to levels above CDWG • Strongly suspected contamination of drinking water supply • Drinking water supply is known not to be contaminated	 9 7 0	Water used for drinking should be protected against contamination from any site.	Review available site data (inspection reports, assessment documentation) to determine if drinking water (groundwater, surface water, private, commercial or municipal supply) is known or suspected to be contaminated above Guidelines for Canadian Drinking Water Quality or applicable provincial/territorial guidelines or policies. If drinking water supply is known to be contaminated above these guidelines, some immediate action (e.g., provision of alternate drinking water supply) should be initiated to reduce or eliminate exposure.	Guidelines for Canadian Drinking Water Quality; other drinking water guidelines developed by recognized agencies (e.g., other Health and Welfare Canada guidelines, U.S. EPA, etc.).
	ii) Potential for impact on drinking water supply • Proximity to drinking water supply • 0 to <100 m • 100 to <300 m • 300 m to <1 km • 1 to 5 km	 6 5 4 3	The nearer a drinking water well is to a contaminant source, the greater the potential for contamination. Well water used for irrigation/agricultural purposes should also be included as it may be used for human consumption.	Review provincial/territorial base mapping or air photos and measure the distance to the nearest resident or drinking water supply. Judge whether the water is being used as a drinking water source. Commonly rural areas use groundwater for drinking purposes. For urban sites, contact the local Public Utilities Commission to determine water source and location.	
	• "Availability" of alternate drinking water supply • Alternate drinking water supply is not available • Alternate drinking water supply would be difficult to obtain • Alternate drinking water supply available	 3 2 1.5 0.5	This factor takes into account the availability of replacement water supplies, and is used in the technical sense as a factor to indicate the degree of urgency, not as a sociopolitical consideration.	Determine availability of alternate drinking water supply or distance to alternate source.	

SITE CLASSIFICATION WORKSHEET - cont'd

III. RECEPTORS SCORE

A. Human and Animal Uses

1. • Known Adverse Impact on Humans or Domestic Animals

Record known or suspected adverse effects on humans or domestic animals: NO RECORD

Scoring Rationale & Information Source: —

2.a.i • Known Contamination of Drinking Water Supply

Record known or suspected incidents of contamination of drinking water: NO RECORD

Scoring Rationale & Information Source: —

2.a.ii.°• Distance to Nearest Drinking Water Supply(s)

Identify nearest drinking water well and measure distance to site: WATER PLANT ≃5 km SOUTHWEST OF THE SITE

Scoring Rationale & Information Source: 3

2.a.ii.°°•Availability of Alternate Drinking Water Supply

Document availabiilty of alternate sources of drinking water and ease of implementation: ANOTHER WATER SUPPLY WOULD BE DIFFICULT TO FIND (CHALK RIVER ?)

Scoring Rationale & Information Source: 1.5 ?

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	A.2. b) Other Water Resources i) Known impact on used water resource Water resource (used for recreational purposes, commercial food preparation, livestock watering, irrigation or other food chain uses) is known to be adversely affected as a result of site contamination		The water used for these purposes (groundwater or surface water) should be protected against contamination.	Review documentation for reported or suspected contamination of water used for recreation or food chain uses, and refer to Canadian Water Quality Guidelines or other relevant guidelines (select appropriate guidelines based on local water use) to determine if supply is considered contaminated.	CCME Canadian Water Quality Guidelines; provincial/territorial water quality guidelines and objectives; etc.
	• Water resource is known to be contaminated above CWQG	4			
	• Water resource is strongly suspected to be contaminated above CWQG	3			
	• Water resource is known not to be contaminated	0			
	ii) Potential for impact on water resources • Proximity to water resources used for activities listed above		The nearer a water resource is to a site, the greater the risk of contamination.	Determine distance from the site to the nearest recreational or food chain used water resource.	
	• 0 to <100 m	2			
	• 100 to <300 m	1.5			
	• 300 m to <1 km	1			
	• 1 to 5 km	0.5			
	• Use of water resources - if multiple uses, give highest score (use following table)	0.2 - 2	Potential for impact due to use of water resource is related to the type and frequency of use. Human uses are of the highest concern.	Assess water users adjacent to the site from maps and directories.	

Water Use	Frequency of Use: Frequent	Frequency of Use: Occasional
Recreational (swimming, fishing)	2	1
Commercial food preparation	1.5	0.8
Livestock watering	1	0.5
Irrigation	1	0.5
Other domestic or food chain uses	0.5	0.3
Not currently used but likely future use	0.5	0.2

SITE CLASSIFICATION WORKSHEET - cont'd

III. RECEPTORS (cont'd) SCORE

A. Human and Animal Uses (cont'd)

2.b.i • Known Impact on Used Water Resource

Record information on water resource that is or is potentially affected by site contamination: NO RECORD

Scoring Rationale & Information Source: —

2.b.ii.°• Proximity of Water Resources to Site

Locate and measure nearest water resource areas to site: OTTAWA RIVER ≃3 KM WEST

Scoring Rationale & Information Source: 0.5

2.b.ii.°°• Water Uses

Record uses of nearby water resources: BOATING
FISHING
SWIMMING

Scoring Rationale & Information Source: 2

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	A. 2. c) Direct human exposure i) Known contamination of land used by humans • Known contamination of land used for agricultural or residential/parkland/school purposes above AG or R/P EQC values • Known contamination of land used for commercial or industrial purposes above C/I EQC values • Land is known not to be contaminated	 5 3.5 0	Hazards associated with soil contamination are directly related to land use.	Review zoning and land use maps for lands adjacent the site. Evaluate levels of soil contamination against Canadian Environmental Quality Criteria (EQC) for Contaminated Sites (AG = agricultural level; R/P = residential/parkland level; C/I = commercial/industrial level). If soil is known to be contaminated above these levels and possibly endangering public health, some immediate action (e.g., fencing the area, limiting public access, etc.) should be initiated to reduce or eliminate the exposure.	CCME Canadian Environmental Quality Criteria for Contaminated Sites.
	ii) Potential human exposure through land use • Use of land at and surrounding site (use following table; give highest score to worst case scenario)	0.5 - 5	Hazards associated with soil contamination are directly related to land use and distance of the used land from the site. Residential and agricultural land uses are of highest concern because humans are situated at these locations for longer periods.	Review zoning and land use maps over the distances indicated. If the proposed future land use is more "sensitive" than the current land use, evaluate this factor assuming the proposed future use is in place (indicate in the worksheet that future land use is the consideration). Agricultural land use is defined as uses of land where the activities are related to the productive capability of the land or facility (e.g., greenhouse) and are agricultural in nature, or activities related to the feeding and housing of animals as livestock. Residential/Parkland land uses are defined as uses of land on which dwelling on a permanent, temporary, or seasonal basis is the activity (residential), as well as uses on which the activities are recreational in nature and require the natural or human designed capability of the land to sustain that activity (parkland). Commercial/Industrial land uses are defined as land on which the activities are related to the buying, selling, or trading of merchandise or services (commercial), as well as land uses which are related to the production, manufacture, or storage of materials (industrial).	
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	

	Distance from Site		
Land Use (current or future)	0 - 300m	300m - 1km	1 - 5km
Residential	5	4.5	3
Agricultural	5	4	2.5
Parkland/School	4	3	1.5
Commercial/Industrial	3	1	0.5

3. Special considerations (detailed) :			
People affected by contamination : • ≤ 250 • 250 à 1000 • > 1000	 0 1,5* 3*	* The weighting suggested is valid if there are no points affected to other special considerations.	
Type of person using the site : • Workers • Adults • Children and seniors	 0 1* 2*	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	
Other special considerations	(-5 à 5)		

III. RECEPTORS (cont'd) SCORE

A. Human and Animal Uses (cont'd)

2.c.i • **Known Contamination of Land Used by Humans**

Record land use type (current or proposed) and level of contamination for land known to be contaminated due to site: NO RECORD

Scoring Rationale & Information Source: —

2.c.ii • **Land Use at and Adjacent to the Site**

Document land uses (current and proposed) for up to 5 km from the site: MILITARY EXERCISES

	N	E	S	W
0 - <300 m	TRAINING AREA	HIGHWAY 17	IMPACT	IMPACT
300 m - <1 km	O	CP RAILROAD	AREA 2	AREA 4
1 km - 5 km				

Scoring Rationale & Information Source: 0

3. • **Special Considerations**

Document any other important human or animal use information, including details of air contamination if known: PEOPLE AFFECTED < 250 => 0

SITE IS USED BY MILITARY PEOPLE

Scoring Rationale & Information Source: 0

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	B. Environment 1. Known adverse impact on a sensitive environment as a result of the contaminated site • Known adverse impact on sensitive environment • Evidence of stress on aquatic species or vegetative stress on trees, crops or plant life located on properties neighbouring the site • Strongly suspected adverse impact on sensitive environment	 16 14 12	The environment should be protected against site contamination. Evidence of impact(s) shows that protection is lacking.	Review records for evidence of vegetative stress or impairment of any nearby sensitive environments. A sensitive environment is defined as a sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980).	
	2. Potential for impact on sensitive environments a) Distance from site to nearest sensitive environment (e.g., sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc.) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km	 10 6 2 0.5	It is considered that within approximately 1 km of the site there is immediate concern for contamination. Therefore, an environmentally sensitive area located within this area of the site will be subject to concern. It is also generally considered that any sensitive area located greater than 10 km from the site will not be impacted.	Review Conservation Authority mapping and literature. Also review Ministry of Natural Resources records and Federal Land Capability maps. Identify provincial/territorial and federal designated environmentally sensitive areas.	Relevant provincial /territorial and federal maps of sensitive environments.
	b) Groundwater - distance to important or susceptible groundwater resource(s) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km	 6 4 2 1	The closer a site is to a discharge or recharge area, the greater the potential for contamination of a groundwater or surface water resource.	Review groundwater contour maps, if available, and other available reports. Otherwise use established hydrogeologic principles.	Local groundwater maps, etc.
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	

III. RECEPTORS (cont'd) SCORE

B. <u>Environment</u>

1. • **Known Adverse Impact(s) on Sensitive Environment**

Record known impact(s) on any sensitive biological environment at and/or around the site: NO RECORD

Scoring Rationale & Information Source: —

2.a • **Distance from Site to Nearest Sensitive Environment**

Document location, distance, type and details of any nearby sensitive environments or habitats: SOME MARSHES ALONG TUCKER CREEK

Scoring Rationale & Information Source: 10

2.b • **Groundwater**

Measure distance to major recharge or discharge area: TUCHER CREEK SEEMS TO BE A DISCHARGE ZONE

Scoring Rationale & Information Source:

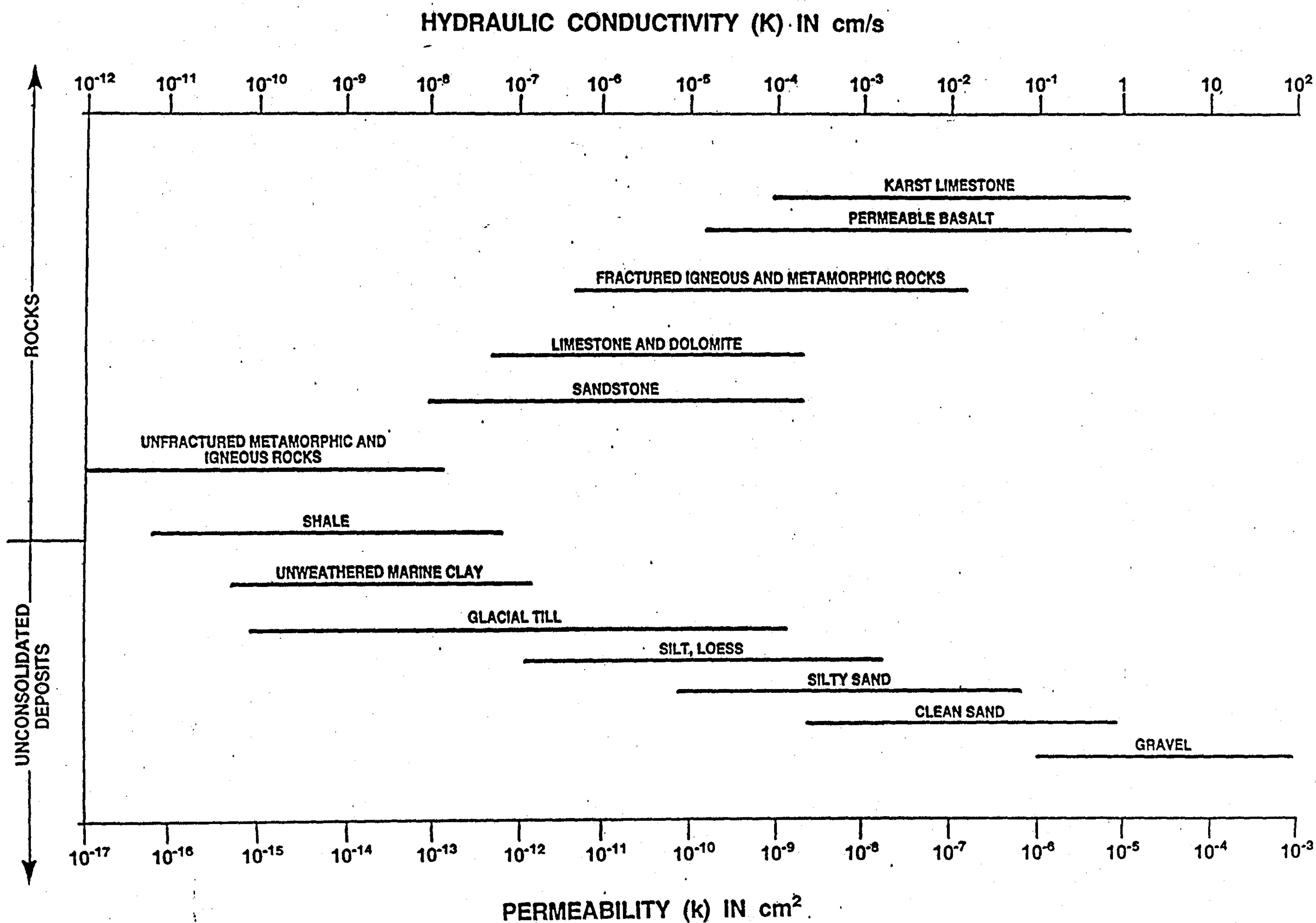
3. • **Special Considerations**

Document any other important impacts on the environment not addressed above:

Scoring Rationale & Information Source: —

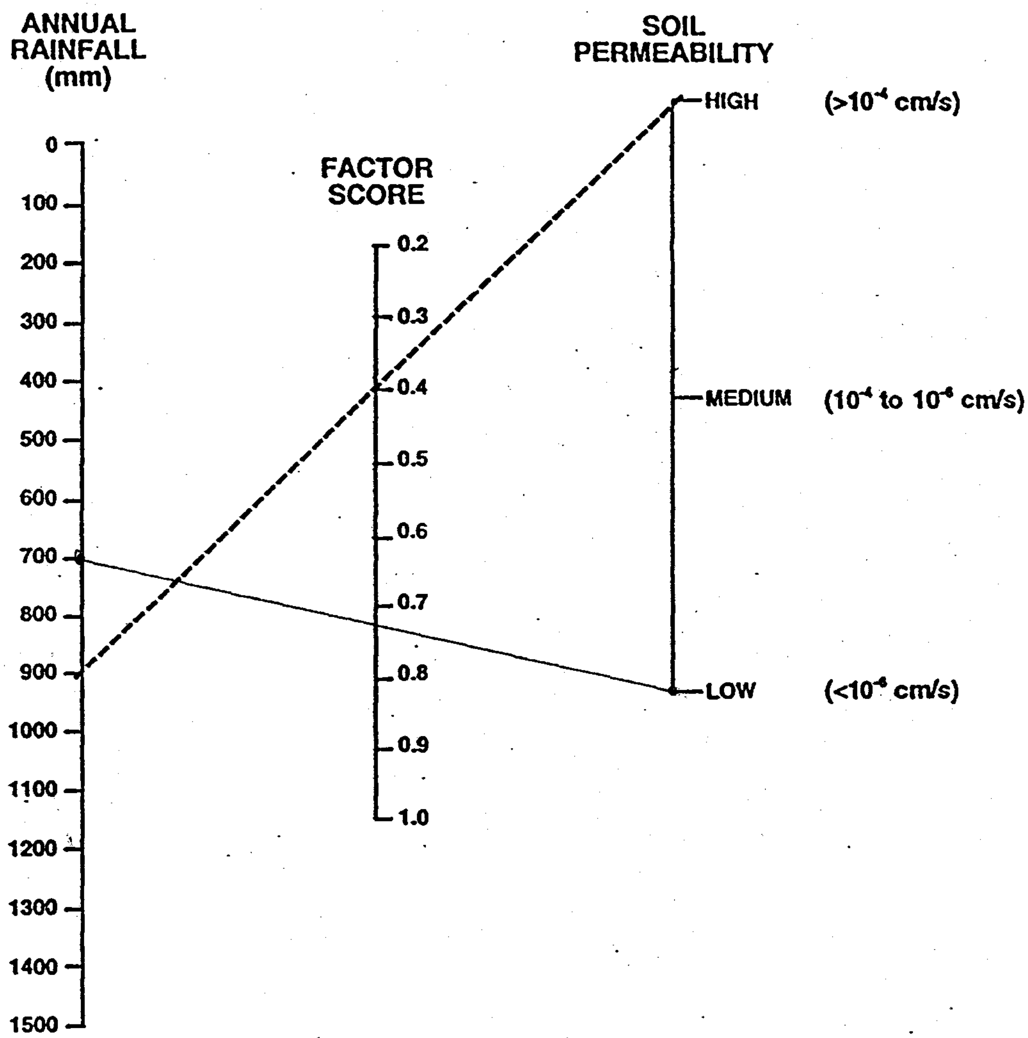
Site Identification:

RANGE OF VALUES OF HYDRAULIC CONDUCTIVITY AND PERMEABILITY



MODIFIED FROM FREEZE AND CHERRY, 1979 AND TODD, 1959

RUN-OFF POTENTIAL NOMOGRAPH
(FACTOR II B 2 d)



To determine the factor score, use a ruler and join the annual rainfall value (mm) with the soil permeability data; take the factor score from the middle line.

For example, if rainfall is 900 mm and soil permeability is high, the score would be 0.4.

Compounds	Abbreviations	Solubility	T	Vapour pressure	T	Degradation	Degradation constants (mu)			Kd	Toxicity	'EPA drinking water standard"	MEF water quality criteria	Drinkability standard	Danger criteria (Daniels)	Danger criteria (Rouisse)	References
							Sand	Silt	Clay								
Units		(mg/L)	(C)	(atm)	(C)		(/hr)	(/hr)	(/hr)	(L/kg)		(mg/L)	(mg/L)	(ppb-ug/L)	(mg/K)	(mg/Kg)	
2,4,6 trinitrotoluene	2,4,6 TNT	150	25	7,25E-09	25	Mostly anaerobic					Possibly toxic	0,02					(1)
		130	20	1,45E-09	20									1	0,3	0,024	(2)
		150	25	9,49E-09	25												(3)
		130	20	4,61E-09	20												(3)
				1,66E-09	20												(4)
							3,20E-03	1,40E-01	8,30E-02								(5)
										Ottawa sand: 1,5							(6)
										Silt: 4,5							(6)
										Clay: 10							(6)
													0,12*				(7)
2,4 dinitrotoluene	2,4 DNT	280	25	2,86E-07	25	Aerobic and anaerobic					Possibly carconogenous						(1)
		270	22	2,89E-07	20									5			(2)
				3,17E-08	25												(3)
		270	20	1,61E-08	20												(3)
													1,10E-04				(7)
2,6 dinitrotoluene	2,6 DNT	208	25	7,46E-07	25	Aerobic and anaerobic											(1)
		206	25	7,46E-07	20									5			(2)
													0,93*				(7)
cyclo - 1,3,5 - triméthylene - 2,4,6 - trinitramine	RDX	45	25	5,30E-12	25	Anaerobique					Possibly carconogenous	0,1					(1)
		42	20	5,53E-12	20									2	0,3	0,00024	(2)
(or hexahydro - 1,3,5 - trinitro - 1,3,5 - triazine, or		50	20	2,56E-12	20												(3)
							0	6,50E-03	1,40E-02								(5)
										0,1 à 13,26							(6)
cyclo - 1,3,5,7 - tetramethylene - 2,4,6,8 - tetranitramine	HMX	5	25	4,38E-17	25	Anaerobique						nd		400	1,7	2,2	(1)
(or octahydro - 1,3,5,7 - tetranitro - 1,3,5,7 - tetrazocine)		5	25	4,34E-17	20												(2)
										0,2 à 4,2							(6)
							0	3,60E-03	3,20E-02								(5)

(1) McGrath, 1995
(2) Thiboutot *et al*, 1998
(3) Pheelan and Webb, 1997
(4) Hayes, 1992
(5) Myers *et al*, 1996
(6) Townsend *et al*, 1996
(7) http://www.mef.gouv.qc.ca/fr/environn/criteres_eau

* Provisory criteria for aquatic life (surface water)

Conversion table for pressure units

	atm	mm Hg	torr	kPa	bar
1 atm =	1	760	760	101,3	1,013250274
1 mm Hg =	0,00131579	1	1	0,13328947	0,001333224
1 torr =	0,00131579	1	1	0,13328947	0,001333224
1 kPa =	0,00987167	7,50246792	7,50246792	1	0,010002471
1 bar =	0,986923	750,06148	750,06148	99,9752999	1

Site classification computerised worksheet

Site: Impact Area A Date: 06-27-2000 User (s): Marc-André Lavigne

	Sections	Score for potential impacts	Known and/or potential impacts		?	Comments
	CONTAMINANT(S) CHARACTERISTICS					
A)	DEGREE OF HAZARD	11	11	/14	0	Energetic materials found in ordnances.
B)	CONTAMINANT QUANTITY	10	10	/10	0	Area = 22.5926 km², no register before 1995
C)	PHYSICAL STATE OF CONTAMINANTS	3	3	/9	0	TNT, RDX, HMX, etc
	Special considerations	0	0	/6		
	TOTAL	24	24	/33	0	N.B.: If the total is < 0 or > 33, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 33).
	EXPOSURE PATHWAYS					
A)	GROUNDWATER					
	Known contamination at or beyond property boundary		-100	/11		
	Engineered subsurface containment	4	4	/4	0	No engineered system.
	Thickness of confining layer over aquifer(s) of concern	1.5	1.5	/1,5	0	No confining layer.
	Hydraulic conductivity of the confining layer	1.5	1.5	/1,5	0	No confining layer.
	Annual rainfall	0.7	0.7	/1	0	700 mm between 1950 and 1981.
	Hydraulic conductivity of the aquifer(s) of concern	1.5	1.5	/3	0	From 10E-01 cm/s to 10E01 cm/s.
	Special considerations	1.3	1.3	/4		Solubility: 4/3, Retardation Factor: -1/2, Biodegradation: not observed
	TOTAL	10.5	10.5	/11	0.0	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
B)	SURFACE WATER					
	Observed or mesured contamination of water/effluent discharged from site		-100	/11		
	Surface containment	3	3	/5	0	Trees surrounding the firing ranges and almost all over the area.
	Distance to perennial surface water	2	2	/3	0	Sturgeon Lake within the area.
	Topography	1	1	/1,5	0	Hills with some flat areas, contaminants at or below ground level.
	Run-off potential (see nomograph)	0.31	0.31	/1	0	
	Flood potential	0.25	0.25	/0,5	0.25	No flood in the last 50 years but Sturgeon Lake increases the possibility.
	Special considerations	2.0	2.0	/4		Solubility: 2
	TOTAL	8.6	8.6	/11	0.3	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
C)	DIRECT CONTACT					
	Known contamination of media off-site		-100	/11		
	Airborne emissions (gases, vapour, dust, etc.)	2.5	2.5	/5	2.5	Possible but unknown.
	Accessibility of site (ability to contact materials)	2	2	/4	0	There is a fence, contaminants not totally covered.
	Hazardous soil gas migration	0	0	/2	0	No putrescible contaminants.
	Special considerations	-1.3	-1.3	/4		Vapor pressure: -2, powderiness: 2/3
	TOTAL	3.2	3.2	/11	2.5	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
	RECEPTORS					
A)	HUMANS AND ANIMALS					
	Known adverse impact on living things as a result of the contaminated site		-100	/18		
	Known impact on drinking water supply		-100	/9		
	Proximity to drinking water supply	3	3	/6	0	Chalk River 2 km west and some cabins 2 km north
	"Availability" of alternate drinking water supply	1.5	1.5	/3	1.5	Unknown but possible.
	Known impact on used water resource		-100	/4		
	Proximity to water resources used for activities	0.5	0.5	/2	0	Sturgeon Lake within the area, Perch Lake, Maskinonge Lake 1 km north.
	Use of water resources	2	2	/2	0	Fishing, swimming ?
	Known contamination of land used by humans		-100	/5		
	Use of land at and surrounding site	0.5	0.5	/5	0	Military exercises.
	Special considerations	0.0	0.0	/5		People affected lower than 250, military people.
	TOTAL	7.5	7.5	/18	1.5	N.B.: If the total is < 0 or > 18, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 18).
B)	ENVIRONMENT					
	Known adverse impact on sensitive environment as a result of the contaminated site		-100	/16		
	Distance from site to nearest sensitive environment	10	10	/10	0	Some marshes in the southern and northeastern part of the area.
	Distance to important or susceptible groundwater resource(s)	6	6	/6	0	Sturgeon Lake is a discharge zone.
	Special considerations	0	0	/5		
	TOTAL	16	16	/16	0	N.B.: If the total is < 0 or > 16, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 16).

Total score (potential impacts)	67.8	+	2.0	/100	+/-	4.3
Total score (known impacts or potential impacts if the former is not known)	67.8	+	2.0	/100	+/-	4.3

N.B. : If the uncertainty exceeds 15, we consider that there if insufficient information to assign a significant score and the site is therefore classified in class I (for insufficient information).

Score	Class	Risk potential	Action required
70-100	1	High	Yes
50-69	2	Medium	Likely
38-49	3	Medium low	May be
<=37	N	Low	Not likely

N.B. : The number "-100" has been used as default when no information was available about the contamination of the site. This value (-100) was chosen to avoid any confusion with possible scores.

Appendix C

Facility/Site Description

FACILITY/SITE DESCRIPTION

Document site information as completely as possible:

Site No.: RA 614 *Site Name:* IMPACT AREA A *Province/Territory:* ONTARIO

Custodian Dept.: DND *Facility Name:* CFB PETAWAWA *Site Operator/Manager:* CFB PETAWAWA

Type of Site: IMPACT AREA *Site Owner:* DND

Zone: ______ *UTM Coordinates:* ________ *Easting* *Latitude:* ____ *deg.* ____ *min.* ____ *sec.*

________ *Northing* *Longitude:* ____ *deg.* ____ *min.* ____ *sec.*

Location: ______ *Legal Land Description:* ______

Address ______ *Provincial Parcel No.:* ______

Brief Description of Site: ______

Site Land Use: *Current:* MILITARY TRAINING *Proposed:* IDEM

Comments:

Summary of Site Classification Information:

Completed Evaluation Form: X *Detailed* X *Short*

Site Score: 69.8 *Total* ± 4.3 *Estimated Score*

Class: (1, 2, 3, N, or I) 2→1 *Risk:* MEDIUM TO HIGH

Notes:

12

Contact Name: CHRIS HOGAN / SEAN MOYLES

Position: ______

Address: ______

City: PETAWAWA *Prov./Terr.:* ONT. *Postal Code:* ______

Phone No.: ______ *Fax No.:* ______

Site Classified by above ______ *or* MARC-ANDRÉ LAVIGNE / KARINE CHAMPAGNE

Degree of Familiarity with Site: ____ *Very familiar* X *Moderately familiar* ____ *Indirectly familiar* ____ *Unfamiliar*

Visited site: X *Yes* ____ *No*

Position: RESEARCH ASSISTANT *Phone No.:* (418) 654-2647

Address: 880 CHEMIN STE FOY, BUR. 840 CP 7500

City: QUEBEC *Prov./Terr.:* QUEBEC *Postal Code:* G1V 4C7 *Date of Completed Classification:* ______

Site Identification: ______

National Classification System Process Checklist

_____ USER'S GUIDE REVIEWED

__x__ MINIMUM DATA REQUIREMENTS MET

- __x__ Description of site location
- __x__ Type of contaminants or materials likely to be present at site (and/or description of historical activities)
- __x__ Approximate size of site and quantity of contaminants
- _____ Approximate depth to water table
- __x__ Geologic map or survey information (soil, overburden, and bedrock information)
- __x__ Annual rainfall data (can be inferred from rainfall map of Canada)
- __x__ Surface cover information
- __x__ Proximity to surface water
- __x__ Topographic information
- _____ Flood potential of site
- _____ Proximity to drinking water supply
- __x__ Uses of adjacent water resources
- __x__ Land use information (on-site and surrounding)

__x__ FACILITY/SITE DESCRIPTION COMPLETED

__x__ SITE CLASSIFICATION WORKSHEET COMPLETED

__x__ REFERENCES ATTACHED/CITED

__x__ EVALUATION FORM COMPLETED

__x__ Detailed Form __x__ Short Form

__x__ SCORE SHEET COMPLETED

__x__ SITE CLASSIFICATION

Class: __x__ 1 __x__ 2 _____ 3 _____ N _____ I

Score: __69.8__ ± __4.3__
Total Estimated Score

_____ SITE INFORMATION ENTERED ON NCS COMPUTERIZED VERSION

Site Identification: ______________________________

SHORT EVALUATION FORM

Instructions for Use

Answer Yes or No to questions 1 to 5 below. If the response to question 1a) or 1b) is Yes, automatically rate the site as Class 1 (C1). If the answers to any three of questions 2 to 5 are Yes, the site should also be rated as Class 1. For all Yes answers, supporting documentation and rationale must be referenced or attached.

To confirm Class 1 rating and/or if two or more No responses are given, the Detailed Evaluation Form should also be completed.

		No	Yes		Reference Attached
1	a) Is site contamination known to have caused adverse impacts on humans or sensitive environments? (see User's Guide)	☒	☐	→ Class 1	☐
	b) Is the site a fire or explosion hazard as it currently exists?	☒	☐	→ Class 1	☐
I	**Contaminant(s) Characteristics**				
	2 Are contaminants that can be classified as 'high concern' (as defined in the User's Guide) present at the site?	☐	☒		☐
	3 Are the high concern contaminants known to be present in large quantities? Answer yes if contaminant is: • liquid (as disposed/spilled) • in quantity >1,000 m³ • in an area of contamination >10 ha • distributed or placed in such a manner as to have the potential to cause significant off-site contamination	☐	☒		☐
II	**Pathways**				
	4 Is the site known to have caused contamination (above national or applicable provincial/territorial guidelines or policies) of off-site groundwater, adjacent surface water, neighbouring surficial material (i.e., soil) or air? (see User's Guide)	☒	☐		☐
III	**Receptors**				
	5 Is the site contamination known to have a) impacted the quality of local drinking water or other water resources (i.e., exceeds Guidelines for Canadian Drinking Water and/or Canadian Water Quality Guidelines or applicable provincial/territorial guidelines or policies); b) contaminated lands used for agricultural, residential or parkland purposes (i.e., exceeds the AG or R/P values of Canadian Environmental Quality Criteria for Contaminated Sites or applicable provincial/territorial guidelines or policies); or c) caused vegetative stress or other known environmental impairment? (A Yes answer should be given if the impact has made the water, land, environment, or air unacceptable for use.)	☒	☐		☐

If 3 or more Yes answers are given in Sections I, II, and III above, rate site as Class 1. Check box if Class 1 rating. ☐

Site Identification:

Appendix D

User's Guide (even pages) and Site Classification Worksheet (odd pages)

USER'S GUIDE

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
I. Contaminant(s) Characteristics	A. Degree of hazard • High concern contaminants - high concentration • High concern contaminants - low concentration • Medium concern contaminants - high concentration • Medium concern contaminants - low concentration • Low concern contaminants	14 11 8 5 3	In determining the degree of hazard of a waste, it is recognized that a listed hazardous waste is generally of greater concern than a liquid or solid industrial waste. These are in turn of greater concern than other solid wastes. Municipal and organic wastes are considered medium concern contaminants due to their putrescible nature (production of methane and other landfill gases). Household wastes may contain hazardous materials (e.g., batteries, medical wastes, paints, etc).	Determine the level of hazard according to the following table of typical contaminants and definition of high concentrations: <u>High Concern Contaminants</u> • Materials defined as dangerous goods in the Transport of Dangerous Goods Act and Regulations • Materials identified by Province as hazardous waste (pesticides, herbicides, paint sludge, acid and alkaline solutions, solvents, etc.) • Materials regulated by the Canadian Environmental Protection Act (e.g., PCBs) • Institutional waste (lab, schools hospitals, etc.) • Pathological wastes and animal carcasses • Radioactive wastes <u>Medium Concern Contaminants</u> • Liquid waste not referred to in above, petroleum products septic tank pumpings, agricultural and chemical containers • Food processing wastes • Non-hazardous incinerator residues • Municipal solid (household) wastes • Organic and vegetable wastes • Mining residues <u>Low Concern Contaminants</u> • Industrial and commercial solid wastes, (e.g., construction materials such as wood, metal, hay, sand/silt piles, etc.) • Other nearly inert wastes (e.g., foundry sands) <u>High Concentration of Contaminants</u> • contaminant concentrations in soil, groundwater or surface water exceed Canadian Environmental Quality Criteria for Contaminated Sites (>2x commercial/ industrial level); or material that was deposited in highly concentrated form (e.g., >5000 ppm)	Transport of Dangerous Goods Act; Provincial/ Territorial Hazardous Wastes lists; regulations under Canadian Environmental Protection Act; Canadian Environmental Quality Criteria for Contaminated Sites; etc.
	B. Contaminant Quantity (area/volume of site contamination) • >10 ha, or >1000 m^3, or drums of liquid • 2 to 10 ha, or 100 to 1000 m^3 • <2 ha, or <100 m^3	10 6 2	Little information is known about the quantity of wastes at abandoned sites in Canada. Therefore, waste quantity estimates may be interpreted from area or quantity information.	Measure or estimate the area or quantity of potential contamination. Note: Any number of drums abandoned or disposed is considered a high concern.	
	C. Physical State of Contaminants • Liquid/gas • Sludge • Solid	9 7 3	Contaminants in liquid form are more mobile in the ground and water than solids. However, certain water-soluble solid wastes are more mobile than viscous liquids, and these should be evaluated on a case-by-case basis.	Determine the state of the contaminant when it was disposed or deposited.	
	Special Considerations	-6 to +6	(See 3.7.3 in text)	Technical judgment.	

SITE CLASSIFICATION WORKSHEET

(Instructions: Document site information, assign score, provide rationale behind score and indicate source of information in the spaces provided.)

I. CONTAMINANT(S) CHARACTERISTICS

SCORE

A. • Degree of Hazard

List possible contaminants and estimated concentrations: ENERGETIC MATERIALS FOUND IN AMMUNITION (TNT, RDX HMX)
POSSIBILITY OF HEAVY METAL CONTAMINATION

Scoring Rationale & Information Source: 11

B. • Contaminant Quantity

Estimated or measured areal volume of contaminated zone: NO REGISTER OF UNEXPLODED SHELLS OR AMMUNITION FIRED BEFORE 1995
AREA ≃ 22.59 km²
QUANTITY ESTIMATED WITH THE AREA OF THE RANGE

Scoring Rationale & Information Source: 10

C. • Physical State of Contaminant

Does the site contain:
a) Predominantly liquids/gases
b) Primarily sludges
c) Primarily solids TNT, RDX, HMX (ENERGETIC MATERIALS)

Scoring Rationale & Information Source: 3

• Special Considerations

Document any other important contaminant characteristics not addressed above:

Scoring Rationale & Information Source: –

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways	A. Groundwater 1. Known contamination at or beyond property boundary • Groundwater significantly exceeds Canadian Drinking Water Guidelines (CDWG) by >2x or known contact of contaminants with groundwater • Between 1 and 2x CDWG or probable contact with groundwater • Meets Canadian Drinking Water Guidelines	 11 6 0	The legislative basis for most jurisdictions is to prevent off-site migration of contamination.	Review chemical data and evaluate groundwater quality. If contamination at or beyond the property boundary exceeds Canadian Drinking Water Guidelines (CDWG) or applicable provincial/territorial guidelines or policies, or if contaminants are known to be in contact with groundwater, then evaluate the site as high.	Canadian Water Quality Guidelines; Provincial/ Territorial Water Quality Guidelines or policies; Guidelines for Canadian Drinking Water Quality.
	2. Potential for groundwater contamination (a) Engineered subsurface containment • No containment • Partial containment • Full containment	 4 2 0	Well contained sites have minimal potential for pollution. Potential for pollution decreases with increasing containment.	Review the existing engineered systems and relate these structures to hydrogeology of the site and determine if full containment is achieved. Full containment is defined as an engineered system, monitored as being effective, which provides for the capture and treatment of contaminants. If there is no system, this factor is evaluated high. If there is less than full containment or if uncertain then evaluate as medium. Typical engineered systems include leachate collection systems and low permeability liners.	
	(b) Thickness of confining layer over aquifer(s) of concern • 3 m or less • 3 to 10 m • >10 m	 1.5 1 0	The thickness of a confining layer (e.g., clay, shale, etc.) between contaminants and any aquifers of concern will affect the attenuation of contaminants and hence the quantity and quality of contaminants reaching the aquifers.	Measure or estimate thickness of any confining layer (e.g., clay, shale, etc.) over all aquifers of concern from existing well records or from a general knowledge of local conditions. If possible, an estimate of the continuity of the confining layer should be made from borehole well record information. Note: an aquifer is defined as a geologic material that will yield groundwater in usable quantities.	Historical geologic maps, well records, government hydrogeologist or local consultants.
	(c) Hydraulic conductivity of the confining layer • >10^{-4} cm/sec • 10^{-4} to 10^{-6} cm/sec • <10^{-6} cm/sec	 1.5 1 0.5	The rate at which contaminants migrate through the confining layer will affect attenuation and the contaminant loading to the aquifers.	Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Apppendix D). Clays, granite, shales should be scored low. Silts etc. should be scored medium. Sand, gravel, and limestone should be scored high.	Freeze and Cherry, 1979, and other groundwater texts.

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS

SCORE

A. Groundwater

1. • Known Groundwater Contamination

Document information on known groundwater contamination: NO RECORD

Scoring Rationale & Information Source: ______ [–]

2.a • Engineered Subsurface Containment

Document engineered systems protecting groundwater: NO ENGINEERED SYSTEM

Scoring Rationale & Information Source: ______ [4]

2.b • Thickness of Confining Layer Over Aquifer(s) of Concern

Document local geological conditions: BEDROCK (LIMESTONE, MINOR DOLOSTONE, SHALE, SANDSTONE) OVERLAINED BY THIN AND DISCONTINUOUS DRIFT COVER, GLACIOFLUVIAL OUTWASH

Identify water-bearing zones used for water supply: AND DELTAIC DEPOSITS (GRAVEL, GRAVELLY SAND, SAND, ...) NO CONFINING LAYER

Scoring Rationale & Information Source: ______ [1.5]

2.c • Hydraulic Conductivity of the Confining Layer

Estimate hydraulic conductivity of any confining layer: NO CONFINING LAYER

Scoring Rationale & Information Source: ______ [1.5]

Site Identification: ______

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	A.2. (d) Annual Rainfall • >1000 mm • 600 mm • 400 mm • 200 mm	 1 0.6 0.4 0.2	The quantity of rainfall affects the quantity of leachate produced. Higher leachate quantities have a higher impact on the environment.	Refer to Environment Canada rainfall records for relevant areas. Use 30-year average rainfall for evaluation purposes. Divide rainfall by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score)	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	(e) Hydraulic conductivity of aquifer(s) of concern • $>10^{-2}$ cm/sec • 10^{-2}-10^{-4} cm/sec • $<10^{-4}$ cm/sec	 3 1.5 0.5	Aquifers with high hydraulic conductivity can transport contaminants at high velocity over great distances, e.g., solution limestones, highly fractured rocks or gravel deposits.	Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Appendix D).	Freeze and Cherry, 1979.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) : Solubility (S) : • low (S/standard ≈ 10^1) • medium (S/standard ≈ 10^2) • high (S/standard ≈ 10^3) Retardation factor (R) : • important delay ($R / R_{Cl} \approx 10^2$) or ($K_d \approx 12{,}51$) • delayed ($R / R_{Cl} \approx 10^1$) or ($K_d \approx 1{,}14$) • little or no delay ($R / R_{Cl} \approx 10^0$) or ($K_d \approx 0$) Biodegradation (μ) : • observed • non observed • non biodegradable Other special considerations	 -4/3* 0 4/3* -4/3* 0 4/3* -4/3* 0 4/3* (-4 à 4)	* The weighting suggested is valid if there are no points affected to other special considerations. N.B. : the R calculation was done using $n = 0{,}33$ et $\rho_b = 1{,}75$ g/cm^3 ; if the studied soil is neither sand, silt or clay, the R factor must be recalculated because n et ρ_b change. ($R_{Cl} \approx 1$) N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS (cont'd) — SCORE

A. Groundwater (cont'd)

2.d • Annual Rainfall

Document rainfall data: BETWEEN 1950 AND 1980 ≅ 700 mm

Scoring Rationale & Information Source: CLIMATIC ATLAS - CANADA — 0.7

2.e • Hydraulic Conductivity of Aquifer(s) of Concern

Estimate hydraulic conductivity of relevant aquifer(s): π RANGES FROM 10^{-2} cm/s TO 10^{1} cm/s

Scoring Rationale & Information Source: — 3

3. • Special Considerations

Document any other important ground water issues not addressed above:
SOLUBILITY (S / STANDARD = 130/0.12) => 4/3
RETARDATION FACTOR => -1/2 (Kd ≅ 4.5)
BIODEGRADATION - NON OBSERVED => 0

Scoring Rationale & Information Source: ARBITRARY VALUE FOR RETARDATION FACTOR — 5/6

Site Identification: ____________

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	B. Surface Water 1. Observed or measured contamination of water/effluent discharged from site • Known or strongly suspected to exceed Canadian Water Quality Guidelines (CWQG) by >2x • Known or strongly suspected to be between 1 - 2x CWQG • Meets Canadian Water Quality Guidelines	 11 6 0	The legislative basis in all jurisdictions is not to contaminate surface water beyond established limits.	Collect all available information on quality of surface water near to site. Evaluate available data against Canadian Water Quality Guidelines (select appropriate guidelines based on local water use, e.g., recreational, irrigation, freshwater aquatic life, etc.) and relevant provincial/territorial water quality objectives.	CCME Canadian Water Quality Guidelines; Relevant provincial /territorial and federal legislation and regulations.
	2. Potential for surface water contamination a) Surface Containment • No containment • Partial containment • Full containment	 5 3 0.5	The level and type of engineered containment will affect the potential for contaminants to be released to surface water.	Review the existing engineered systems and relate these structures to site conditions and proximity to surface water and determine if full containment is achieved; e.g., evaluate low if there is full containment such as capping, berms, dikes; evaluate medium if there is partial containment such as natural barriers, trees, ditches, sedimentation ponds; evaluate high if there are no intervening barriers between the site and nearby surface water.	Site inspection reports, air photos, etc.
	b) Distance to perennial surface water • 0 to <100 m • 100 to 300 m • >300 m	 3 2 0.5	The distance to surface water will affect the probability of contaminants reaching the watercourse. The Ontario Ministry of the Environment has established a classification for immediate impact zone at 50 m. For conservatism, this zone has been broadened to 100 m.	Review available mapping and survey data to determine distance to nearest surface water bodies.	
	c) Topography • Contaminants above ground level and slope is steep • Contaminants at or below ground level and slope is steep • Contaminants above ground level and slope is flat • Contaminants at or below ground level and slope is flat	 1.5 1.2 1 0.8 0	Water can run off (and therefore potentially contaminate surface water) with greater ease from elevated sites on slopes.	Review engineering documents on the topography of the site and the slope of surrounding terrain. • steep slope = >50% • flat slope = <5% Note: Type of fill placement (e.g., trench, above ground, etc.)	

II. EXPOSURE PATHWAYS (cont'd)

SCORE

B. Surface Water

1. • Observed or Measured Contamination

Document information on surface water contamination: NO RECORD

Scoring Rationale & Information Source: —

2.a • Surface Containment

Review and document engineered or natural systems protecting surface water: THERE ARE TREES ALMOST ALL OVER THE AREA AND THEY SURROUND THE FIRING RANGES

Scoring Rationale & Information Source: 3

2.b • Distance to Perennial Surface Water

Estimate distance from site to nearest stream or other water body: STURGEON LAKE WITHIN THE AREA

Scoring Rationale & Information Source: 3

2.c • Topography

Document terrain conditions: MOSTLY HILLS WITH FLAT ZONES

Document position of contaminants (are they above ground or buried?) AT OR BELOW GROUND LEVEL

Scoring Rationale & Information Source: 1

Site Identification: ________

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	B. 2. d) Run-off potential (see nomograph, end of Appendix D) • >1000 mm rainfall and low permeability surface material • 500 to 1000 mm rainfall and moderately permeable surface material • <500 mm rainfall and highly permeable surface material	 1 0.6 0.2	Run-off transports contaminants into water bodies. Water run-off is a function of precipitation and the rate of infiltration (less permeable soils will allow greater run-off).	Refer to Environment Canada precipitation records for relevant areas. Use 30-year average precipitation for evaluation purposes. Determine factor score using "Run-Off Potential Nomograph" figure at end of Appendix D.	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	e) Flood potential • 1 in 2 years • 1 in 10 years • 1 in 50 years	 0.5 0.3 0.25 0.1	The potential for large quantities and concentrations of contaminants to be released to surface water courses over a short period of time will be affected by the flood potential of a water course near the site.	Review published data such as flood plain mapping or flood potential (e.g., spring or mountain run-off) and Conservation Authority records to evaluate flood potential of nearby water courses both up and down gradient. Rate zero if site not in flood plain.	Established flood plain guidelines/ maps; provincial/ territorial soil survey maps.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) : Solubility (S) : • low (S/standard ≈ 10^1) • medium (S/standard ≈ 10^2) • high (S/standard ≈ 10^3)	 -2* 0 2*	* The weighting suggested is valid if there are no points affected to other special considerations.		
Biodegradation (μ) : • observed • non observed • non biodegradable Other special considerations	 -2* 0 2* (-4 à 4)	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.		

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS (cont'd) — **SCORE**

B. Surface Water (cont'd)

2.d • Run-off Potential

Document geological and rainfall conditions: ANNUAL RAINFALLS ≈ 700 mm
PERMEABILITY VARIES FROM 10^{-3} cm/s TO 1 cm/s

Scoring Rationale & Information Source: SEE P. 35 — $\boxed{0.31}$

2.e • Flood Potential

Estimate flood frequency of nearby water courses or water bodies: NO FLOOD IN THE LAST 50 YEARS BUT STURGEON LAKE INCREASES THE PROBABILITY

Scoring Rationale & Information Source: — $\boxed{0.25}$?

3. • Special Considerations

Document any other important surface water conditions not addressed above: SOLUBILITY (S/STANDARD = 130/0.10) => 2
BIODEGRADATION (NON OBSERVED) => 0

Scoring Rationale & Information Source: — $\boxed{2}$

Site Identification: ____________

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	C. Direct Contact 1. Known contamination of media off-site • Known contamination of soil, sediment or air off-site due to contact with contaminated soil, dust, air, etc. (vector transported should also be considered). • Strongly suspected contamination of media off-site • No contamination of media off-site	 11 6 0	Known or measured contamination off-site is an important consideration for determining impact of contaminants.	Record known or measured contamination of soil, sediment or air on or off-site. Note any presence of soil gas, such as methane, associated with site.	
	2. Potential for direct human and/or animal contact a) Airborne Emissions (gases, vapours, dust, etc.) • Known or suspected airborne emissions impacting on neighbouring properties • Airborne emissions generally restricted to site • No airborne emissions	 5 6.5 3 0	If air emissions are evident off-site, there is a great hazard for direct contamination of neighbouring biota and/or resources.	Review available site information to determine if there have been complaints off-site (due to vapours, gas, dust, etc). Reports for these problems are not likely available for most abandoned sites. Review regulatory site inspection reports. If airborne emissions are known to be impacting neighbouring properties and possibly endangering the public, some immediate action (including characterization of emissions) should be initiated to curtail hazardous emissions or otherwise reduce or eliminate exposure.	Site inspection reports, etc.
	b) Accessibility of Site (ability to contact materials) • Limited or no barriers to prevent site access; contaminants not covered • Moderate accessibility or intervening barriers; contaminants are covered • Controlled access or remote location and contaminants are covered	 4 5 3 0	The greater the accessibility to a site and to contaminants, the greater the chance for contamination of human and animal life by direct contact.	Review location and engineering of the site and determine if there are intervening barriers between the site and humans or animals. A low rating should be assigned to a (covered) site surrounded by a locked chain link fence or in a remote location, whereas a high score should be assigned to a site that has no cover, fence, natural barriers or buffer.	
	c) Hazardous soil gas migration • Contaminants are putrescible and soil permeability is high • Soil contaminants are putrescible but soil permeability is low and/or groundwater is <2 m from surface • No putrescible contaminants at the site.	 2 1 0	Methane gas migration has been known to cause explosions adjacent to abandoned landfills.	Consider presence of organic material on site, the depth to water table, soil hydraulic conductivity, vegetative stress, odours, etc.	
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	

	3. Special considerations (detailed) : Vapor pressure : • < 0,1 kPa • 0,1 à 0,5 kPa • 0,5 à 1,5 kPa • > 1,5 kPa Powderiness : • < 0,1 % • 0,1 à 1 % • 1 à 10 % • > 10 % Other special considerations	 -2* -2/3* 2/3* 2* -2* -2/3* 2/3* 2* (-4 à 4)	(N.B. : vapor pressure limits are valid at a 20°C temperature) * The weighting suggested is valid if there are no points affected to other special considerations. (i.e. the sample % with a grain size ≤ 45 µm) N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS (cont'd) **SCORE**

C. Direct Contact

1. • Known Contamination Off-site:

Document reports of off-site contamination due to contact with contaminated soil, dust, air, etc.: NO RECORD

Scoring Rationale & Information Source: —

2.a • Airborne Emissions

Document incidents or complaints about fumes, gases, dust, odours, etc.: POSSIBLE, BUT UNKNOWN

Scoring Rationale & Information Source: 2.5 ?

2.b • Accessibility of Site

Review and document avenues of site access by humans and animals: THERE IS A FENCE THAT SURROUND THE AREA, BUT THE CONTAMINANTS ARE NOT TOTALLY COVERED

Scoring Rationale & Information Source: 2

2.c • Hazardous Soil Gas Migration

Review potential for hazardous soil gas production and migration from site: NO PUTRESCIBLE CONTAMINANTS

Scoring Rationale & Information Source: 0

3. • Special Considerations

Document any other conditions whereby humans/animals could contact contamination: VAPOR PRESSURE $\simeq 1.49 \times 10^{-9}$ atm AT 30°C => -2
POWDERINES => ARBITRARY VALUE

Scoring Rationale & Information Source:

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors	A. Human and Animal Uses 1. Known adverse impact on humans or domestic animals as a result of the contaminated site • Known adverse effect on humans or domestic animals • Strongly suspected adverse effect on humans or domestic animals	 18 15	Contamination from a site that causes a measurable impact on humans is a great concern.	Review and evaluate reports of impact(s) of site contamination (e.g., increased heavy metal levels measured in blood of nearby residents as a result of site contamination). Any site assigned 15 or more points for this factor should automatically be classified as Class 1. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980)	
	2. Potential for impact on humans or animals a) Drinking water supply i) Known impact on drinking water supply Drinking water supply is known to be adversely affected as a result of site contamination • Known contamination of drinking water supply to levels above CDWG • Strongly suspected contamination of drinking water supply • Drinking water supply is known not to be contaminated	 9 7 0	Water used for drinking should be protected against contamination from any site.	Review available site data (inspection reports, assessment documentation) to determine if drinking water (groundwater, surface water, private, commercial or municipal supply) is known or suspected to be contaminated above Guidelines for Canadian Drinking Water Quality or applicable provincial/territorial guidelines or policies. If drinking water supply is known to be contaminated above these guidelines, some immediate action (e.g., provision of alternate drinking water supply) should be initiated to reduce or eliminate exposure.	Guidelines for Canadian Drinking Water Quality; other drinking water guidelines developed by recognized agencies (e.g., other Health and Welfare Canada guidelines, U.S. EPA, etc.).
	ii) Potential for impact on drinking water supply • Proximity to drinking water supply • 0 to <100 m • 100 to <300 m • 300 m to <1 km • 1 to 5 km	 6 5 4 3	The nearer a drinking water well is to a contaminant source, the greater the potential for contamination. Well water used for irrigation/agricultural purposes should also be included as it may be used for human consumption.	Review provincial/territorial base mapping or air photos and measure the distance to the nearest resident or drinking water supply. Judge whether the water is being used as a drinking water source. Commonly rural areas use groundwater for drinking purposes. For urban sites, contact the local Public Utilities Commission to determine water source and location.	
	• "Availability" of alternate drinking water supply • Alternate drinking water supply is not available • Alternate drinking water supply would be difficult to obtain • Alternate drinking water supply available	 3 2 0.5	This factor takes into account the availability of replacement water supplies, and is used in the technical sense as a factor to indicate the degree of urgency, not as a sociopolitical consideration.	Determine availability of alternate drinking water supply or distance to alternate source.	

III. RECEPTORS SCORE

A. Human and Animal Uses

1. • Known Adverse Impact on Humans or Domestic Animals

Record known or suspected adverse effects on humans or domestic animals: NO RECORD

Scoring Rationale & Information Source: —

2.a.i • Known Contamination of Drinking Water Supply

Record known or suspected incidents of contamination of drinking water: NO RECORD

Scoring Rationale & Information Source: —

2.a.ii.°• Distance to Nearest Drinking Water Supply(s)

Identify nearest drinking water well and measure distance to site: CHALK RIVER 2 KM WEST AND SOME CABINS 2 KM NORTH

Scoring Rationale & Information Source: 3

2.a.ii.°°•Availability of Alternate Drinking Water Supply

Document availabiilty of alternate sources of drinking water and ease of implementation: UNKNOWN, BUT POSSIBLE

Scoring Rationale & Information Source: 1.5 ?

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	A.2. b) Other Water Resources i) Known impact on used water resource Water resource (used for recreational purposes, commercial food preparation, livestock watering, irrigation or other food chain uses) is known to be adversely affected as a result of site contamination		The water used for these purposes (groundwater or surface water) should be protected against contamination.	Review documentation for reported or suspected contamination of water used for recreation or food chain uses, and refer to Canadian Water Quality Guidelines or other relevant guidelines (select appropriate guidelines based on local water use) to determine if supply is considered contaminated.	CCME Canadian Water Quality Guidelines; provincial/ territorial water quality guidelines and objectives; etc.
	• Water resource is known to be contaminated above CWQG	4			
	• Water resource is strongly suspected to be contaminated above CWQG	3			
	• Water resource is known not to be contaminated	0			
	ii) Potential for impact on water resources • Proximity to water resources used for activities listed above		The nearer a water resource is to a site, the greater the risk of contamination.	Determine distance from the site to the nearest recreational or food chain used water resource.	
	• 0 to <100 m	2			
	• 100 to <300 m	1.5			
	• 300 m to <1 km	1			
	• 1 to 5 km	0.5			
	• Use of water resources - if multiple uses, give highest score (use following table)	0.2 - 2	Potential for impact due to use of water resource is related to the type and frequency of use. Human uses are of the highest concern.	Assess water users adjacent to the site from maps and directories.	

Water Use	Frequency of Use: Frequent	Frequency of Use: Occasional
Recreational (swimming, fishing)	2	1
Commercial food preparation	1.5	0.8
Livestock watering	1	0.5
Irrigation	1	0.5
Other domestic or food chain uses	0.5	0.3
Not currently used but likely future use	0.5	0.2

III. RECEPTORS (cont'd) SCORE

A. Human and Animal Uses (cont'd)

2.b.i • Known Impact on Used Water Resource

Record information on water resource that is or is potentially affected by site contamination: NO RECORD

Scoring Rationale & Information Source: —

2.b.ii.°• Proximity of Water Resources to Site

Locate and measure nearest water resource areas to site: STURGEON LAKE WITHIN THE AREA
MASKINONGE LAKE 1 Km NORTH

Scoring Rationale & Information Source: 2

2.b.ii.°°• Water Uses

Record uses of nearby water resources: FISHING
SWIMMING ?

Scoring Rationale & Information Source: 2

°' Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	A. 2. c) Direct human exposure i) Known contamination of land used by humans • Known contamination of land used for agricultural or residential/parkland/school purposes above AG or R/P EQC values • Known contamination of land used for commercial or industrial purposes above C/I EQC values • Land is known not to be contaminated	 5 3.5 0	Hazards associated with soil contamination are directly related to land use.	Review zoning and land use maps for lands adjacent the site. Evaluate levels of soil contamination against Canadian Environmental Quality Criteria (EQC) for Contaminated Sites (AG = agricultural level; R/P = residential/parkland level; C/I = commercial/industrial level). If soil is known to be contaminated above these levels and possibly endangering public health, some immediate action (e.g., fencing the area, limiting public access, etc.) should be initiated to reduce or eliminate the exposure.	CCME Canadian Environmental Quality Criteria for Contaminated Sites.
	ii) Potential human exposure through land use • Use of land at and surrounding site (use following table; give highest score to worst case scenario) Distance from Site Land Use (current or future) / 0 - 300m / 300m - 1km / 1 - 5km Residential: 5 / 4.5 / 3 Agricultural: 5 / 4 / 2.5 Parkland/School: 4 / 3 / 1.5 Commercial/Industrial: 3 / 1 / 0.5	0.5 - 5	Hazards associated with soil contamination are directly related to land use and distance of the used land from the site. Residential and agricultural land uses are of highest concern because humans are situated at these locations for longer periods.	Review zoning and land use maps over the distances indicated. If the proposed future land use is more "sensitive" than the current land use, evaluate this factor assuming the proposed future use is in place (indicate in the worksheet that future land use is the consideration). Agricultural land use is defined as uses of land where the activities are related to the productive capability of the land or facility (e.g., greenhouse) and are agricultural in nature, or activities related to the feeding and housing of animals as livestock. Residential/Parkland land uses are defined as uses of land on which dwelling on a permanent, temporary, or seasonal basis is the activity (residential), as well as uses on which the activities are recreational in nature and require the natural or human designed capability of the land to sustain that activity (parkland). Commercial/Industrial land uses are defined as land on which the activities are related to the buying, selling, or trading of merchandise or services (commercial), as well as land uses which are related to the production, manufacture, or storage of materials (industrial).	
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) : People affected by contamination : • ≤ 250 • 250 à 1000 • > 1000 Type of person using the site : • Workers • Adults • Children and seniors Other special considerations	 0 1,5* 3* 0 1* 2* (-5 à 5)	* The weighting suggested is valid if there are no points affected to other special considerations. N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	

SITE CLASSIFICATION WORKSHEET - cont'd

III. RECEPTORS (cont'd) **SCORE**

A. Human and Animal Uses (cont'd)

2.c.i • Known Contamination of Land Used by Humans

Record land use type (current or proposed) and level of contamination for land known to be contaminated due to site: NO RECORD

Scoring Rationale & Information Source: —

2.c.ii • Land Use at and Adjacent to the Site

Document land uses (current and proposed) for up to 5 km from the site: MILITARY EXERCISES

	N	E	S	W
0 - <300 m	CHALK RIVER	TRAINING	TRAINING	HIGHWAY 17
300 m - <1 km	NUCLEAR POWER PLANT	AREA B	AREAS D,C	CP RAILROAD
1 km - 5 km				

Scoring Rationale & Information Source: 0.5

3. • Special Considerations

Document any other important human or animal use information, including details of air contamination if known:

PEOPLE AFFECTED < 250 => 0

THE SITES ARE USED BY MILITARY PEOPLE

Scoring Rationale & Information Source: 0

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	B. Environment 1. Known adverse impact on a sensitive environment as a result of the contaminated site • Known adverse impact on sensitive environment • Evidence of stress on aquatic species or vegetative stress on trees, crops or plant life located on properties neighbouring the site • Strongly suspected adverse impact on sensitive environment	 16 14 12	The environment should be protected against site contamination. Evidence of impact(s) shows that protection is lacking.	Review records for evidence of vegetative stress or impairment of any nearby sensitive environments. A sensitive environment is defined as a sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980).	
	2. Potential for impact on sensitive environments a) Distance from site to nearest sensitive environment (e.g., sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc.) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km	 10 6 2 0.5	It is considered that within approximately 1 km of the site there is immediate concern for contamination. Therefore, an environmentally sensitive area located within this area of the site will be subject to concern. It is also generally considered that any sensitive area located greater than 10 km from the site will not be impacted.	Review Conservation Authority mapping and literature. Also review Ministry of Natural Resources records and Federal Land Capability maps. Identify provincial/territorial and federal designated environmentally sensitive areas.	Relevant provincial /territorial and federal maps of sensitive environments.
	b) Groundwater - distance to important or susceptible groundwater resource(s) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km	 6 4 2 1	The closer a site is to a discharge or recharge area, the greater the potential for contamination of a groundwater or surface water resource.	Review groundwater contour maps, if available, and other available reports. Otherwise use established hydrogeologic principles.	Local groundwater maps, etc.
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	

SITE CLASSIFICATION WORKSHEET - cont'd

III. RECEPTORS (cont'd) SCORE

B. Environment

1. • **Known Adverse Impact(s) on Sensitive Environment**

Record known impact(s) on any sensitive biological environment at and/or around the site: NO RECORD

Scoring Rationale & Information Source: —

2.a • **Distance from Site to Nearest Sensitive Environment**

Document location, distance, type and details of any nearby sensitive environments or habitats: SOME MARSHES IN THE SOUTHERN AND NORTHEASTERN PART OF THE AREA

Scoring Rationale & Information Source: 10

33

2.b • **Groundwater**

Measure distance to major recharge or discharge area: STURGEON LAKE IS A DISCHARGE ZONE

Scoring Rationale & Information Source: 6

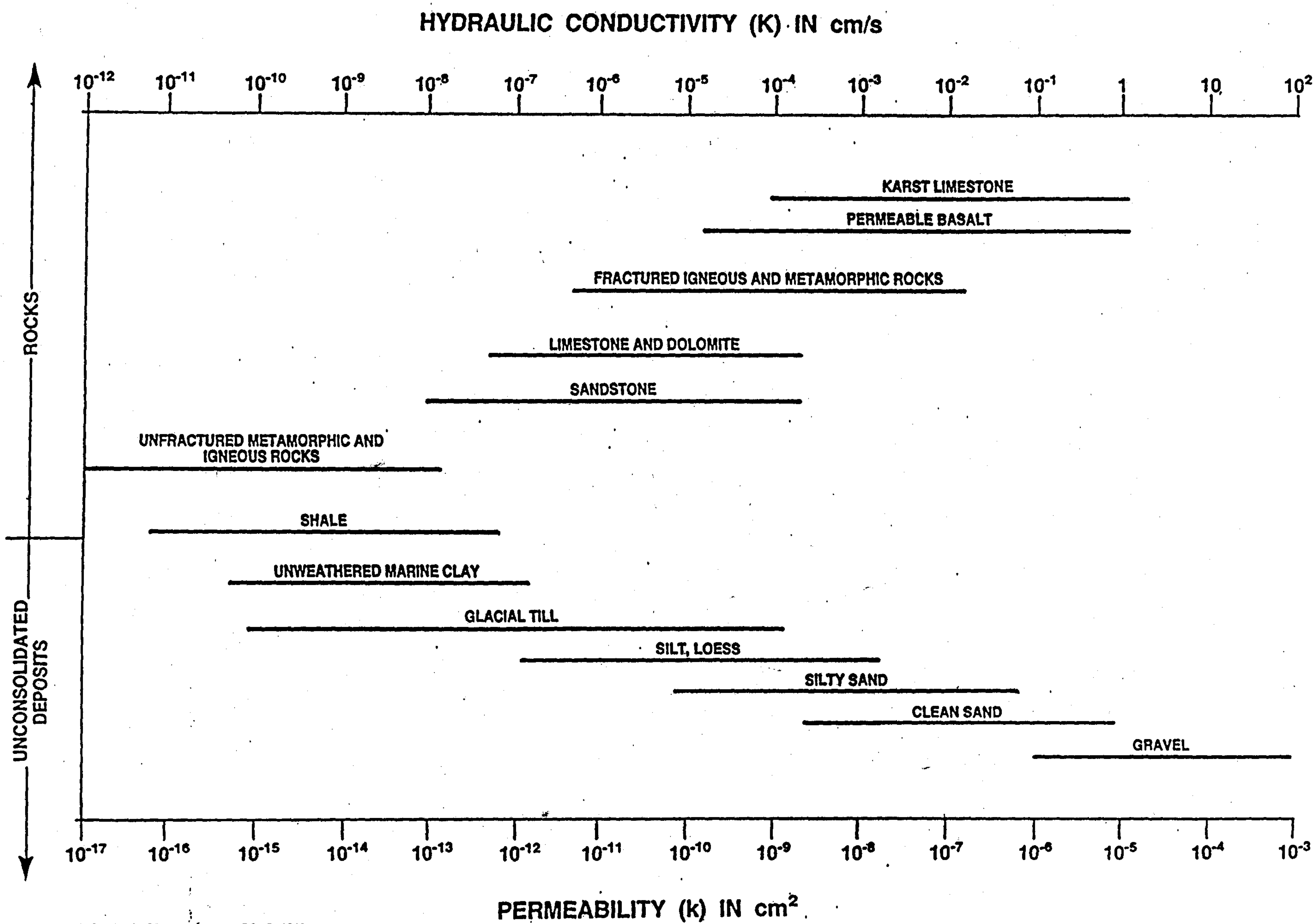
3. • **Special Considerations**

Document any other important impacts on the environment not addressed above:

Scoring Rationale & Information Source: —

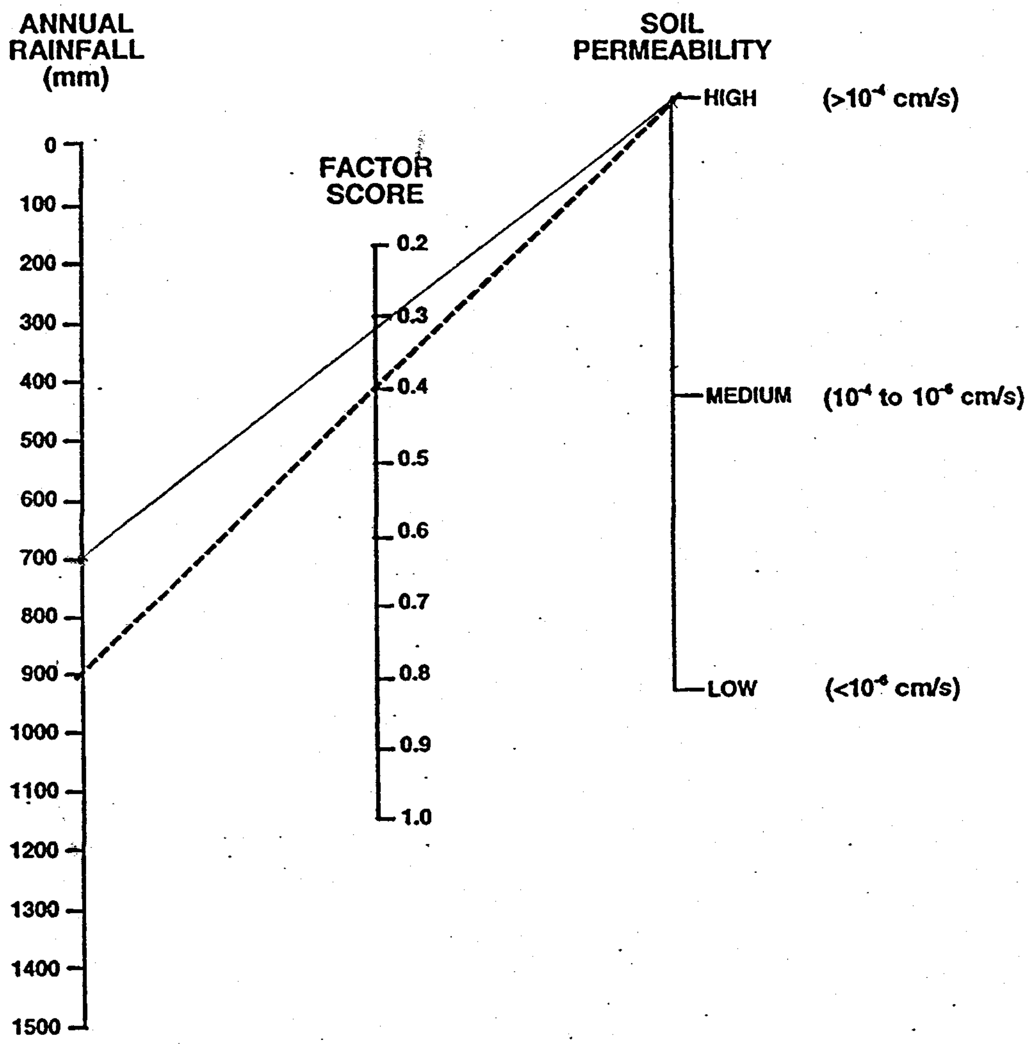
Site Identification:

RANGE OF VALUES OF HYDRAULIC CONDUCTIVITY AND PERMEABILITY



MODIFIED FROM FREEZE AND CHERRY, 1979 AND TODD, 1959

RUN-OFF POTENTIAL NOMOGRAPH
(FACTOR II B 2 d)



To determine the factor score, use a ruler and join the annual rainfall value (mm) with the soil permeability data; take the factor score from the middle line.

For example, if rainfall is 900 mm and soil permeability is high, the score would be 0.4.

Compounds	Abbreviations	Solubility	T	Vapour pressure	T	Degradation	Degradation constants (mu)			Kd	Toxicity	'EPA drinking water standard"	MEF water quality criteria	Drinkability standard	Danger criteria (Daniels)	Danger criteria (Rouisse)	References
							Sand	Silt	Clay								
Units		(mg/L)	(C)	(atm)	(C)		(/hr)	(/hr)	(/hr)	(L/kg)		(mg/L)	(mg/L)	(ppb-ug/L)	(mg/K)	(mg/Kg)	
2,4,6 trinitrotoluene	2,4,6 TNT	150	25	7,25E-09	25	Mostly anaerobic					Possibly toxic	0,02					(1)
		130	20	1,45E-09	20									1	0,3	0,024	(2)
		150	25	9,49E-09	25												(3)
		130	20	4,61E-09	20												(3)
				1,66E-09	20												(4)
							3,20E-03	1,40E-01	8,30E-02								(5)
										Ottawa sand: 1,5							(6)
										Silt: 4,5							(6)
										Clay: 10							(6)
													0,12*				(7)
2,4 dinitrotoluene	2,4 DNT	280	25	2,86E-07	25	Aerobic and anaerobic					Possibly carconogenous						(1)
		270	22	2,89E-07	20									5			(2)
				3,17E-08	25												(3)
		270	20	1,61E-08	20												(3)
													1,10E-04				(7)
2,6 dinitrotoluene	2,6 DNT	208	25	7,46E-07	25	Aerobic and anaerobic											(1)
		206	25	7,46E-07	20									5			(2)
													0,93*				(7)
cyclo - 1,3,5 - triméthylene - 2,4,6 - trinitramine	RDX	45	25	5,30E-12	25	Anaerobique					Possibly carconogenous	0,1					(1)
		42	20	5,53E-12	20									2	0,3	0,00024	(2)
(or hexahydro - 1,3,5 - trinitro - 1,3,5 - triazine, or		50	20	2,56E-12	20												(3)
							0	6,50E-03	1,40E-02								(5)
										0,1 à 13,26							(6)
cyclo - 1,3,5,7 - tetramethylene - 2,4,6,8 - tetranitramine	HMX	5	25	4,38E-17	25	Anaerobique						nd		400	1,7	2,2	(1)
(or octahydro - 1,3,5,7 - tetranitro - 1,3,5,7 - tetrazocine)		5	25	4,34E-17	20												(2)
										0,2 à 4,2							(6)
							0	3,60E-03	3,20E-02								(5)

(1) McGrath, 1995
(2) Thiboutot *et al*, 1998
(3) Pheelan and Webb, 1997
(4) Hayes, 1992
(5) Myers *et al*, 1996
(6) Townsend *et al*, 1996
(7) http://www.mef.gouv.qc.ca/fr/environn/criteres_eau

* Provisory criteria for aquatic life (surface water)

Conversion table for pressure units

	atm	mm Hg	torr	kPa	bar
1 atm =	1	760	760	101,3	1,013250274
1 mm Hg =	0,00131579	1	1	0,13328947	0,001333224
1 torr =	0,00131579	1	1	0,13328947	0,001333224
1 kPa =	0,00987167	7,50246792	7,50246792	1	0,010002471
1 bar =	0,986923	750,06148	750,06148	99,9752999	1

Site classification computerised worksheet

Site: Impact Area B | Date: 06-27-2000 | User (s): Marc-André Lavigne

	Sections	Score for potential impacts	Known and/or potential impacts		?	Comments
	CONTAMINANT(S) CHARACTERISTICS					
A)	DEGREE OF HAZARD	11	11	/14	0	Energetic materials found in ordnances.
B)	CONTAMINANT QUANTITY	10	10	/10	0	Area = 14.6681 km², no register before 1995
C)	PHYSICAL STATE OF CONTAMINANTS	3	3	/9	0	TNT, RDX, HMX, etc
	Special considerations	0	0	/6		
	TOTAL	24	24	/33	0	N.B.: If the total is < 0 or > 33, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 33)
	EXPOSURE PATHWAYS					
A)	GROUNDWATER					
	Known contamination at or beyond property boundary		-100	/11		
	Engineered subsurface containment	4	4	/4	0	No engineered system.
	Thickness of confining layer over aquifer(s) of concern	1.5	1.5	/1,5	0	No confining layer.
	Hydraulic conductivity of the confining layer	1.5	1.5	/1,5	0	No confining layer.
	Annual rainfall	0.7	0.7	/1	0	700 mm between 1950 and 1981.
	Hydraulic conductivity of the aquifer(s) of concern	2.5	2.5	/3	0	From 10E-03 cm/s to 1 cm/s.
	Special considerations	0.8	0.8	/4		Solubility: 4/3, Retardation Factor: -1/2, Biodegradation: not observed
	TOTAL	11.0	11.0	/11	0.0	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
B)	SURFACE WATER					
	Observed or mesured contamination of water/effluent discharged from site		-100	/11		
	Surface containment	5	5	/5	0	Trees all over the area but no particular surface containment.
	Distance to perennial surface water	3	3	/3	0	Chalk Bay south, Ottawa River east and Mason Lake within the area
	Topography	1	1	/1,5	0	Mountains with flat zones, contaminants at or below ground level.
	Run-off potential (see nomograph)	0.31	0.31	/1	0	
	Flood potential	0.25	0.25	/0,5	0.25	No flood in the last 50 years but Sturgeon Lake increases the possibilities.
	Special considerations	1.4	1.4	/4		Solubility: 2
	TOTAL	11.0	11.0	/11	0.3	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
C)	DIRECT CONTACT					
	Known contamination of media off-site		-100	/11		
	Airborne emissions (gases, vapour, dust, etc.)	2.5	2.5	/5	2.5	Possible but unknown.
	Accessibility of site (ability to contact materials)	3.5	3.5	/4	0	People come by boat, contaminants not totally covered.
	Hazardous soil gas migration	0	0	/2	0	No putrescible contaminants.
	Special considerations	-1.3	-1.3	/4		Vapor pressure: -2, powderiness: 2/3
	TOTAL	4.7	4.7	/11	2.5	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11)
	RECEPTORS					
A)	HUMANS AND ANIMALS					
	Known adverse impact on living things as a result of the contaminated site		-100	/18		
	Known impact on drinking water supply		-100	/9		
	Proximity to drinking water supply	2	2	/6	0	Water plant approx. 7 km south.
	"Availability" of alternate drinking water supply	1.5	1.5	/3	1.5	Unknown but possible.
	Known impact on used water resource		-100	/4		
	Proximity to water resources used for activities	2	2	/2	0	Chalk Bay and Ottawa River
	Use of water resources	2	2	/2	0	Fishing, swimming
	Known contamination of land used by humans		-100	/5		
	Use of land at and surrounding site	0.5	0.5	/5	0	Military exercises.
	Special considerations	0.0	0.0	/5		People affected lower than 250, military people.
	TOTAL	8.0	8.0	/18	1.5	N.B.: If the total is < 0 or > 18, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 18).
B)	ENVIRONMENT					
	Known adverse impact on sensitive environment as a result of the contaminated site		-100	/16		
	Distance from site to nearest sensitive environment	10	10	/10	0	Some marshes within the area.
	Distance to important or susceptible groundwater resource(s)	6	6	/6	0	Mountains and outcrops act as recharge zones
	Special considerations	0	0	/5		
	TOTAL	16	16	/16	0	N.B.: If the total is < 0 or > 16, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 16)

Total score (potential impacts)	73.8	+	0.9	/100	+/-	4.3
Total score (known impacts or potential impacts if the former is not known)	73.8	+	0.9	/100	+/-	4.3

Score	Class	Risk potential	Action required
70-100	1	High	Yes
50-69	2	Medium	Likely
38-49	3	Medium low	May be
<=37	N	Low	Not likely

N.B. : If the uncertainty exceeds 15, we consider that there if insufficient information to assign a significant score and the site is therefore classified in class I (for insufficient information).

N.B. : The number "-100" has been used as default when no information was available about the contamination of the site. This value (-100) was chosen to avoid any confusion with possible scores.

Appendix C

Facility/Site Description

FACILITY/SITE DESCRIPTION

Document site information as completely as possible:

Site No.: RA 684 *Site Name:* IMPACT AREA B *Province/Territory:* ONTARIO

Custodian Dept.: DND *Facility Name:* CFB PETAWAWA *Site Operator/Manager:* CFB PETAWAWA

Type of Site: IMPACT AREA / NOW TRAINING AREA *Site Owner:* DND

Zone: ______ *UTM Coordinates:* ________ *Easting* ________ *Northing* *Latitude:* ___ *deg.* ___ *min.* ___ *sec.* *Longitude:* ___ *deg.* ___ *min.* ___ *sec.*

Location: ______ *Legal Land Description:* ______

Address ______ *Provincial Parcel No.:* ______

Brief Description of Site: ______

Site Land Use: *Current:* MILITARY TRAINING *Proposed:* IDEM

Comments:

12

Summary of Site Classification Information:

Completed Evaluation Form: x *Detailed* x *Short*

Site Score: 74.7 *Total* ± 4.3 *Estimated Score*

Class: (1, 2, 3, N, or I) $\boxed{1}$ *Risk:* HIGH

Notes: ______

Contact Name: CHRIS HOGAN / SEAN MOYLES

Position: ______

Address: ______

City: PETAWAWA *Prov./Terr.:* ONT. *Postal Code:* ______

Phone No.: ______ *Fax No.:* ______

Site Classified by above ______ *or* MARC-ANDRÉ LAVIGNE / KARINE CHAMPAGNE

Degree of Familiarity with Site: ___ *Very familiar* x *Moderately familiar* ___ *Indirectly familiar* ___ *Unfamiliar*

Visited site: X *Yes* ___ *No*

Position: RESEARCH ASSISTANT *Phone No.:* (418) 654-2647

Address: 880 CHEMIN STE-FOY, BUR 840, CP7500

City: QUEBEC *Prov./Terr.:* QUEBEC *Postal Code:* G1V 4C7 *Date of Completed Classification:* ______

Site Identification: ______

National Classification System Process Checklist

_____ USER'S GUIDE REVIEWED

__X__ MINIMUM DATA REQUIREMENTS MET

- __X__ Description of site location
- __X__ Type of contaminants or materials likely to be present at site (and/or description of historical activities)
- __X__ Approximate size of site and quantity of contaminants
- _____ Approximate depth to water table
- __X__ Geologic map or survey information (soil, overburden, and bedrock information)
- __X__ Annual rainfall data (can be inferred from rainfall map of Canada)
- __X__ Surface cover information
- __X__ Proximity to surface water
- __X__ Topographic information
- _____ Flood potential of site
- _____ Proximity to drinking water supply
- __X__ Uses of adjacent water resources
- __X__ Land use information (on-site and surrounding)

__X__ FACILITY/SITE DESCRIPTION COMPLETED

__X__ SITE CLASSIFICATION WORKSHEET COMPLETED

__X__ REFERENCES ATTACHED/CITED

__X__ EVALUATION FORM COMPLETED

__X__ Detailed Form __X__ Short Form

__X__ SCORE SHEET COMPLETED

__X__ SITE CLASSIFICATION

Class: __X__ 1 _____ 2 _____ 3 _____ N _____ I

Score: __74.7__ ± __4.3__
Total Estimated Score

_____ SITE INFORMATION ENTERED ON NCS COMPUTERIZED VERSION

Site Identification: ____________________________________

SHORT EVALUATION FORM

Instructions for Use

Answer Yes or No to questions 1 to 5 below. If the response to question 1a) or 1b) is Yes, automatically rate the site as Class 1 (C1). If the answers to any three of questions 2 to 5 are Yes, the site should also be rated as Class 1. For all Yes answers, supporting documentation and rationale must be referenced or attached.
To confirm Class 1 rating and/or if two or more No responses are given, the Detailed Evaluation Form should also be completed.

			No	Yes		Reference Attached
1	a)	Is site contamination known to have caused adverse impacts on humans or sensitive environments? (see User's Guide)	☒	☐	→ Class 1	☐
	b)	Is the site a fire or explosion hazard as it currently exists?	☒	☐	→ Class 1	☐
I		**Contaminant(s) Characteristics**				
	2	Are contaminants that can be classified as 'high concern' (as defined in the User's Guide) present at the site?	☐	☒		☐
	3	Are the high concern contaminants known to be present in large quantities? Answer yes if contaminant is: • liquid (as disposed/spilled) • in quantity >1,000 m³ • in an area of contamination >10 ha • distributed or placed in such a manner as to have the potential to cause significant off-site contamination	☐	☒		☐
II		**Pathways**				
	4	Is the site known to have caused contamination (above national or applicable provincial/territorial guidelines or policies) of off-site groundwater, adjacent surface water, neighbouring surficial material (i.e., soil) or air? (see User's Guide)	☒	☐		☐
III		**Receptors**				
	5	Is the site contamination known to have a) impacted the quality of local drinking water or other water resources (i.e., exceeds Guidelines for Canadian Drinking Water and/or Canadian Water Quality Guidelines or applicable provincial/territorial guidelines or policies); b) contaminated lands used for agricultural, residential or parkland purposes (i.e., exceeds the AG or R/P values of Canadian Environmental Quality Criteria for Contaminated Sites or applicable provincial/territorial guidelines or policies); or c) caused vegetative stress or other known environmental impairment? (A Yes answer should be given if the impact has made the water, land, environment, or air unacceptable for use.)	☒	☐		☐

If 3 or more Yes answers are given in Sections I, II, and III above, rate site as Class 1. Check box if Class 1 rating. ☐

Site Identification:

Appendix D

User's Guide (even pages) and Site Classification Worksheet (odd pages)

USER'S GUIDE

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
I. Contaminant(s) Characteristics	A. Degree of hazard • High concern contaminants - high concentration • High concern contaminants - low concentration • Medium concern contaminants - high concentration • Medium concern contaminants - low concentration • Low concern contaminants	 14 11 8 5 3	In determining the degree of hazard of a waste, it is recognized that a listed hazardous waste is generally of greater concern than a liquid or solid industrial waste. These are in turn of greater concern than other solid wastes. Municipal and organic wastes are considered medium concern contaminants due to their putrescible nature (production of methane and other landfill gases). Household wastes may contain hazardous materials (e.g., batteries, medical wastes, paints, etc).	Determine the level of hazard according to the following table of typical contaminants and definition of high concentrations: <u>High Concern Contaminants</u> • Materials defined as dangerous goods in the Transport of Dangerous Goods Act and Regulations • Materials identified by Province as hazardous waste (pesticides, herbicides, paint sludge, acid and alkaline solutions, solvents, etc.) • Materials regulated by the Canadian Environmental Protection Act (e.g., PCBs) • Institutional waste (lab, schools hospitals, etc.) • Pathological wastes and animal carcasses • Radioactive wastes <u>Medium Concern Contaminants</u> • Liquid waste not referred to in above, petroleum products septic tank pumpings, agricultural and chemical containers • Food processing wastes • Non-hazardous incinerator residues • Municipal solid (household) wastes • Organic and vegetable wastes • Mining residues <u>Low Concern Contaminants</u> • Industrial and commercial solid wastes, (e.g., construction materials such as wood, metal, hay, sand/silt piles, etc.) • Other nearly inert wastes (e.g., foundry sands) <u>High Concentration of Contaminants</u> • contaminant concentrations in soil, groundwater or surface water exceed Canadian Environmental Quality Criteria for Contaminated Sites (>2x commercial/industrial level); or material that was deposited in highly concentrated form (e.g., >5000 ppm)	Transport of Dangerous Goods Act; Provincial/Territorial Hazardous Wastes lists; regulations under Canadian Environmental Protection Act; Canadian Environmental Quality Criteria for Contaminated Sites; etc.
	B. Contaminant Quantity (area/volume of site contamination) • >10 ha, or >1000 m^3, or drums of liquid • 2 to 10 ha, or 100 to 1000 m^3 • <2 ha, or <100 m^3	 10 6 2	Little information is known about the quantity of wastes at abandoned sites in Canada. Therefore, waste quantity estimates may be interpreted from area or quantity information.	Measure or estimate the area or quantity of potential contamination. Note: Any number of drums abandoned or disposed is considered a high concern.	
	C. Physical State of Contaminants • Liquid/gas • Sludge • Solid	 9 7 3	Contaminants in liquid form are more mobile in the ground and water than solids. However, certain water-soluble solid wastes are more mobile than viscous liquids, and these should be evaluated on a case-by-case basis.	Determine the state of the contaminant when it was disposed or deposited.	
	Special Considerations	-6 to +6	(See 3.7.3 in text)	Technical judgment.	

SITE CLASSIFICATION WORKSHEET

(Instructions: Document site information, assign score, provide rationale behind score and indicate source of information in the spaces provided.)

I. CONTAMINANT(S) CHARACTERISTICS

SCORE

A. • Degree of Hazard

List possible contaminants and estimated concentrations: ENERGETIC MATERIALS FOUND IN AMMUNITION (TNT, HMX, RDX)

POSSIBILITY OF HEAVY METAL CONTAMINATION

Scoring Rationale & Information Source: ______

11

B. • Contaminant Quantity

Estimated or measured areal volume of contaminated zone: NO REGISTER OF UNEXPLODED SHELLS BEFORE 1995

AREA : 14.6681 Km^2

QUANTITY ESTIMATED WITH AREA OF THE RANGE

Scoring Rationale & Information Source: CHRIS HOGAN / SEAN MOYLES

10

C. • Physical State of Contaminant

Does the site contain:

a) Predominantly liquids/gases ______

b) Primarily sludges ______

c) Primarily solids ENERGETIC MATERIALS ARE PRESENT IN A SOLID STATE

Scoring Rationale & Information Source: ______

3

• Special Considerations

Document any other important contaminant characteristics not addressed above: ______

Scoring Rationale & Information Source: ______

—

Site Identification: ______

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways	A. Groundwater 1. Known contamination at or beyond property boundary • Groundwater significantly exceeds Canadian Drinking Water Guidelines (CDWG) by >2x or known contact of contaminants with groundwater • Between 1 and 2x CDWG or probable contact with groundwater • Meets Canadian Drinking Water Guidelines	 11 6 0	The legislative basis for most jurisdictions is to prevent off-site migration of contamination.	Review chemical data and evaluate groundwater quality. If contamination at or beyond the property boundary exceeds Canadian Drinking Water Guidelines (CDWG) or applicable provincial/territorial guidelines or policies, or if contaminants are known to be in contact with groundwater, then evaluate the site as high.	Canadian Water Quality Guidelines; Provincial/ Territorial Water Quality Guidelines or policies; Guidelines for Canadian Drinking Water Quality.
	2. Potential for groundwater contamination (a) Engineered subsurface containment • No containment • Partial containment • Full containment	 4 2 0	Well contained sites have minimal potential for pollution. Potential for pollution decreases with increasing containment.	Review the existing engineered systems and relate these structures to hydrogeology of the site and determine if full containment is achieved. Full containment is defined as an engineered system, monitored as being effective, which provides for the capture and treatment of contaminants. If there is no system, this factor is evaluated high. If there is less than full containment or if uncertain then evaluate as medium. Typical engineered systems include leachate collection systems and low permeability liners.	
	(b) Thickness of confining layer over aquifer(s) of concern • 3 m or less • 3 to 10 m • >10 m	 1.5 1 0	The thickness of a confining layer (e.g., clay, shale, etc.) between contaminants and any aquifers of concern will affect the attenuation of contaminants and hence the quantity and quality of contaminants reaching the aquifers.	Measure or estimate thickness of any confining layer (e.g., clay, shale, etc.) over all aquifers of concern from existing well records or from a general knowledge of local conditions. If possible, an estimate of the continuity of the confining layer should be made from borehole well record information. Note: an aquifer is defined as a geologic material that will yield groundwater in usable quantities.	Historical geologic maps, well records, government hydrogeologist or local consultants.
	(c) Hydraulic conductivity of the confining layer • $>10^{-4}$ cm/sec • 10^{-4} to 10^{-6} cm/sec • $<10^{-6}$ cm/sec	 1.5 1 0.5	The rate at which contaminants migrate through the confining layer will affect attenuation and the contaminant loading to the aquifers.	Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Apppendix D). Clays, granite, shales should be scored low. Silts etc. should be scored medium. Sand, gravel, and limestone should be scored high.	Freeze and Cherry, 1979, and other groundwater texts.

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS

SCORE

A. Groundwater

1. • Known Groundwater Contamination

Document information on known groundwater contamination: NO RECORD

Scoring Rationale & Information Source: ______ [—]

2.a • Engineered Subsurface Containment

Document engineered systems protecting groundwater: NO ENGINEERED SYSTEM

Scoring Rationale & Information Source: ______ [4]

2.b • Thickness of Confining Layer Over Aquifer(s) of Concern

Document local geological conditions: NO CONFINING LAYER
BEDROCK (PRECAMBRIAN ROCKS - INTRUSIVE AND METAMORPHIC)

Identify water-bearing zones used for water supply: OVERLAIN BY OLDER ALLUVIUM IN TERRACE REMNANTS: SAND, GRAVELLY SAND

Scoring Rationale & Information Source: THICKNESS VARIES BETWEEN 65 AND 95 FEET [1.5]

2.c • Hydraulic Conductivity of the Confining Layer

Estimate hydraulic conductivity of any confining layer: IT RANGES FROM 10^{-3} TO 1

Scoring Rationale & Information Source: ______ [1.5]

Site Identification: ______

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	A.2. (d) Annual Rainfall • >1000 mm • 600 mm • 400 mm • 200 mm	0.7 0.6 0.4 0.2	The quantity of rainfall affects the quantity of leachate produced. Higher leachate quantities have a higher impact on the environment.	Refer to Environment Canada rainfall records for relevant areas. Use 30-year average rainfall for evaluation purposes. Divide rainfall by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score)	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	(e) Hydraulic conductivity of aquifer(s) of concern • $>10^{-2}$ cm/sec • 10^{-2}-10^{-4} cm/sec • $<10^{-4}$ cm/sec	3 0.5 1.5 0.5	Aquifers with high hydraulic conductivity can transport contaminants at high velocity over great distances, e.g., solution limestones, highly fractured rocks or gravel deposits.	Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Appendix D).	Freeze and Cherry, 1979.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) :			
Solubility (S) :			
• low (S/standard ≈ 10^1)	-4/3*	* The weighting suggested is valid if there are no points affected to other special considerations.	
• medium (S/standard ≈ 10^2)	0		
• high (S/standard ≈ 10^3)	4/3*		
Retardation factor (R) :		N.B. : the R calculation was done using n = 0,33 et ρ_b = 1,75 g/cm³ ; if the studied soil is neither sand, silt or clay, the R factor must be recalculated because n et ρ_b change. (R_{Cl} ≈ 1)	
• important delay ($R / R_{Cl} \approx 10^2$) or ($K_d \approx 12{,}51$)	-4/3* 0.6		
• delayed ($R / R_{Cl} \approx 10^1$) or ($K_d \approx 1{,}14$)	0		
• little or no delay ($R / R_{Cl} \approx 10^0$) or ($K_d \approx 0$)	4/3*		
Biodegradation (μ) :			
• observed	-4/3*		
• non observed	0		
• non biodegradable	4/3*		
Other special considerations	(-4 à 4)	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	

II. EXPOSURE PATHWAYS (cont'd)

SCORE

A. Groundwater (cont'd)

2.d • Annual Rainfall

Document rainfall data: BETWEEN 1951 AND 1980 → ≃ 700 mm

Scoring Rationale & Information Source: CLIMATIC ATLAS - CANADA

0.7

2.e • Hydraulic Conductivity of Aquifer(s) of Concern

Estimate hydraulic conductivity of relevant aquifer(s): SAND AND GRAVELLY SAND HAVE A HYDROLIC CONDUCTIVITY RANGING FROM 10^{-3} TO 1

Scoring Rationale & Information Source:

2.5

3. • Special Considerations

Document any other important ground water issues not addressed above: HIGH SOLUBILITY OF ENERGETIC MATERIALS (130/0.12 = 5/STANDARD) => 4/3
RETARDATION FACTOR (K_D ≃ 4.5) => -0.5
BIODEGRADATION (NOT OBSERVED) => 0

Scoring Rationale & Information Source: ARBITRARY SCORE FOR RETARDATION FACTOR

5/6

Site Identification: ________________

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	B. Surface Water 1. Observed or measured contamination of water/effluent discharged from site • Known or strongly suspected to exceed Canadian Water Quality Guidelines (CWQG) by >2x • Known or strongly suspected to be between 1 - 2x CWQG • Meets Canadian Water Quality Guidelines	 11 6 0	The legislative basis in all jurisdictions is not to contaminate surface water beyond established limits.	Collect all available information on quality of surface water near to site. Evaluate available data against Canadian Water Quality Guidelines (select appropriate guidelines based on local water use, e.g., recreational, irrigation, freshwater aquatic life, etc.) and relevant provincial/territorial water quality objectives.	CCME Canadian Water Quality Guidelines; Relevant provincial /territorial and federal legislation and regulations.
	2. Potential for surface water contamination a) Surface Containment • No containment • Partial containment • Full containment	 5 3 0.5	The level and type of engineered containment will affect the potential for contaminants to be released to surface water.	Review the existing engineered systems and relate these structures to site conditions and proximity to surface water and determine if full containment is achieved; e.g., evaluate low if there is full containment such as capping, berms, dikes; evaluate medium if there is partial containment such as natural barriers, trees, ditches, sedimentation ponds; evaluate high if there are no intervening barriers between the site and nearby surface water.	Site inspection reports, air photos, etc.
	b) Distance to perennial surface water • 0 to <100 m • 100 to 300 m • >300 m	 3 2 0.5	The distance to surface water will affect the probability of contaminants reaching the watercourse. The Ontario Ministry of the Environment has established a classification for immediate impact zone at 50 m. For conservatism, this zone has been broadened to 100 m.	Review available mapping and survey data to determine distance to nearest surface water bodies.	
	c) Topography • Contaminants above ground level and slope is steep • Contaminants at or below ground level and slope is steep • Contaminants above ground level and slope is flat • Contaminants at or below ground level and slope is flat	 1.5 1.2 1 0.8 0	Water can run off (and therefore potentially contaminate surface water) with greater ease from elevated sites on slopes.	Review engineering documents on the topography of the site and the slope of surrounding terrain. • steep slope = >50% • flat slope = <5% Note: Type of fill placement (e.g., trench, above ground, etc.)	

II. EXPOSURE PATHWAYS (cont'd) SCORE

B. Surface Water

1. • Observed or Measured Contamination

Document information on surface water contamination: NO RECORD

Scoring Rationale & Information Source: —

2.a • Surface Containment

Review and document engineered or natural systems protecting surface water: NO SURFACE CONTAINMENT

Scoring Rationale & Information Source: 5

2.b • Distance to Perennial Surface Water

Estimate distance from site to nearest stream or other water body: OTTAWA RIVER TO THE EAST, CHALK BAY TO THE SOUTH AND MASON LAKE WITHIN THE AREA

Scoring Rationale & Information Source: 3

2.c • Topography

Document terrain conditions: FLAT SLOPE TO STEEP SLOPE

Document position of contaminants (are they above ground or buried?) CONTAMINANTS AT OR BELOW GROUND LEVEL

Scoring Rationale & Information Source: MAP MCE 132 Ed 8 TR 99 1

Site Identification: ______

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	B. 2. d) Run-off potential (see nomograph, end of Appendix D) • >1000 mm rainfall and low permeability surface material • 500 to 1000 mm rainfall and moderately permeable surface material • <500 mm rainfall and highly permeable surface material	 1 0.6 0.2	Run-off transports contaminants into water bodies. Water run-off is a function of precipitation and the rate of infiltration (less permeable soils will allow greater run-off).	Refer to Environment Canada precipitation records for relevant areas. Use 30-year average precipitation for evaluation purposes. Determine factor score using "Run-Off Potential Nomograph" figure at end of Appendix D.	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	e) Flood potential • 1 in 2 years • 1 in 10 years • 1 in 50 years	 0.5 0.3 0.1	The potential for large quantities and concentrations of contaminants to be released to surface water courses over a short period of time will be affected by the flood potential of a water course near the site.	Review published data such as flood plain mapping or flood potential (e.g., spring or mountain run-off) and Conservation Authority records to evaluate flood potential of nearby water courses both up and down gradient. Rate zero if site not in flood plain.	Established flood plain guidelines/ maps; provincial/ territorial soil survey maps.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) : Solubility (S) : • low (S/standard ≈ 10^1) • medium (S/standard ≈ 10^2) • high (S/standard ≈ 10^3)	 -2* 0 2*	* The weighting suggested is valid if there are no points affected to other special considerations.	
Biodegradation (μ) : • observed • non observed • non biodegradable Other special considerations :	 -2* 0 2* (-4 à 4)	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS (cont'd) **SCORE**

B. Surface Water (cont'd)

2.d • Run-off Potential

Document geological and rainfall conditions: PRECIPITATION ≃ 700 mm + PERMEABLE SURFACE MATERIALS

Scoring Rationale & Information Source: 0.6

2.e • Flood Potential

Estimate flood frequency of nearby water courses or water bodies: UNKNOWN
ACCORDING TO CHRIS HOGAN, NO FLOOD HAPPENS IN THE LAST 50 YEARS

Scoring Rationale & Information Source: 0.25 ?

3. • Special Considerations

Document any other important surface water conditions not addressed above: HIGH SOLUBILITY (S/STANDARD ≃ 130/0.12) => 2
BIODEGRADATION (NON OBSERVED)

Scoring Rationale & Information Source: 2

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	C. Direct Contact 1. Known contamination of media off-site • Known contamination of soil, sediment or air off-site due to contact with contaminated soil, dust, air, etc. (vector transported should also be considered). • Strongly suspected contamination of media off-site • No contamination of media off-site	 11 6 0	Known or measured contamination off-site is an important consideration for determining impact of contaminants.	Record known or measured contamination of soil, sediment or air on or off-site. Note any presence of soil gas, such as methane, associated with site.	
	2. Potential for direct human and/or animal contact a) Airborne Emissions (gases, vapours, dust, etc.) • Known or suspected airborne emissions impacting on neighbouring properties • Airborne emissions generally restricted to site • No airborne emissions	 5 6.5 3 0	If air emissions are evident off-site, there is a great hazard for direct contamination of neighbouring biota and/or resources.	Review available site information to determine if there have been complaints off-site (due to vapours, gas, dust, etc). Reports for these problems are not likely available for most abandoned sites. Review regulatory site inspection reports. If airborne emissions are known to be impacting neighbouring properties and possibly endangering the public, some immediate action (including characterization of emissions) should be initiated to curtail hazardous emissions or otherwise reduce or eliminate exposure.	Site inspection reports, etc.
	b) Accessibility of Site (ability to contact materials) • Limited or no barriers to prevent site access; contaminants not covered • Moderate accessibility or intervening barriers; contaminants are covered • Controlled access or remote location and contaminants are covered	 4 3.5 3 0	The greater the accessibility to a site and to contaminants, the greater the chance for contamination of human and animal life by direct contact.	Review location and engineering of the site and determine if there are intervening barriers between the site and humans or animals. A low rating should be assigned to a (covered) site surrounded by a locked chain link fence or in a remote location, whereas a high score should be assigned to a site that has no cover, fence, natural barriers or buffer.	
	c) Hazardous soil gas migration • Contaminants are putrescible and soil permeability is high • Soil contaminants are putrescible but soil permeability is low and/or groundwater is <2 m from surface • No putrescible contaminants at the site.	 2 1 0	Methane gas migration has been known to cause explosions adjacent to abandoned landfills.	Consider presence of organic material on site, the depth to water table, soil hydraulic conductivity, vegetative stress, odours, etc.	
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) : Vapor pressure : • < 0,1 kPa • 0,1 à 0,5 kPa • 0,5 à 1,5 kPa • > 1,5 kPa Powderiness : • < 0,1 % • 0,1 à 1 % • 1 à 10 % • > 10 % Other special considerations	 -2* -2/3* 2/3* 2* -2* -2/3* 2/3* 2* (-4 à 4)	(N.B. : vapor pressure limits are valid at a 20°C temperature) * The weighting suggested is valid if there are no points affected to other special considerations. (i.e. the sample % with a grain size ≤ 45 µm) N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS (cont'd) — **SCORE**

C. Direct Contact

1. • Known Contamination Off-site:

Document reports of off-site contamination due to contact with contaminated soil, dust, air, etc.: NO RECORD

Scoring Rationale & Information Source: ____ | Score: –

2.a • Airborne Emissions

Document incidents or complaints about fumes, gases, dust, odours, etc.: POSSIBLE BUT UNKNOWN

Scoring Rationale & Information Source: ____ | Score: 3 ?

2.b • Accessibility of Site

Review and document avenues of site access by humans and animals: THE ACCESS IS CONTROLED, BUT PEOPLE COMING BY BOAT NEGLECT THE "NO TRESPASSING" RULE

Scoring Rationale & Information Source: SEAN MOYLES | Score: 3 ?

2.c • Hazardous Soil Gas Migration

Review potential for hazardous soil gas production and migration from site: NO PUTRESCIBLE CONTAMINANTS

Scoring Rationale & Information Source: ____ | Score: 0

3. • Special Considerations

Document any other conditions whereby humans/animals could contact contamination: VAPOR PRESSURE ($\simeq 1,49 \times 10^{-9}$ atm)

Scoring Rationale & Information Source: ____ | Score: -2

Site Identification: ____

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors	A. Human and Animal Uses 1. Known adverse impact on humans or domestic animals as a result of the contaminated site • Known adverse effect on humans or domestic animals • Strongly suspected adverse effect on humans or domestic animals	 18 15	Contamination from a site that causes a measurable impact on humans is a great concern.	Review and evaluate reports of impact(s) of site contamination (e.g., increased heavy metal levels measured in blood of nearby residents as a result of site contamination). Any site assigned 15 or more points for this factor should automatically be classified as Class 1. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980)	
	2. Potential for impact on humans or animals a) Drinking water supply i) Known impact on drinking water supply Drinking water supply is known to be adversely affected as a result of site contamination • Known contamination of drinking water supply to levels above CDWG • Strongly suspected contamination of drinking water supply • Drinking water supply is known not to be contaminated	 9 7 0	Water used for drinking should be protected against contamination from any site.	Review available site data (inspection reports, assessment documentation) to determine if drinking water (groundwater, surface water, private, commercial or municipal supply) is known or suspected to be contaminated above Guidelines for Canadian Drinking Water Quality or applicable provincial/territorial guidelines or policies. If drinking water supply is known to be contaminated above these guidelines, some immediate action (e.g., provision of alternate drinking water supply) should be initiated to reduce or eliminate exposure.	Guidelines for Canadian Drinking Water Quality; other drinking water guidelines developed by recognized agencies (e.g., other Health and Welfare Canada guidelines, U.S. EPA, etc.).
	ii) Potential for impact on drinking water supply • Proximity to drinking water supply • 0 to <100 m • 100 to <300 m • 300 m to <1 km • 1 to 5 km	 6 5 4 3 2	The nearer a drinking water well is to a contaminant source, the greater the potential for contamination. Well water used for irrigation/agricultural purposes should also be included as it may be used for human consumption.	Review provincial/territorial base mapping or air photos and measure the distance to the nearest resident or drinking water supply. Judge whether the water is being used as a drinking water source. Commonly rural areas use groundwater for drinking purposes. For urban sites, contact the local Public Utilities Commission to determine water source and location.	
	• "Availability" of alternate drinking water supply • Alternate drinking water supply is not available • Alternate drinking water supply would be difficult to obtain • Alternate drinking water supply available	 3 2 0.5	This factor takes into account the availability of replacement water supplies, and is used in the technical sense as a factor to indicate the degree of urgency, not as a sociopolitical consideration.	Determine availability of alternate drinking water supply or distance to alternate source.	

SITE CLASSIFICATION WORKSHEET - cont'd

III. RECEPTORS SCORE

A. Human and Animal Uses

1. • Known Adverse Impact on Humans or Domestic Animals

Record known or suspected adverse effects on humans or domestic animals: NO RECORD

Scoring Rationale & Information Source: —

2.a.i • Known Contamination of Drinking Water Supply

Record known or suspected incidents of contamination of drinking water: NO RECORD

Scoring Rationale & Information Source: —

2.a.ii.°• Distance to Nearest Drinking Water Supply(s)

Identify nearest drinking water well and measure distance to site: THE WATER WELL, WHICH PROVIDE WATER FOR PETAWAWA VILLAGE AND THE BASE IS LOCATED 7 Km SOUTH FROM THE SITE (DOWNSTREAM)

Scoring Rationale & Information Source: 2

2.a.ii.°°•Availability of Alternate Drinking Water Supply

Document availability of alternate sources of drinking water and ease of implementation: OTHER WATER SUPPLY WOULD BE DIFFICULT TO OBTAIN (PEMBROKE, DEEP RIVER)

Scoring Rationale & Information Source: 3

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	A.2. b) Other Water Resources i) Known impact on used water resource Water resource (used for recreational purposes, commercial food preparation, livestock watering, irrigation or other food chain uses) is known to be adversely affected as a result of site contamination • Water resource is known to be contaminated above CWQG • Water resource is strongly suspected to be contaminated above CWQG • Water resource is known not to be contaminated	 4 3 0	The water used for these purposes (groundwater or surface water) should be protected against contamination.	Review documentation for reported or suspected contamination of water used for recreation or food chain uses, and refer to Canadian Water Quality Guidelines or other relevant guidelines (select appropriate guidelines based on local water use) to determine if supply is considered contaminated.	CCME Canadian Water Quality Guidelines; provincial/ territorial water quality guidelines and objectives; etc.
	ii) Potential for impact on water resources • Proximity to water resources used for activities listed above • 0 to <100 m • 100 to <300 m • 300 m to <1 km • 1 to 5 km	 2 1.5 1 0.5	The nearer a water resource is to a site, the greater the risk of contamination.	Determine distance from the site to the nearest recreational or food chain used water resource.	
	• Use of water resources - if multiple uses, give highest score (use following table)	0.2 - 2	Potential for impact due to use of water resource is related to the type and frequency of use. Human uses are of the highest concern.	Assess water users adjacent to the site from maps and directories.	

Water Use	Frequency of Use: Frequent	Occasional
Recreational (swimming, fishing)	2	1
Commercial food preparation	1.5	0.8
Livestock watering	1	0.5
Irrigation	1	0.5
Other domestic or food chain uses	0.5	0.3
Not currently used but likely future use	0.5	0.2

SITE CLASSIFICATION WORKSHEET - cont'd

III. RECEPTORS (cont'd) **SCORE**

A. Human and Animal Uses (cont'd)

2.b.i • Known Impact on Used Water Resource

Record information on water resource that is or is potentially affected by site contamination: NO RECORD

Scoring Rationale & Information Source: –

2.b.ii.°• Proximity of Water Resources to Site

Locate and measure nearest water resource areas to site: CHALK BAY AND OTTAWA RIVER

Scoring Rationale & Information Source: 2

2.b.ii.°°• Water Uses

Record uses of nearby water resources: RECREATIONAL FISHING + SWIMMING

Scoring Rationale & Information Source: 2

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	A. 2. c) Direct human exposure i) Known contamination of land used by humans • Known contamination of land used for agricultural or residential/parkland/school purposes above AG or R/P EQC values • Known contamination of land used for commercial or industrial purposes above C/I EQC values • Land is known not to be contaminated	 5 3.5 0	Hazards associated with soil contamination are directly related to land use.	Review zoning and land use maps for lands adjacent the site. Evaluate levels of soil contamination against Canadian Environmental Quality Criteria (EQC) for Contaminated Sites (AG = agricultural level; R/P = residential/parkland level; C/I = commercial/industrial level). If soil is known to be contaminated above these levels and possibly endangering public health, some immediate action (e.g., fencing the area, limiting public access, etc.) should be initiated to reduce or eliminate the exposure.	CCME Canadian Environmental Quality Criteria for Contaminated Sites.
	ii) Potential human exposure through land use • Use of land at and surrounding site (use following table; give highest score to worst case scenario)	0.5 - 5 3	Hazards associated with soil contamination are directly related to land use and distance of the used land from the site. Residential and agricultural land uses are of highest concern because humans are situated at these locations for longer periods.	Review zoning and land use maps over the distances indicated. If the proposed future land use is more "sensitive" than the current land use, evaluate this factor assuming the proposed future use is in place (indicate in the worksheet that future land use is the consideration). Agricultural land use is defined as uses of land where the activities are related to the productive capability of the land or facility (e.g., greenhouse) and are agricultural in nature, or activities related to the feeding and housing of animals as livestock. Residential/Parkland land uses are defined as uses of land on which dwelling on a permanent, temporary, or seasonal basis is the activity (residential), as well as uses on which the activities are recreational in nature and require the natural or human designed capability of the land to sustain that activity (parkland). Commercial/Industrial land uses are defined as land on which the activities are related to the buying, selling, or trading of merchandise or services (commercial), as well as land uses which are related to the production, manufacture, or storage of materials (industrial).	
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	

Land Use (current or future)	Distance from Site: 0 - 300m	300m - 1km	1 - 5km
Residential	5	4.5	3
Agricultural	5	4	2.5
Parkland/School	4	3	1.5
Commercial/Industrial	3	1	0.5

3. Special considerations (detailed) :			
People affected by contamination : • ≤ 250 • 250 à 1000 • > 1000	0 1,5* 3*	* The weighting suggested is valid if there are no points affected to other special considerations.	
Type of person using the site : • Workers • Adults • Children and seniors	0 1* 2*	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	
Other special considerations	(-5 à 5)		

III. RECEPTORS (cont'd) **SCORE**

A. Human and Animal Uses (cont'd)

2.c.i • Known Contamination of Land Used by Humans

Record land use type (current or proposed) and level of contamination for land known to be contaminated due to site: NO RECORD

Scoring Rationale & Information Source: —

2.c.ii • Land Use at and Adjacent to the Site

Document land uses (current and proposed) for up to 5 km from the site: MILITARY EXERCISES

	N	E	S	W
0 - <300 m	OTTAWA RIVER	OTTAWA RIVER	CHALK BAY	TRAINING
300 m - <1 km			OTTAWA RIVER	AREA A
1 km - 5 km				

Scoring Rationale & Information Source: 3

3. • Special Considerations

Document any other important human or animal use information, including details of air contamination if known:
PEOPLE AFFECTED => <250 => 0
THE SITE IS USED BY MILITARY PEOPLE

Scoring Rationale & Information Source: 0

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	B. Environment 1. Known adverse impact on a sensitive environment as a result of the contaminated site • Known adverse impact on sensitive environment • Evidence of stress on aquatic species or vegetative stress on trees, crops or plant life located on properties neighbouring the site • Strongly suspected adverse impact on sensitive environment	 16 14 12	The environment should be protected against site contamination. Evidence of impact(s) shows that protection is lacking.	Review records for evidence of vegetative stress or impairment of any nearby sensitive environments. A sensitive environment is defined as a sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980).	
	2. Potential for impact on sensitive environments a) Distance from site to nearest sensitive environment (e.g., sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc.) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km	 10 6 2 0.5	It is considered that within approximately 1 km of the site there is immediate concern for contamination. Therefore, an environmentally sensitive area located within this area of the site will be subject to concern. It is also generally considered that any sensitive area located greater than 10 km from the site will not be impacted.	Review Conservation Authority mapping and literature. Also review Ministry of Natural Resources records and Federal Land Capability maps. Identify provincial/territorial and federal designated environmentally sensitive areas.	Relevant provincial /territorial and federal maps of sensitive environments.
	b) Groundwater - distance to important or susceptible groundwater resource(s) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km	 6 4 2 1	The closer a site is to a discharge or recharge area, the greater the potential for contamination of a groundwater or surface water resource.	Review groundwater contour maps, if available, and other available reports. Otherwise use established hydrogeologic principles.	Local groundwater maps, etc.
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	

SITE CLASSIFICATION WORKSHEET - cont'd

III. RECEPTORS (cont'd) **SCORE**

B. Environment

1. • Known Adverse Impact(s) on Sensitive Environment

Record known impact(s) on any sensitive biological environment at and/or around the site: NO RECORD

Scoring Rationale & Information Source: —

2.a • Distance from Site to Nearest Sensitive Environment

Document location, distance, type and details of any nearby sensitive environments or habitats: SOME MARSHES WITHIN THE AREA

Scoring Rationale & Information Source: 10

2.b • Groundwater

Measure distance to major recharge or discharge area: RECHAGE AREA WITHIN THE SITE (MOUNTAINS, OUTCROP)

Scoring Rationale & Information Source: 6

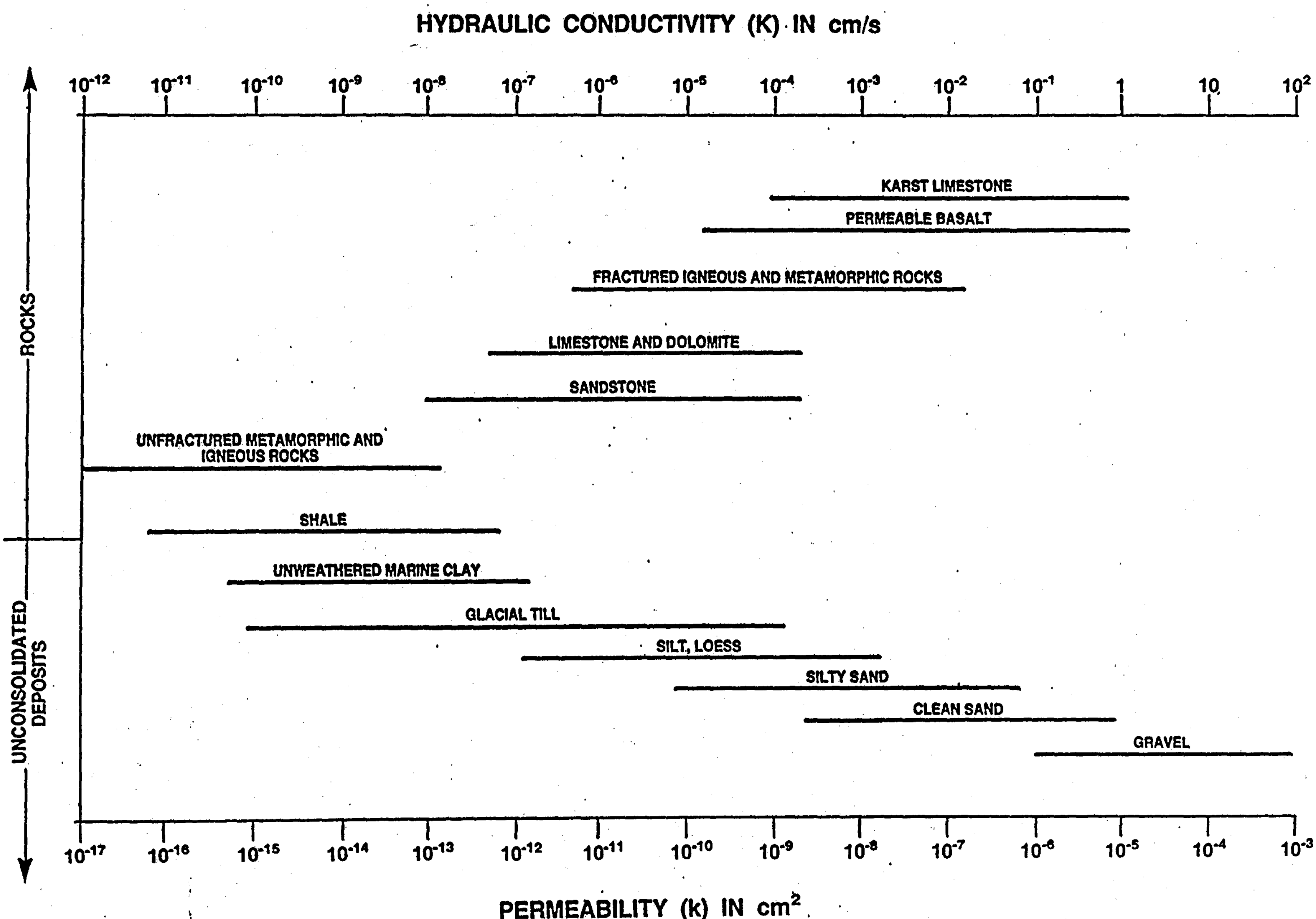
3. • Special Considerations

Document any other important impacts on the environment not addressed above:

Scoring Rationale & Information Source: —

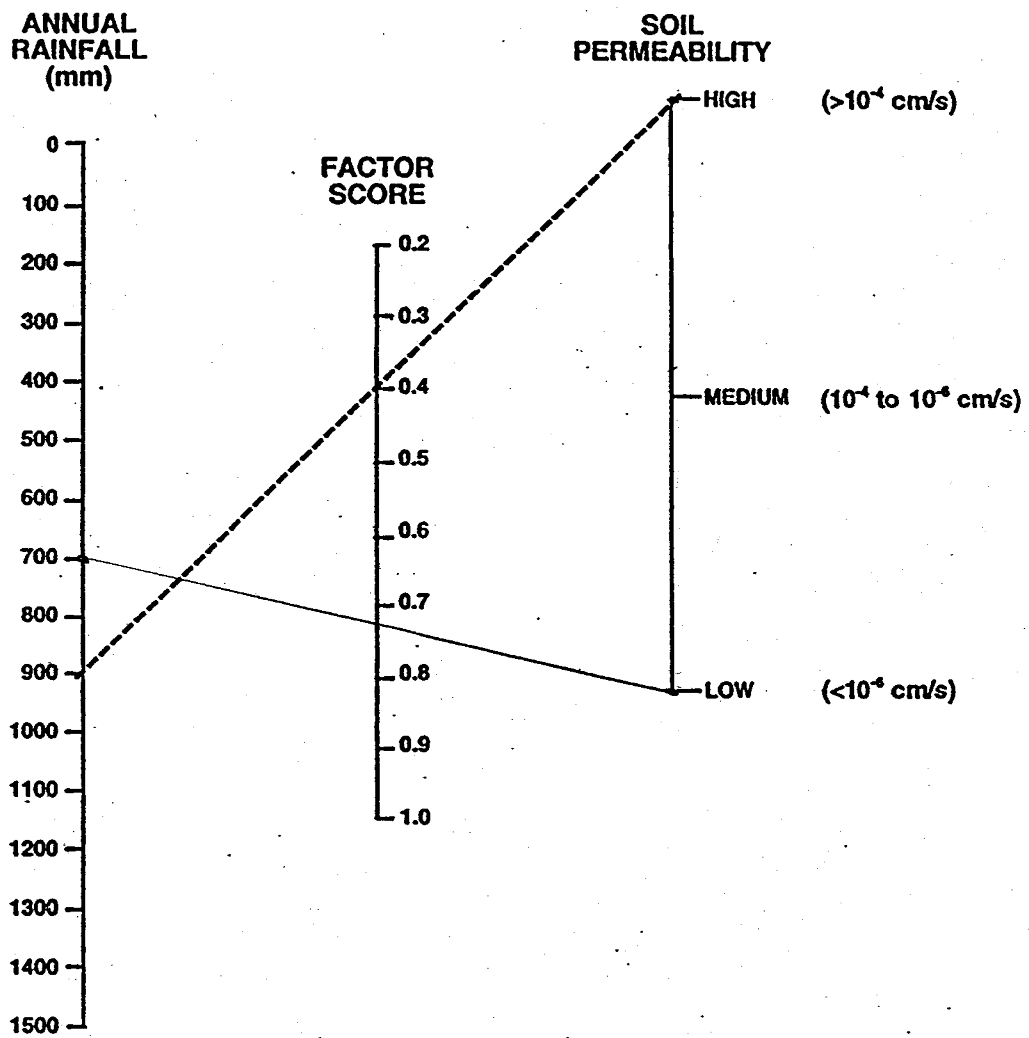
Site Identification:

RANGE OF VALUES OF HYDRAULIC CONDUCTIVITY AND PERMEABILITY



MODIFIED FROM FREEZE AND CHERRY, 1979 AND TODD, 1959

RUN-OFF POTENTIAL NOMOGRAPH
(FACTOR II B 2 d)



To determine the factor score, use a ruler and join the annual rainfall value (mm) with the soil permeability data; take the factor score from the middle line.

For example, if rainfall is 900 mm and soil permeability is high, the score would be 0.4.

Compounds	Abbreviations	Solubility	T	Vapour pressure	T	Degradation	Degradation constants (mu)			Kd	Toxicity	'EPA drinking water standard"	MEF water quality criteria	Drinkability standard	Danger criteria (Daniels)	Danger criteria (Rouisse)	References
							Sand	Silt	Clay								
Units		(mg/L)	(C)	(atm)	(C)		(/hr)	(/hr)	(/hr)	(L/kg)		(mg/L)	(mg/L)	(ppb-ug/L)	(mg/K)	(mg/Kg)	
2,4,6 trinitrotoluene	2,4,6 TNT	150	25	7,25E-09	25	Mostly anaerobic					Possibly toxic	0,02					(1)
		130	20	1,45E-09	20									1	0,3	0,024	(2)
		150	25	9,49E-09	25												(3)
		130	20	4,61E-09	20												(3)
				1,66E-09	20												(4)
							3,20E-03	1,40E-01	8,30E-02								(5)
										Ottawa sand: 1,5							(6)
										Silt: 4,5							(6)
										Clay: 10							(6)
													0,12*				(7)
2,4 dinitrotoluene	2,4 DNT	280	25	2,86E-07	25	Aerobic and anaerobic					Possibly carconogenous						(1)
		270	22	2,89E-07	20									5			(2)
				3,17E-08	25												(3)
		270	20	1,61E-08	20												(3)
													1,10E-04				(7)
2,6 dinitrotoluene	2,6 DNT	208	25	7,46E-07	25	Aerobic and anaerobic											(1)
		206	25	7,46E-07	20									5			(2)
													0,93*				(7)
cyclo - 1,3,5 - triméthylene - 2,4,6 - trinitramine	RDX	45	25	5,30E-12	25	Anaerobique					Possibly carconogenous	0,1					(1)
		42	20	5,53E-12	20									2	0,3	0,00024	(2)
(or hexahydro - 1,3,5 - trinitro - 1,3,5 - triazine, or		50	20	2,56E-12	20												(3)
							0	6,50E-03	1,40E-02								(5)
										0,1 à 13,26							(6)
cyclo - 1,3,5,7 - tetramethylene - 2,4,6,8 - tetranitramine	HMX	5	25	4,38E-17	25	Anaerobique						nd		400	1,7	2,2	(1)
(or octahydro - 1,3,5,7 -		5	25	4,34E-17	20												(2)
tetranitro - 1,3,5,7 -										0,2 à 4,2							(6)
tetrazocine)							0	3,60E-03	3,20E-02								(5)

(1) McGrath, 1995
(2) Thiboutot *et al*, 1998
(3) Pheelan and Webb, 1997
(4) Hayes, 1992
(5) Myers *et al*, 1996
(6) Townsend *et al*, 1996
(7) http://www.mef.gouv.qc.ca/fr/environn/criteres_eau

* Provisory criteria for aquatic life (surface water)

Conversion table for pressure units

	atm	mm Hg	torr	kPa	bar
1 atm =	1	760	760	101,3	1,013250274
1 mm Hg =	0,00131579	1	1	0,13328947	0,001333224
1 torr =	0,00131579	1	1	0,13328947	0,001333224
1 kPa =	0,00987167	7,50246792	7,50246792	1	0,010002471
1 bar =	0,986923	750,06148	750,06148	99,9752999	1

Site classification computerised worksheet

Site: Petawawa Grenade Range Date: 06-27-2000 User (s): Marc-André Lavigne

	Sections	Score for potential impacts	Known and/or potential impacts		?	Comments
	CONTAMINANT(S) CHARACTERISTICS					
A)	DEGREE OF HAZARD	11	11	/14	0	Energetic materials found in ordnances.
B)	CONTAMINANT QUANTITY	2	2	/10	0	Area < 1 km², no register before 1995.
C)	PHYSICAL STATE OF CONTAMINANTS	3	3	/9	0	TNT, RDX, HMX, etc.
	Special considerations	0	0	/6		
	TOTAL	16	16	/33	0	N.B.: If the total is < 0 or > 33, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 33).
	EXPOSURE PATHWAYS					
A)	GROUNDWATER					
	Known contamination at or beyond property boundary		-100	/11		
	Engineered subsurface containment	4	4	/4	0	No engineered system.
	Thickness of confining layer over aquifer(s) of concern	1.5	1.5	/1,5	0	No confining layer.
	Hydraulic conductivity of the confining layer	2	2	/1,5	0	No confining layer.
	Annual rainfall	0.7	0.7	/1	0	700 mm between 1950 and 1981.
	Hydraulic conductivity of the aquifer(s) of concern	1.5	1.5	/3	0	From 10E-04 cm/s to 10E-01 cm/s.
	Special considerations	1.3	1.3	/4		Solubility: 4/3, Retardation Factor: 0, Biodegradation: not observed
	TOTAL	11.0	11.0	/11	0.0	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
B)	SURFACE WATER					
	Observed or mesured contamination of water/effluent discharged from site		-100	/11		
	Surface containment	5	5	/5	0	No surface containment.
	Distance to perennial surface water	0.5	0.5	/3	0	Ottawa River 3 km east.
	Topography	0	0	/1,5	0	Flat, contaminants are at or below ground level.
	Run-off potential (see nomograph)	0.31	0.31	/1	0	
	Flood potential	0.1	0.1	/0,5	0.1	No flood in the last 50 years.
	Special considerations	2.0	2.0	/4		Solubility: 2
	TOTAL	7.9	7.9	/11	0.1	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
C)	DIRECT CONTACT					
	Known contamination of media off-site		-100	/11		
	Airborne emissions (gases, vapour, dust, etc.)	2.5	2.5	/5	2.5	Possible but unknown.
	Accessibility of site (ability to contact materials)	2	2	/4	0	Access controled, contaminants not totally covered.
	Hazardous soil gas migration	0	0	/2	0	No putrescible contaminants.
	Special considerations	-1.3	-1.3	/4		Vapor pressure: -2, powderiness: 2/3
	TOTAL	3.2	3.2	/11	2.5	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
	RECEPTORS					
A)	HUMANS AND ANIMALS					
	Known adverse impact on living things as a result of the contaminated site		-100	/18		
	Known impact on drinking water supply		-100	/9		
	Proximity to drinking water supply	3	3	/6	0	Water plant southwest of the site.
	"Availability" of alternate drinking water supply	1.5	1.5	/3	1.5	Unknown but possible.
	Known impact on used water resource		-100	/4		
	Proximity to water resources used for activities	0.5	0.5	/2	0	Ottawa River 3 km west.
	Use of water resources	2	2	/2	0	Boating, fishing and swimming.
	Known contamination of land used by humans		-100	/5		
	Use of land at and surrounding site	0	0	/5	0	Military exercises.
	Special considerations	0.0	0.0	/5		People affected lower than 250, military people.
	TOTAL	7.0	7.0	/18	1.5	N.B.: If the total is < 0 or > 18, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 18).
B)	ENVIRONMENT					
	Known adverse impact on sensitive environment as a result of the contaminated site		-100	/16		
	Distance from site to nearest sensitive environment	2	2	/10	0	Some marshes along Tucker Creek and Jorgens Lake.
	Distance to important or susceptible groundwater resource(s)	2	2	/6	0	Jorgens Lake: recharge area.
	Special considerations	0	0	/5		
	TOTAL	4	4	/16	0	N.B.: If the total is < 0 or > 16, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 16).

Total score (potential impacts)	47.1	+	2.0	/100	+/-	4.1
Total score (known impacts or potential impacts if the former is not known)	47.1	+	2.0	/100	+/-	4.1

N.B. : If the uncertainty exceeds 15, we consider that there if insufficient information to assign a significant score and the site is therefore classified in class I (for insufficient information).

Score	Class	Risk potential	Action required
70-100	1	High	Yes
50-69	2	Medium	Likely
38-49	3	Medium low	May be
<=37	N	Low	Not likely

N.B. : The number "-100" has been used as default when no information was available about the contamination of the site. This value (-100) was chosen to avoid any confusion with possible scores.

Appendix C

Facility/Site Description

FACILITY/SITE DESCRIPTION

Document site information as completely as possible:

Site No.: RA611 Site Name: PETAWAWA GRENADE RGE Province/Territory: ONTARIO

Custodian Dept.: DND Facility Name: CFB PETAWAWA Site Operator/Manager: CFB PETAWAWA

Type of Site: GRENADE RANGE Site Owner: DND

Zone: ____ UTM Coordinates: 3188000 Easting Latitude: ____ deg. ____ min. ____ sec.

5088300 Northing Longitude: ____ deg. ____ min. ____ sec.

Location: ____ Legal Land Description: ____

Address ____ Provincial Parcel No.: ____

Brief Description of Site: ____

Site Land Use: Current: MILITARY TRAINING Proposed: IDEM

Comments:

Summary of Site Classification Information:

Completed Evaluation Form: X Detailed X Short

Site Score: 49.1 Total ± 4.1 Estimated Score

Class: (1, 2, 3, N, or I) 3-2 Risk: MEDIUM LOW TO MEDIUM

Notes: DESPITE ITS LOW MARK, A MORE PRECISE STUDY INCLUDING SOIL AND WATER SAMPLING WOULD BE NECESSARY IN ORDER TO KNOW THE INFLUENCE OF THE MILITARY TRAININGS.

12

Contact Name: CHRIS HOGAN / SEAN MOYLES

Position: ____

Address: ____

City: PETAWAWA Prov./Terr.: ONT. Postal Code: ____

Phone No.: ____ Fax No.: ____

Site Classified by above ____ or MARC-ANDRÉ LAVIGNÉ / KARINE CHAMPAGNE

Degree of Familiarity with Site: ____ Very familiar ____ Moderately familiar X Indirectly familiar ____ Unfamiliar

Visited site: ____ Yes X No

Position: RESEARCH ASSISTANT Phone No.: (418) 654-2647

Address: 880 CHEMIN STE-FOY, BUR 840 CP 7500

City: QUEBEC Prov./Terr.: QUEBEC Postal Code: G1V 4C7 Date of Completed Classification: ____

Site Identification: ____

National Classification System Process Checklist

____ USER'S GUIDE REVIEWED

_x_ MINIMUM DATA REQUIREMENTS MET

- _x_ Description of site location
- _x_ Type of contaminants or materials likely to be present at site (and/or description of historical activities)
- _x_ Approximate size of site and quantity of contaminants
- ____ Approximate depth to water table
- _x_ Geologic map or survey information (soil, overburden, and bedrock information)
- _x_ Annual rainfall data (can be inferred from rainfall map of Canada)
- _x_ Surface cover information
- _x_ Proximity to surface water
- _x_ Topographic information
- ____ Flood potential of site
- _x_ Proximity to drinking water supply
- _x_ Uses of adjacent water resources
- _x_ Land use information (on-site and surrounding)

_x_ FACILITY/SITE DESCRIPTION COMPLETED

_x_ SITE CLASSIFICATION WORKSHEET COMPLETED

_x_ REFERENCES ATTACHED/CITED

_x_ EVALUATION FORM COMPLETED

_x_ Detailed Form   _x_ Short Form

____ SCORE SHEET COMPLETED

_x_ SITE CLASSIFICATION

Class: ____ 1   _x_ 2   _x_ 3   ____ N   ____ I

Score: 49.1 (Total) ± 4.1 (Estimated Score)

____ SITE INFORMATION ENTERED ON NCS COMPUTERIZED VERSION

Site Identification: ________________________

SHORT EVALUATION FORM

Instructions for Use

Answer Yes or No to questions 1 to 5 below. If the response to question 1a) or 1b) is Yes, automatically rate the site as Class 1 (C1). If the answers to any three of questions 2 to 5 are Yes, the site should also be rated as Class 1. For all Yes answers, supporting documentation and rationale must be referenced or attached.
To confirm Class 1 rating and/or if two or more No responses are given, the Detailed Evaluation Form should also be completed.

		No	Yes	Reference Attached
1	a) Is site contamination known to have caused adverse impacts on humans or sensitive environments? (see User's Guide)	☒	☐ → Class 1	☐
	b) Is the site a fire or explosion hazard as it currently exists?	☒	☐ → Class 1	☐
I	**Contaminant(s) Characteristics**			
	2 Are contaminants that can be classified as 'high concern' (as defined in the User's Guide) present at the site?	☐	☒	☐
	3 Are the high concern contaminants known to be present in large quantities? Answer yes if contaminant is: • liquid (as disposed/spilled) • in quantity >1,000 m³ • in an area of contamination >10 ha • distributed or placed in such a manner as to have the potential to cause significant off-site contamination	☐	☒	☐
II	**Pathways**			
	4 Is the site known to have caused contamination (above national or applicable provincial/territorial guidelines or policies) of off-site groundwater, adjacent surface water, neighbouring surficial material (i.e., soil) or air? (see User's Guide)	☒	☐	☐
III	**Receptors**			
	5 Is the site contamination known to have a) impacted the quality of local drinking water or other water resources (i.e., exceeds Guidelines for Canadian Drinking Water and/or Canadian Water Quality Guidelines or applicable provincial/territorial guidelines or policies); b) contaminated lands used for agricultural, residential or parkland purposes (i.e., exceeds the AG or R/P values of Canadian Environmental Quality Criteria for Contaminated Sites or applicable provincial/territorial guidelines or policies); or c) caused vegetative stress or other known environmental impairment? (A Yes answer should be given if the impact has made the water, land, environment, or air unacceptable for use.)	☒	☐	☐

If 3 or more Yes answers are given in Sections I, II, and III above, rate site as Class 1. Check box if Class 1 rating. ☐

Site Identification: ____________

Appendix D

User's Guide (even pages) and Site Classification Worksheet (odd pages)

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
I. Contaminant(s) Characteristics	A. Degree of hazard • High concern contaminants - high concentration • High concern contaminants - low concentration • Medium concern contaminants - high concentration • Medium concern contaminants - low concentration • Low concern contaminants	14 11 8 5 3	In determining the degree of hazard of a waste, it is recognized that a listed hazardous waste is generally of greater concern than a liquid or solid industrial waste. These are in turn of greater concern than other solid wastes. Municipal and organic wastes are considered medium concern contaminants due to their putrescible nature (production of methane and other landfill gases). Household wastes may contain hazardous materials (e.g., batteries, medical wastes, paints, etc).	Determine the level of hazard according to the following table of typical contaminants and definition of high concentrations: High Concern Contaminants • Materials defined as dangerous goods in the Transport of Dangerous Goods Act and Regulations • Materials identified by Province as hazardous waste (pesticides, herbicides, paint sludge, acid and alkaline solutions, solvents, etc.) • Materials regulated by the Canadian Environmental Protection Act (e.g., PCBs) • Institutional waste (lab, schools hospitals, etc.) • Pathological wastes and animal carcasses • Radioactive wastes Medium Concern Contaminants • Liquid waste not referred to in above, petroleum products septic tank pumpings, agricultural and chemical containers • Food processing wastes • Non-hazardous incinerator residues • Municipal solid (household) wastes • Organic and vegetable wastes • Mining residues Low Concern Contaminants • Industrial and commercial solid wastes, (e.g., construction materials such as wood, metal, hay, sand/silt piles, etc.) • Other nearly inert wastes (e.g., foundry sands) High Concentration of Contaminants • contaminant concentrations in soil, groundwater or surface water exceed Canadian Environmental Quality Criteria for Contaminated Sites (>2x commercial/industrial level); or material that was deposited in highly concentrated form (e.g., >5000 ppm)	Transport of Dangerous Goods Act; Provincial/Territorial Hazardous Wastes lists; regulations under Canadian Environmental Protection Act; Canadian Environmental Quality Criteria for Contaminated Sites; etc.
	B. Contaminant Quantity (area/volume of site contamination) • >10 ha, or >1000 m^3, or drums of liquid • 2 to 10 ha, or 100 to 1000 m^3 • <2 ha, or <100 m^3	10 6 2	Little information is known about the quantity of wastes at abandoned sites in Canada. Therefore, waste quantity estimates may be interpreted from area or quantity information.	Measure or estimate the area or quantity of potential contamination. Note: Any number of drums abandoned or disposed is considered a high concern.	
	C. Physical State of Contaminants • Liquid/gas • Sludge • Solid	9 7 3	Contaminants in liquid form are more mobile in the ground and water than solids. However, certain water-soluble solid wastes are more mobile than viscous liquids, and these should be evaluated on a case-by-case basis.	Determine the state of the contaminant when it was disposed or deposited.	
	Special Considerations	-6 to +6	(See 3.7.3 in text)	Technical judgment.	

SITE CLASSIFICATION WORKSHEET

(Instructions: Document site information, assign score, provide rationale behind score and indicate source of information in the spaces provided.)

I. CONTAMINANT(S) CHARACTERISTICS — SCORE

A. • Degree of Hazard

List possible contaminants and estimated concentrations: ENERGETIC MATERIALS FOUND IN AMMUNITION (TNT, RDX AND HMX)

Scoring Rationale & Information Source: ______ [11]

B. • Contaminant Quantity

Estimated or measured areal volume of contaminated zone: NO RECORD OF UNEXPLODED SHELLS AND ORDNANCES FIRED BEFORE 1995
AREA < 2 ha
VOLUME OF CONTAMINANTS ESTIMATED BY AREA OF THE SITE

Scoring Rationale & Information Source: ______ [2]

C. • Physical State of Contaminant

Does the site contain:
a) Predominantly liquids/gases ______
b) Primarily sludges ______
c) Primarily solids TNT, RDX, HMX, etc

Scoring Rationale & Information Source: ______ [3]

• Special Considerations

Document any other important contaminant characteristics not addressed above: ______

Scoring Rationale & Information Source: ______ [ ]

Site Identification: ______

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways	A. Groundwater 1. Known contamination at or beyond property boundary • Groundwater significantly exceeds Canadian Drinking Water Guidelines (CDWG) by >2x or known contact of contaminants with groundwater • Between 1 and 2x CDWG or probable contact with groundwater • Meets Canadian Drinking Water Guidelines	11 6 0	The legislative basis for most jurisdictions is to prevent off-site migration of contamination.	Review chemical data and evaluate groundwater quality. If contamination at or beyond the property boundary exceeds Canadian Drinking Water Guidelines (CDWG) or applicable provincial/territorial guidelines or policies, or if contaminants are known to be in contact with groundwater, then evaluate the site as high.	Canadian Water Quality Guidelines; Provincial/ Territorial Water Quality Guidelines or policies; Guidelines for Canadian Drinking Water Quality.
	2. Potential for groundwater contamination (a) Engineered subsurface containment • No containment • Partial containment • Full containment	4 2 0	Well contained sites have minimal potential for pollution. Potential for pollution decreases with increasing containment.	Review the existing engineered systems and relate these structures to hydrogeology of the site and determine if full containment is achieved. Full containment is defined as an engineered system, monitored as being effective, which provides for the capture and treatment of contaminants. If there is no system, this factor is evaluated high. If there is less than full containment or if uncertain then evaluate as medium. Typical engineered systems include leachate collection systems and low permeability liners.	
	(b) Thickness of confining layer over aquifer(s) of concern • 3 m or less • 3 to 10 m • >10 m	1.5 1 0	The thickness of a confining layer (e.g., clay, shale, etc.) between contaminants and any aquifers of concern will affect the attenuation of contaminants and hence the quantity and quality of contaminants reaching the aquifers.	Measure or estimate thickness of any confining layer (e.g., clay, shale, etc.) over all aquifers of concern from existing well records or from a general knowledge of local conditions. If possible, an estimate of the continuity of the confining layer should be made from borehole well record information. Note: an aquifer is defined as a geologic material that will yield groundwater in usable quantities.	Historical geologic maps, well records, government hydrogeologist or local consultants.
	(c) Hydraulic conductivity of the confining layer • $>10^{-4}$ cm/sec • 10^{-4} to 10^{-6} cm/sec • $<10^{-6}$ cm/sec	1.5 1 0.5	The rate at which contaminants migrate through the confining layer will affect attenuation and the contaminant loading to the aquifers.	Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Apppendix D). Clays, granite, shales should be scored low. Silts etc. should be scored medium. Sand, gravel, and limestone should be scored high.	Freeze and Cherry, 1979, and other groundwater texts.

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS — **SCORE**

A. Groundwater

1. • Known Groundwater Contamination

Document information on known groundwater contamination: NO RECORD

Scoring Rationale & Information Source: ______ [—]

2.a • Engineered Subsurface Containment

Document engineered systems protecting groundwater: NO ENGINEERED SYSTEM

Scoring Rationale & Information Source: ______ [ ]

17

2.b • Thickness of Confining Layer Over Aquifer(s) of Concern

Document local geological conditions: BEDROCK (SHALE, SANDSTONE, MINOR DOLOSTONE) OVERLAINED BY SAND

Identify water-bearing zones used for water supply: NO CONFINING LAYER

Scoring Rationale & Information Source: ______ [1.5]

2.c • Hydraulic Conductivity of the Confining Layer

Estimate hydraulic conductivity of any confining layer: NO CONFINING LAYER

Scoring Rationale & Information Source: ______ [1.5]

Site Identification: ______

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	A.2. (d) Annual Rainfall • >1000 mm • 600 mm • 400 mm • 200 mm	 1 0.7 0.6 0.4 0.2	The quantity of rainfall affects the quantity of leachate produced. Higher leachate quantities have a higher impact on the environment.	Refer to Environment Canada rainfall records for relevant areas. Use 30-year average rainfall for evaluation purposes. Divide rainfall by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score)	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	(e) Hydraulic conductivity of aquifer(s) of concern • $>10^{-2}$ cm/sec • 10^{-2}-10^{-4} cm/sec • $<10^{-4}$ cm/sec	 3 3 1.5 0.5	Aquifers with high hydraulic conductivity can transport contaminants at high velocity over great distances, e.g., solution limestones, highly fractured rocks or gravel deposits.	Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Appendix D).	Freeze and Cherry, 1979.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) : Solubility (S) : • low (S/standard ≈ 10^1) • medium (S/standard ≈ 10^2) • high (S/standard ≈ 10^3)	 -4/3* 0 4/3*	 * The weighting suggested is valid if there are no points affected to other special considerations.	
Retardation factor (R) : • important delay (R / R_{Cl} ≈ 10^2) or (K_d ≈ 12,51) • delayed (R / R_{Cl} ≈ 10^1) or (K_d ≈ 1,14) • little or no delay (R / R_{Cl} ≈ 10^0) or (K_d ≈ 0)	 -4/3* ~~0~~ 4/3*	N.B. : the R calculation was done using n = 0,33 et ρ_b = 1,75 g/cm^3 ; if the studied soil is neither sand, silt or clay, the R factor must be recalculated because n et ρ_b change. (R_{Cl} ≈ 1)	
Biodegradation (µ) : • observed • non observed • non biodegradable Other special considerations	 -4/3* 0 4/3* (-4 à 4)	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	

II. EXPOSURE PATHWAYS (cont'd)

SCORE

A. Groundwater (cont'd)

2.d • Annual Rainfall

Document rainfall data: BETWEEN 1950 AND 1981 : 700 mm

Scoring Rationale & Information Source: CLIMATIC ATLAS - CANADA — 0.7

2.e • Hydraulic Conductivity of Aquifer(s) of Concern

Estimate hydraulic conductivity of relevant aquifer(s): VARIES FROM 10^{-4} cm/s to 10^{-1} cm/s

Scoring Rationale & Information Source: — 2

3. • Special Considerations

Document any other important ground water issues not addressed above:
SOLUBILITY (S/STANDARD = 130/0.12) => 4/3
RETARDATION FACTOR (Kd ≃ 1.50) => 0
BIODEGRADATION (NOT OBSERVED) => 0

Scoring Rationale & Information Source: — 4/3

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	B. Surface Water 1. Observed or measured contamination of water/effluent discharged from site • Known or strongly suspected to exceed Canadian Water Quality Guidelines (CWQG) by >2x • Known or strongly suspected to be between 1 - 2x CWQG • Meets Canadian Water Quality Guidelines	 11 6 0	The legislative basis in all jurisdictions is not to contaminate surface water beyond established limits.	Collect all available information on quality of surface water near to site. Evaluate available data against Canadian Water Quality Guidelines (select appropriate guidelines based on local water use, e.g., recreational, irrigation, freshwater aquatic life, etc.) and relevant provincial/territorial water quality objectives.	CCME Canadian Water Quality Guidelines; Relevant provincial /territorial and federal legislation and regulations.
	2. Potential for surface water contamination a) Surface Containment • No containment • Partial containment • Full containment	 5 3 0.5	The level and type of engineered containment will affect the potential for contaminants to be released to surface water.	Review the existing engineered systems and relate these structures to site conditions and proximity to surface water and determine if full containment is achieved; e.g., evaluate low if there is full containment such as capping, berms, dikes; evaluate medium if there is partial containment such as natural barriers, trees, ditches, sedimentation ponds; evaluate high if there are no intervening barriers between the site and nearby surface water.	Site inspection reports, air photos, etc.
	b) Distance to perennial surface water • 0 to <100 m • 100 to 300 m • >300 m	 3 2 0.5	The distance to surface water will affect the probability of contaminants reaching the watercourse. The Ontario Ministry of the Environment has established a classification for immediate impact zone at 50 m. For conservatism, this zone has been broadened to 100 m.	Review available mapping and survey data to determine distance to nearest surface water bodies.	
	c) Topography • Contaminants above ground level and slope is steep • Contaminants at or below ground level and slope is steep • Contaminants above ground level and slope is flat • Contaminants at or below ground level and slope is flat	 1.5 1.2 0.8 0	Water can run off (and therefore potentially contaminate surface water) with greater ease from elevated sites on slopes.	Review engineering documents on the topography of the site and the slope of surrounding terrain. • steep slope = >50% • flat slope = <5% Note: Type of fill placement (e.g., trench, above ground, etc.)	

II. EXPOSURE PATHWAYS (cont'd)

SCORE

B. Surface Water

1. • Observed or Measured Contamination

Document information on surface water contamination: NO RECORD

Scoring Rationale & Information Source:

Score: —

2.a • Surface Containment

Review and document engineered or natural systems protecting surface water: NO SURFACE CONTAINMENT

Scoring Rationale & Information Source:

Score: 5

2.b • Distance to Perennial Surface Water

Estimate distance from site to nearest stream or other water body: OTTAWA RIVER 3 Km WEST
JORGENS LAKE 2 KM SOUTH

Scoring Rationale & Information Source:

Score: 0.5

2.c • Topography

Document terrain conditions: FLAT TERRAIN

Document position of contaminants (are they above ground or buried?) AT OR BELOW GROUND LEVEL

Scoring Rationale & Information Source:

Score: 0

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	B. 2. d) Run-off potential (see nomograph, end of Appendix D) • >1000 mm rainfall and low permeability surface material • 500 to 1000 mm rainfall and moderately permeable surface material • <500 mm rainfall and highly permeable surface material	 1 0.6 0.31 0.2	Run-off transports contaminants into water bodies. Water run-off is a function of precipitation and the rate of infiltration (less permeable soils will allow greater run-off).	Refer to Environment Canada precipitation records for relevant areas. Use 30-year average precipitation for evaluation purposes. Determine factor score using "Run-Off Potential Nomograph" figure at end of Appendix D.	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	e) Flood potential • 1 in 2 years • 1 in 10 years • 1 in 50 years	 0.5 0.3 0.25 0.1	The potential for large quantities and concentrations of contaminants to be released to surface water courses over a short period of time will be affected by the flood potential of a water course near the site.	Review published data such as flood plain mapping or flood potential (e.g., spring or mountain run-off) and Conservation Authority records to evaluate flood potential of nearby water courses both up and down gradient. Rate zero if site not in flood plain.	Established flood plain guidelines/ maps; provincial/ territorial soil survey maps.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) :			
Solubility (S) :			
• low (S/standard ≈ 10^1)	-2*	* The weighting suggested is valid if there are no points affected to other special considerations.	
• medium (S/standard ≈ 10^2)	0		
• high (S/standard ≈ 10^3)	2*		
Biodegradation (μ) :			
• observed	-2*		
• non observed	0	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	
• non biodegradable	2*		
Other special considerations	(-4 à 4)		

II. EXPOSURE PATHWAYS (cont'd) SCORE

B. Surface Water (cont'd)

2.d • Run-off Potential

Document geological and rainfall conditions: ANNUAL RAINFALLS : 700 mm
HYDRAULIC CONDUCTIVITY : FROM 10^{-4} cm/s TO 10^{-1} cm/s

Scoring Rationale & Information Source: SEE P. 35 — 0.31

2.e • Flood Potential

Estimate flood frequency of nearby water courses or water bodies: NO FLOOD IN THE LAST 50 YEARS

Scoring Rationale & Information Source: — 0.25 ?

3. • Special Considerations

Document any other important surface water conditions not addressed above: SOLUBILITY (S/STANDARD = 130/0.12) => 2
BIODEGRADATION (NOT OBSERVED) => 0

Scoring Rationale & Information Source: — 2

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	C. Direct Contact 1. Known contamination of media off-site • Known contamination of soil, sediment or air off-site due to contact with contaminated soil, dust, air, etc. (vector transported should also be considered). • Strongly suspected contamination of media off-site • No contamination of media off-site	11 6 0	Known or measured contamination off-site is an important consideration for determining impact of contaminants.	Record known or measured contamination of soil, sediment or air on or off-site. Note any presence of soil gas, such as methane, associated with site.	
	2. Potential for direct human and/or animal contact a) Airborne Emissions (gases, vapours, dust, etc.) • Known or suspected airborne emissions impacting on neighbouring properties • Airborne emissions generally restricted to site • No airborne emissions	5 5.5 3 0	If air emissions are evident off-site, there is a great hazard for direct contamination of neighbouring biota and/or resources.	Review available site information to determine if there have been complaints off-site (due to vapours, gas, dust, etc). Reports for these problems are not likely available for most abandoned sites. Review regulatory site inspection reports. If airborne emissions are known to be impacting neighbouring properties and possibly endangering the public, some immediate action (including characterization of emissions) should be initiated to curtail hazardous emissions or otherwise reduce or eliminate exposure.	Site inspection reports, etc.
	b) Accessibility of Site (ability to contact materials) • Limited or no barriers to prevent site access; contaminants not covered • Moderate accessibility or intervening barriers; contaminants are covered • Controlled access or remote location and contaminants are covered	4 3 2 0	The greater the accessibility to a site and to contaminants, the greater the chance for contamination of human and animal life by direct contact.	Review location and engineering of the site and determine if there are intervening barriers between the site and humans or animals. A low rating should be assigned to a (covered) site surrounded by a locked chain link fence or in a remote location, whereas a high score should be assigned to a site that has no cover, fence, natural barriers or buffer.	
	c) Hazardous soil gas migration • Contaminants are putrescible and soil permeability is high • Soil contaminants are putrescible but soil permeability is low and/or groundwater is <2 m from surface • No putrescible contaminants at the site.	2 1 0	Methane gas migration has been known to cause explosions adjacent to abandoned landfills.	Consider presence of organic material on site, the depth to water table, soil hydraulic conductivity, vegetative stress, odours, etc.	
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) : Vapor pressure : • < 0,1 kPa • 0,1 à 0,5 kPa • 0,5 à 1,5 kPa • > 1,5 kPa	 -2* -2/3* 2/3* 2*	(N.B. : vapor pressure limits are valid at a 20°C temperature) * The weighting suggested is valid if there are no points affected to other special considerations.	
Powderiness : • < 0,1 % • 0,1 à 1 % • 1 à 10 % • > 10 % Other special considerations	 -2* -2/3* 2/3* 2* (-4 à 4)	(i.e. the sample % with a grain size ≤ 45 µm) N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS (cont'd) **SCORE**

C. Direct Contact

1. • Known Contamination Off-site:

Document reports of off-site contamination due to contact with contaminated soil, dust, air, etc.: NO RECORD

Scoring Rationale & Information Source: —

2.a • Airborne Emissions

Document incidents or complaints about fumes, gases, dust, odours, etc.: UNKNOWN, BUT POSSIBLE.

Scoring Rationale & Information Source: 2.5 ?

2.b • Accessibility of Site

Review and document avenues of site access by humans and animals: ACCESS LIMITED, CONTAMINANTS NOT TOTALLY COVERED.

Scoring Rationale & Information Source: 2

2.c • Hazardous Soil Gas Migration

Review potential for hazardous soil gas production and migration from site: NO PUTRESCIBLE CONTAMINANTS

Scoring Rationale & Information Source: 0

3. • Special Considerations

Document any other conditions whereby humans/animals could contact contamination: VAPOR PRESSURE: $1{,}49 \times 10^{-9}$ atm AT 30°C => 2
POWDERINESS: 2/3 -> ARBITRARY VALUE

Scoring Rationale & Information Source: -1/3

Site Identification: ____________

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors	A. Human and Animal Uses 1. Known adverse impact on humans or domestic animals as a result of the contaminated site • Known adverse effect on humans or domestic animals • Strongly suspected adverse effect on humans or domestic animals	 18 15	Contamination from a site that causes a measurable impact on humans is a great concern.	Review and evaluate reports of impact(s) of site contamination (e.g., increased heavy metal levels measured in blood of nearby residents as a result of site contamination). Any site assigned 15 or more points for this factor should automatically be classified as Class 1. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980)	
	2. Potential for impact on humans or animals a) Drinking water supply i) Known impact on drinking water supply Drinking water supply is known to be adversely affected as a result of site contamination • Known contamination of drinking water supply to levels above CDWG • Strongly suspected contamination of drinking water supply • Drinking water supply is known not to be contaminated	 9 7 0	Water used for drinking should be protected against contamination from any site.	Review available site data (inspection reports, assessment documentation) to determine if drinking water (groundwater, surface water, private, commercial or municipal supply) is known or suspected to be contaminated above Guidelines for Canadian Drinking Water Quality or applicable provincial/territorial guidelines or policies. If drinking water supply is known to be contaminated above these guidelines, some immediate action (e.g., provision of alternate drinking water supply) should be initiated to reduce or eliminate exposure.	Guidelines for Canadian Drinking Water Quality; other drinking water guidelines developed by recognized agencies (e.g., other Health and Welfare Canada guidelines, U.S. EPA, etc.).
	ii) Potential for impact on drinking water supply • Proximity to drinking water supply • 0 to <100 m • 100 to <300 m • 300 m to <1 km • 1 to 5 km	 6 5 4 3	The nearer a drinking water well is to a contaminant source, the greater the potential for contamination. Well water used for irrigation/agricultural purposes should also be included as it may be used for human consumption.	Review provincial/territorial base mapping or air photos and measure the distance to the nearest resident or drinking water supply. Judge whether the water is being used as a drinking water source. Commonly rural areas use groundwater for drinking purposes. For urban sites, contact the local Public Utilities Commission to determine water source and location.	
	• "Availability" of alternate drinking water supply • Alternate drinking water supply is not available • Alternate drinking water supply would be difficult to obtain • Alternate drinking water supply available	 3 2 1.5 0.5	This factor takes into account the availability of replacement water supplies, and is used in the technical sense as a factor to indicate the degree of urgency, not as a sociopolitical consideration.	Determine availability of alternate drinking water supply or distance to alternate source.	

SITE CLASSIFICATION WORKSHEET - cont'd

III. RECEPTORS | SCORE

A. Human and Animal Uses

1. • Known Adverse Impact on Humans or Domestic Animals

Record known or suspected adverse effects on humans or domestic animals: NO RECORD

Scoring Rationale & Information Source: —

2.a.i • Known Contamination of Drinking Water Supply

Record known or suspected incidents of contamination of drinking water: NO RECORD

27

Scoring Rationale & Information Source: —

2.a.ii.°• Distance to Nearest Drinking Water Supply(s)

Identify nearest drinking water well and measure distance to site: WATER PLANT INTAKE 4 Km EAST

Scoring Rationale & Information Source: 3

2.a.ii.°°•Availability of Alternate Drinking Water Supply

Document availabiilty of alternate sources of drinking water and ease of implementation: UNKNOWN

Scoring Rationale & Information Source: 1.5 ?

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	A.2. b) Other Water Resources				
	i) Known impact on used water resource Water resource (used for recreational purposes, commercial food preparation, livestock watering, irrigation or other food chain uses) is known to be adversely affected as a result of site contamination		The water used for these purposes (groundwater or surface water) should be protected against contamination.	Review documentation for reported or suspected contamination of water used for recreation or food chain uses, and refer to Canadian Water Quality Guidelines or other relevant guidelines (select appropriate guidelines based on local water use) to determine if supply is considered contaminated.	CCME Canadian Water Quality Guidelines; provincial/territorial water quality guidelines and objectives; etc.
	• Water resource is known to be contaminated above CWQG	4			
	• Water resource is strongly suspected to be contaminated above CWQG	3			
	• Water resource is known not to be contaminated	0			
	ii) Potential for impact on water resources • Proximity to water resources used for activities listed above		The nearer a water resource is to a site, the greater the risk of contamination.	Determine distance from the site to the nearest recreational or food chain used water resource.	
	• 0 to <100 m	2			
	• 100 to <300 m	1.5			
	• 300 m to <1 km	1			
	• 1 to 5 km	0.5			
	• Use of water resources - if multiple uses, give highest score (use following table)	0.2 - 2	Potential for impact due to use of water resource is related to the type and frequency of use. Human uses are of the highest concern.	Assess water users adjacent to the site from maps and directories.	

Water Use	Frequency of Use: Frequent	Occasional
Recreational (swimming, fishing)	2	1
Commercial food preparation	1.5	0.8
Livestock watering	1	0.5
Irrigation	1	0.5
Other domestic or food chain uses	0.5	0.3
Not currently used but likely future use	0.5	0.2

SITE CLASSIFICATION WORKSHEET - cont'd

III. RECEPTORS (cont'd) **SCORE**

A. Human and Animal Uses (cont'd)

2.b.i • Known Impact on Used Water Resource

Record information on water resource that is or is potentially affected by site contamination: NO RECORD

Scoring Rationale & Information Source: —

2.b.ii.°• Proximity of Water Resources to Site

Locate and measure nearest water resource areas to site: OTTAWA RIVER 3 Km. EAST

Scoring Rationale & Information Source: 0.5

2.b.ii.°°• Water Uses

Record uses of nearby water resources:
SWIMMING
FISHING
BOATING

Scoring Rationale & Information Source: 2

Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	A. 2. c) Direct human exposure i) Known contamination of land used by humans • Known contamination of land used for agricultural or residential/parkland/school purposes above AG or R/P EQC values • Known contamination of land used for commercial or industrial purposes above C/I EQC values • Land is known not to be contaminated	5 3.5 0	Hazards associated with soil contamination are directly related to land use.	Review zoning and land use maps for lands adjacent the site. Evaluate levels of soil contamination against Canadian Environmental Quality Criteria (EQC) for Contaminated Sites (AG = agricultural level; R/P = residential/parkland level; C/I = commercial/industrial level). If soil is known to be contaminated above these levels and possibly endangering public health, some immediate action (e.g., fencing the area, limiting public access, etc.) should be initiated to reduce or eliminate the exposure.	CCME Canadian Environmental Quality Criteria for Contaminated Sites.
	ii) Potential human exposure through land use • Use of land at and surrounding site (use following table; give highest score to worst case scenario)	0.5 - 5 6	Hazards associated with soil contamination are directly related to land use and distance of the used land from the site. Residential and agricultural land uses are of highest concern because humans are situated at these locations for longer periods.	Review zoning and land use maps over the distances indicated. If the proposed future land use is more "sensitive" than the current land use, evaluate this factor assuming the proposed future use is in place (indicate in the worksheet that future land use is the consideration). Agricultural land use is defined as uses of land where the activities are related to the productive capability of the land or facility (e.g., greenhouse) and are agricultural in nature, or activities related to the feeding and housing of animals as livestock. Residential/Parkland land uses are defined as uses of land on which dwelling on a permanent, temporary, or seasonal basis is the activity (residential), as well as uses on which the activities are recreational in nature and require the natural or human designed capability of the land to sustain that activity (parkland). Commercial/Industrial land uses are defined as land on which the activities are related to the buying, selling, or trading of merchandise or services (commercial), as well as land uses which are related to the production, manufacture, or storage of materials (industrial).	
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	

Land Use (current or future)	Distance from Site: 0 - 300m	300m - 1km	1 - 5km
Residential	5	4.5	3
Agricultural	5	4	2.5
Parkland/School	4	3	1.5
Commercial/Industrial	3	1	0.5

3. Special considerations (detailed) :			
People affected by contamination :			
• ≤ 250	0	* The weighting suggested is valid if there are no points affected to other special considerations.	
• 250 à 1000	1,5*		
• > 1000	3*		
Type of person using the site :			
• Workers	0		
• Adults	1*	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	
• Children and seniors	2*		
Other special considerations	(-5 à 5)		

III. RECEPTORS (cont'd) SCORE

A. <u>Human and Animal Uses</u> (cont'd)

2.c.i • Known Contamination of Land Used by Humans

Record land use type (current or proposed) and level of contamination for land known to be contaminated due to site: NO RECORD

Scoring Rationale & Information Source: ______ [ ]

2.c.ii • Land Use at and Adjacent to the Site

Document land uses (current and proposed) for up to 5 km from the site: MILITARY EXERCISES

	N	E	S	W
0 - <300 m	IMPACT AREA 2			
300 m - <1 km				
1 km - 5 km				

Scoring Rationale & Information Source: ______ [0]

3. • Special Considerations

Document any other important human or animal use information, including details of air contamination if known: PEOPLE AFFECTED ∠ 250 => 0

SITE USED BY MILITARY PEOPLE

Scoring Rationale & Information Source: ______ [0]

Site Identification: ______

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	B. Environment 1. Known adverse impact on a sensitive environment as a result of the contaminated site • Known adverse impact on sensitive environment • Evidence of stress on aquatic species or vegetative stress on trees, crops or plant life located on properties neighbouring the site • Strongly suspected adverse impact on sensitive environment	 16 14 12	The environment should be protected against site contamination. Evidence of impact(s) shows that protection is lacking.	Review records for evidence of vegetative stress or impairment of any nearby sensitive environments. A sensitive environment is defined as a sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980).	
	2. Potential for impact on sensitive environments a) Distance from site to nearest sensitive environment (e.g., sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc.) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km	 10 6 2 0.5	It is considered that within approximately 1 km of the site there is immediate concern for contamination. Therefore, an environmentally sensitive area located within this area of the site will be subject to concern. It is also generally considered that any sensitive area located greater than 10 km from the site will not be impacted.	Review Conservation Authority mapping and literature. Also review Ministry of Natural Resources records and Federal Land Capability maps. Identify provincial/territorial and federal designated environmentally sensitive areas.	Relevant provincial /territorial and federal maps of sensitive environments.
	b) Groundwater - distance to important or susceptible groundwater resource(s) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km	 6 4 2 1	The closer a site is to a discharge or recharge area, the greater the potential for contamination of a groundwater or surface water resource.	Review groundwater contour maps, if available, and other available reports. Otherwise use established hydrogeologic principles.	Local groundwater maps, etc.
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	

SITE CLASSIFICATION WORKSHEET - cont'd

III. RECEPTORS (cont'd) SCORE

B. Environment

1. • **Known Adverse Impact(s) on Sensitive Environment**

Record known impact(s) on any sensitive biological environment at and/or around the site: NO RECORD

Scoring Rationale & Information Source: ________ [–]

2.a • **Distance from Site to Nearest Sensitive Environment**

Document location, distance, type and details of any nearby sensitive environments or habitats: NO RECORD

Scoring Rationale & Information Source: ________ [–]

2.b • **Groundwater**

Measure distance to major recharge or discharge area: SOME MARSHES AROUND JORGENS LAKE

Scoring Rationale & Information Source: ________ [2]

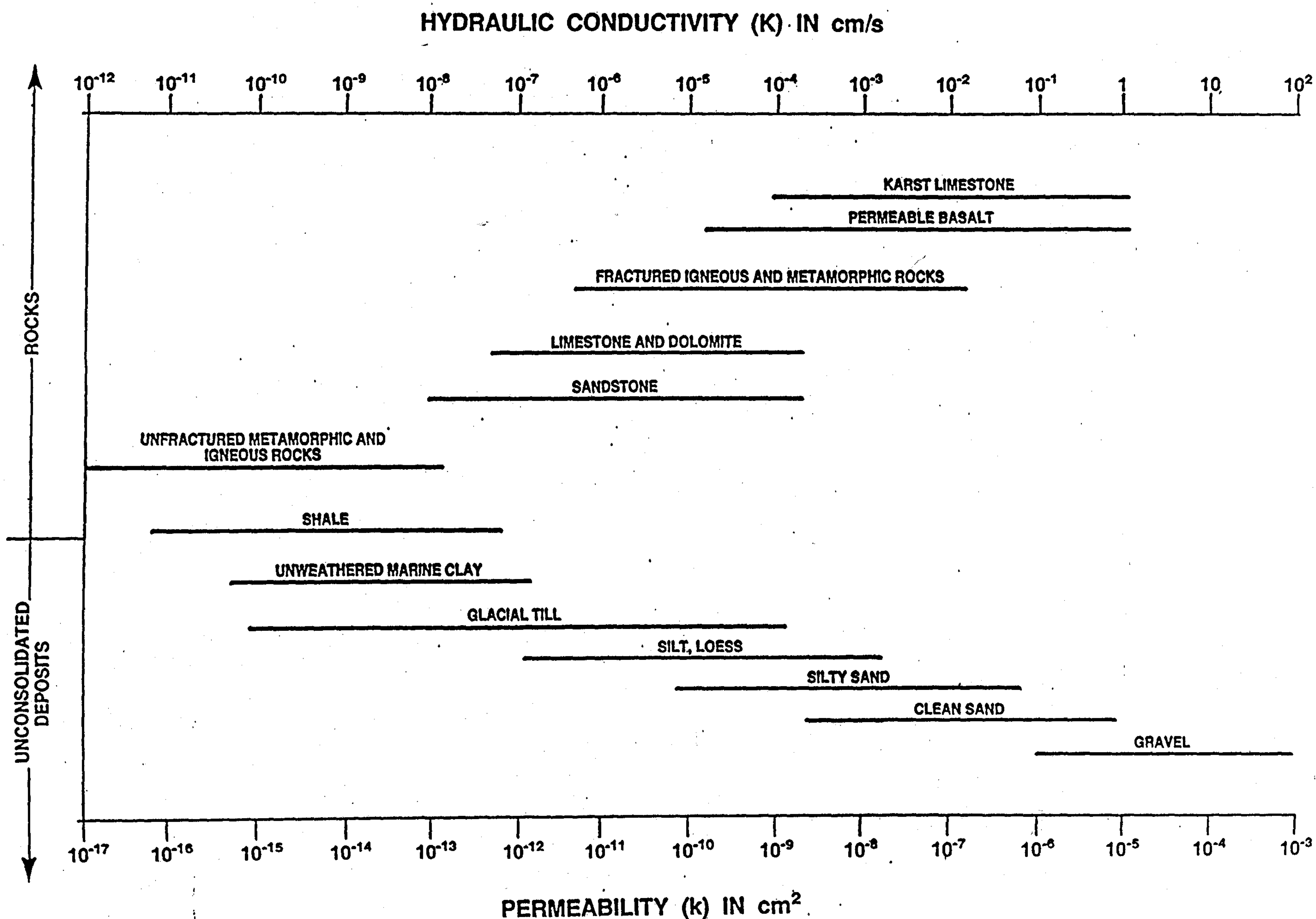
3. • **Special Considerations**

Document any other important impacts on the environment not addressed above: JORGEN LAKES : DISCHARGE AREA - ≈2 km SOUTH

Scoring Rationale & Information Source: ________ [2]

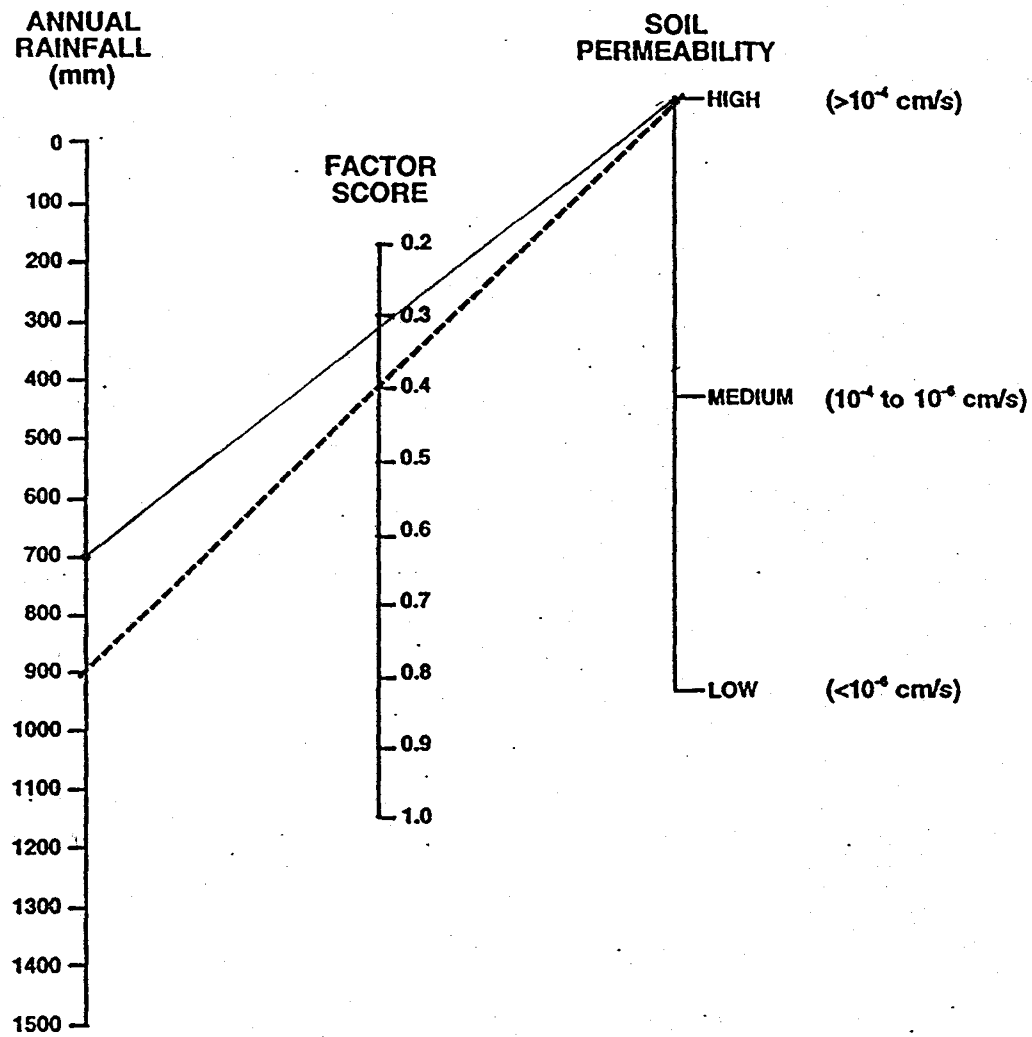
Site Identification: ________

RANGE OF VALUES OF HYDRAULIC CONDUCTIVITY AND PERMEABILITY



MODIFIED FROM FREEZE AND CHERRY, 1979 AND TODD, 1959

RUN-OFF POTENTIAL NOMOGRAPH
(FACTOR II B 2 d)



To determine the factor score, use a ruler and join the annual rainfall value (mm) with the soil permeability data; take the factor score from the middle line.

For example, if rainfall is 900 mm and soil permeability is high, the score would be 0.4.

Compounds	Abbreviations	Solubility	T	Vapour pressure	T	Degradation	Degradation constants (mu)			Kd	Toxicity	'EPA drinking water standard"	MEF water quality criteria	Drinkability standard	Danger criteria (Daniels)	Danger criteria (Rouisse)	References
							Sand	Silt	Clay								
Units		(mg/L)	(C)	(atm)	(C)		(/hr)	(/hr)	(/hr)	(L/kg)		(mg/L)	(mg/L)	(ppb-ug/L)	(mg/K)	(mg/Kg)	
2,4,6 trinitrotoluene	2,4,6 TNT	150	25	7,25E-09	25	Mostly anaerobic					Possibly toxic	0,02					(1)
		130	20	1,45E-09	20									1	0,3	0,024	(2)
		150	25	9,49E-09	25												(3)
		130	20	4,61E-09	20												(3)
				1,66E-09	20												(4)
							3,20E-03	1,40E-01	8,30E-02								(5)
										Ottawa sand: 1,5							(6)
										Silt: 4,5							(6)
										Clay: 10							(6)
													0,12*				(7)
2,4 dinitrotoluene	2,4 DNT	280	25	2,86E-07	25	Aerobic and anaerobic					Possibly carconogenous						(1)
		270	22	2,89E-07	20									5			(2)
				3,17E-08	25												(3)
		270	20	1,61E-08	20												(3)
													1,10E-04				(7)
2,6 dinitrotoluene	2,6 DNT	208	25	7,46E-07	25	Aerobic and anaerobic											(1)
		206	25	7,46E-07	20									5			(2)
													0,93*				(7)
cyclo - 1,3,5 - triméthylene - 2,4,6 - trinitramine	RDX	45	25	5,30E-12	25	Anaerobique					Possibly carconogenous	0,1					(1)
		42	20	5,53E-12	20									2	0,3	0,00024	(2)
(or hexahydro - 1,3,5 - trinitro - 1,3,5 - triazine, or		50	20	2,56E-12	20												(3)
							0	6,50E-03	1,40E-02								(5)
										0,1 à 13,26							(6)
cyclo - 1,3,5,7 - tetramethylene - 2,4,6,8 - tetranitramine	HMX	5	25	4,38E-17	25	Anaerobique						nd		400	1,7	2,2	(1)
(or octahydro - 1,3,5,7 - tetranitro - 1,3,5,7 - tetrazocine)		5	25	4,34E-17	20												(2)
										0,2 à 4,2							(6)
							0	3,60E-03	3,20E-02								(5)

(1) McGrath, 1995
(2) Thiboutot *et al*, 1998
(3) Pheelan and Webb, 1997
(4) Hayes, 1992
(5) Myers *et al*, 1996
(6) Townsend *et al*, 1996
(7) http://www.mef.gouv.qc.ca/fr/environn/criteres_eau

* Provisory criteria for aquatic life (surface water)

Conversion table for pressure units

	atm	mm Hg	torr	kPa	bar
1 atm =	1	760	760	101,3	1,013250274
1 mm Hg =	0,00131579	1	1	0,13328947	0,001333224
1 torr =	0,00131579	1	1	0,13328947	0,001333224
1 kPa =	0,00987167	7,50246792	7,50246792	1	0,010002471
1 bar =	0,986923	750,06148	750,06148	99,9752999	1

Site classification computerised worksheet

Site: Impact Areas 7 and 8 Date: 06-27-2000 User (s): Marc-André Lavigne

Sections	Score for potential impacts	Known and/or potential impacts		?	Comments
CONTAMINANT(S) CHARACTERISTICS					
A) DEGREE OF HAZARD	11	11	/14	0	Energetic materials found in ordnances.
B) CONTAMINANT QUANTITY	10	10	/10	0	Area 7 = 26,2074 km² and Area 8 = 30,1715 km², no register before 1995
C) PHYSICAL STATE OF CONTAMINANTS	3	3	/9	0	TNT, RDX, HMX, etc
Special considerations	0	0	/6		
TOTAL	24	24	/33	0	N.B.: If the total is < 0 or > 33, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 33)
EXPOSURE PATHWAYS					
A) GROUNDWATER					
Known contamination at or beyond property boundary		-100	/11		
Engineered subsurface containment	4	4	/4	0	No engineered system.
Thickness of confining layer over aquifer(s) of concern	1.5	1.5	/1,5	0	No confining layer.
Hydraulic conductivity of the confining layer	1.5	1.5	/1,5	0	No confining layer.
Annual rainfall	0.7	0.7	/1	0	700 mm between 1950 and 1981.
Hydraulic conductivity of the aquifer(s) of concern	3	3	/3	0	From 10E-02 cm/s to 10E02 cm/s.
Special considerations	0.3	0.3	/4		Solubility: 4/3, Retardation Factor: 0, Biodegradation: not observed
TOTAL	11.0	11.0	/11	0.0	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
B) SURFACE WATER					
Observed or mesured contamination of water/effluent discharged from site		-100	/11		
Surface containment	4	4	/5	0	Trees surrounding the major impact zones.
Distance to perennial surface water	3	3	/3	0	Numerous lakes, rivers and creeks within the areas
Topography	1.2	1.2	/1,5	0	Small mountains, contaminants at or below ground level.
Run-off potential (see nomograph)	0.31	0.31	/1	0	
Flood potential	0.25	0.25	/0,5	0.25	No major flood in tha last 50 years but local flood are possible.
Special considerations	2.0	2.0	/4		Solubility: 2
TOTAL	10.8	10.8	/11	0.3	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11).
C) DIRECT CONTACT					
Known contamination of media off-site		-100	/11		
Airborne emissions (gases, vapour, dust, etc.)	2.5	2.5	/5	2.5	Possible but unknown.
Accessibility of site (ability to contact materials)	3	3	/4	0	Moderate access by Petawawa River, contaminants not covered.
Hazardous soil gas migration	0	0	/2	0	No putrescible contaminants.
Special considerations	-1.3	-1.3	/4		Vapor pressure: -2, powderiness: 2/3
TOTAL	4.2	4.2	/11	2.5	N.B.: If the total is < 0 or > 11, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 11)
RECEPTORS					
A) HUMANS AND ANIMALS					
Known adverse impact on living things as a result of the contaminated site		-100	/18		
Known impact on drinking water supply		-100	/9		
Proximity to drinking water supply	3	3	/6	0	Some cabins beside Barron River.
"Availability" of alternate drinking water supply	1.5	1.5	/3	1.5	Other water supply available (lakes, rivers, etc), but quality not known.
Known impact on used water resource		-100	/4		
Proximity to water resources used for activities	2	2	/2	0	Barron River, Petawawa River and Montgomery Lake.
Use of water resources	2	2	/2	0	Fishing, swimming
Known contamination of land used by humans		-100	/5		
Use of land at and surrounding site	3	3	/5	0	Military exercises, bivouac area (west).
Special considerations	0.0	0.0	/5		People affected lower than 250, military people.
TOTAL	11.5	11.5	/18	1.5	N.B.: If the total is < 0 or > 18, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 18).
B) ENVIRONMENT					
Known adverse impact on sensitive environment as a result of the contaminated site		-100	/16		
Distance from site to nearest sensitive environment	10	10	/10	0	Some marshes within the area 8.
Distance to important or susceptible groundwater resource(s)	6	6	/6	0	Petawawa River: discharge zone, outcrops and mountains: recharge zones.
Special considerations	0	0	/5		
TOTAL	16	16	/16	0	N.B.: If the total is < 0 or > 16, the score assigned to special considerations must be changed in order to respect the limits for the corresponding section (i.e between 0 and 16)

Total score (potential impacts)	76.5	+	1.0	/100	+/-	4.3
Total score (known impacts or potential impacts if the former is not known)	76.5	+	1.0	/100	+/-	4.3

Score	Class	Risk potential	Action required
70-100	1	High	Yes
50-69	2	Medium	Likely
38-49	3	Medium low	May be
<=37	N	Low	Not likely

N.B. : If the uncertainty exceeds 15, we consider that there if insufficient information to assign a significant score and the site is therefore classified in class I (for insufficient information).

N.B. : The number "-100" has been used as default when no information was available about the contamination of the site. This value (-100) was chosen to avoid any confusion with possible scores.

Appendix C

Facility/Site Description

FACILITY/SITE DESCRIPTION

Document site information as completely as possible:

Site No.: ______ *Site Name:* IMPACT AREA 7 & 8 *Province/Territory:* ONTARIO

Custodian Dept.: DND *Facility Name:* CFB PETAWAWA *Site Operator/Manager:* CFB PETAWAWA

Type of Site: IMPACT AREA *Site Owner:* DND

Zone: ______ *UTM Coordinates:* ______ *Easting* *Latitude:* ____ *deg.* ____ *min.* ____ *sec.*

______ *Northing* *Longitude:* ____ *deg.* ____ *min.* ____ *sec.*

Location: ______ *Legal Land Description:* ______

Address ______ *Provincial Parcel No.:* ______

Brief Description of Site: ______

Site Land Use: *Current:* MILITARY TRAINING *Proposed:* IDEM

Comments:

Summary of Site Classification Information:

Completed Evaluation Form: X *Detailed* X *Short*

Site Score: 77.5 *Total* ± 4.3 *Estimated Score*

Class: (1, 2, 3, N, or I) 1 *Risk:* HIGH

Notes: ______

Contact Name: SEAN MOYLES / CHRIS HOGAN

Position: ______

Address: ______

City: PETAWAWA *Prov./Terr.:* ONT. *Postal Code:* ______

Phone No.: ______ *Fax No.:* ______

Site Classified by above ______ *or* MARC-ANDRÉ LAVIGNE / KARINE CHAMPAGNE

Degree of Familiarity with Site: ____ *Very familiar* X *Moderately familiar* ____ *Indirectly familiar* ____ *Unfamiliar*

Visited site: X *Yes* ______ *No*

Position: RESEARCH ASSISTANT *Phone No.:* (418) 654-2647

Address: 880 CHEMIN STE-FOY, BUR 840 CP 7500

City: QUEBEC *Prov./Terr.:* QUEBEC *Postal Code:* G1V 4C7 *Date of Completed Classification:* ______

Site Identification: ______

National Classification System Process Checklist

_____ USER'S GUIDE REVIEWED

__X__ MINIMUM DATA REQUIREMENTS MET

- __✓__ Description of site location
- __X__ Type of contaminants or materials likely to be present at site (and/or description of historical activities)
- __X__ Approximate size of site and quantity of contaminants
- _____ Approximate depth to water table
- __X__ Geologic map or survey information (soil, overburden, and bedrock information)
- __X__ Annual rainfall data (can be inferred from rainfall map of Canada)
- __X__ Surface cover information
- __X__ Proximity to surface water
- __X__ Topographic information
- _____ Flood potential of site
- __X__ Proximity to drinking water supply
- __X__ Uses of adjacent water resources
- __X__ Land use information (on-site and surrounding)

__X__ FACILITY/SITE DESCRIPTION COMPLETED

__X__ SITE CLASSIFICATION WORKSHEET COMPLETED

__X__ REFERENCES ATTACHED/CITED

__X__ EVALUATION FORM COMPLETED

__X__ Detailed Form __X__ Short Form

__X__ SCORE SHEET COMPLETED

__X__ SITE CLASSIFICATION

Class: __X__ 1 _____ 2 _____ 3 _____ N _____ I

Score: __77.5__ ± __4.3__
Total Estimated Score

_____ SITE INFORMATION ENTERED ON NCS COMPUTERIZED VERSION

Site Identification: ______________________________

SHORT EVALUATION FORM

Instructions for Use

Answer Yes or No to questions 1 to 5 below. If the response to question 1a) or 1b) is Yes, automatically rate the site as Class 1 (C1). If the answers to any three of questions 2 to 5 are Yes, the site should also be rated as Class 1. For all Yes answers, supporting documentation and rationale must be referenced or attached.
To confirm Class 1 rating and/or if two or more No responses are given, the Detailed Evaluation Form should also be completed.

		No	Yes		Reference Attached
1	a) Is site contamination known to have caused adverse impacts on humans or sensitive environments? (see User's Guide)	☒	☐	→ Class 1	☐
	b) Is the site a fire or explosion hazard as it currently exists?	☒	☐	→ Class 1	☐
I	**Contaminant(s) Characteristics**				
	2 Are contaminants that can be classified as 'high concern' (as defined in the User's Guide) present at the site?	☐	☒		☐
	3 Are the high concern contaminants known to be present in large quantities? Answer yes if contaminant is: • liquid (as disposed/spilled) • in quantity >1,000 m³ • in an area of contamination >10 ha • distributed or placed in such a manner as to have the potential to cause significant off-site contamination	☐	☒		☐
II	**Pathways**				
	4 Is the site known to have caused contamination (above national or applicable provincial/territorial guidelines or policies) of off-site groundwater, adjacent surface water, neighbouring surficial material (i.e., soil) or air? (see User's Guide)	☒	☐		☐
III	**Receptors**				
	5 Is the site contamination known to have a) impacted the quality of local drinking water or other water resources (i.e., exceeds Guidelines for Canadian Drinking Water and/or Canadian Water Quality Guidelines or applicable provincial/territorial guidelines or policies); b) contaminated lands used for agricultural, residential or parkland purposes (i.e., exceeds the AG or R/P values of Canadian Environmental Quality Criteria for Contaminated Sites or applicable provincial/territorial guidelines or policies); or c) caused vegetative stress or other known environmental impairment? (A Yes answer should be given if the impact has made the water, land, environment, or air unacceptable for use.)	☒	☐		☐

If 3 or more Yes answers are given in Sections I, II, and III above, rate site as Class 1. Check box if Class 1 rating. ☐

Appendix D

User's Guide (even pages) and Site Classification Worksheet (odd pages)

USER'S GUIDE

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
I. Contaminant(s) Characteristics	A. Degree of hazard • High concern contaminants - high concentration • High concern contaminants - low concentration • Medium concern contaminants - high concentration • Medium concern contaminants - low concentration • Low concern contaminants	 14 11 8 5 3	In determining the degree of hazard of a waste, it is recognized that a listed hazardous waste is generally of greater concern than a liquid or solid industrial waste. These are in turn of greater concern than other solid wastes. Municipal and organic wastes are considered medium concern contaminants due to their putrescible nature (production of methane and other landfill gases). Household wastes may contain hazardous materials (e.g., batteries, medical wastes, paints, etc).	Determine the level of hazard according to the following table of typical contaminants and definition of high concentrations: High Concern Contaminants • Materials defined as dangerous goods in the Transport of Dangerous Goods Act and Regulations • Materials identified by Province as hazardous waste (pesticides, herbicides, paint sludge, acid and alkaline solutions, solvents, etc.) • Materials regulated by the Canadian Environmental Protection Act (e.g., PCBs) • Institutional waste (lab, schools hospitals, etc.) • Pathological wastes and animal carcasses • Radioactive wastes Medium Concern Contaminants • Liquid waste not referred to in above, petroleum products septic tank pumpings, agricultural and chemical containers • Food processing wastes • Non-hazardous incinerator residues • Municipal solid (household) wastes • Organic and vegetable wastes • Mining residues Low Concern Contaminants • Industrial and commercial solid wastes, (e.g., construction materials such as wood, metal, hay, sand/silt piles, etc.) • Other nearly inert wastes (e.g., foundry sands) High Concentration of Contaminants • contaminant concentrations in soil, groundwater or surface water exceed Canadian Environmental Quality Criteria for Contaminated Sites (>2x commercial/ industrial level); or material that was deposited in highly concentrated form (e.g., >5000 ppm)	Transport of Dangerous Goods Act; Provincial/ Territorial Hazardous Wastes lists; regulations under Canadian Environmental Protection Act; Canadian Environmental Quality Criteria for Contaminated Sites; etc.
	B. Contaminant Quantity (area/volume of site contamination) • >10 ha, or >1000 m^3, or drums of liquid • 2 to 10 ha, or 100 to 1000 m^3 • <2 ha, or <100 m^3	10 6 2	Little information is known about the quantity of wastes at abandoned sites in Canada. Therefore, waste quantity estimates may be interpreted from area or quantity information.	Measure or estimate the area or quantity of potential contamination. Note: Any number of drums abandoned or disposed is considered a high concern.	
	C. Physical State of Contaminants • Liquid/gas • Sludge • Solid	9 7 3	Contaminants in liquid form are more mobile in the ground and water than solids. However, certain water-soluble solid wastes are more mobile than viscous liquids, and these should be evaluated on a case-by-case basis.	Determine the state of the contaminant when it was disposed or deposited.	
	Special Considerations	-6 to +6	(See 3.7.3 in text)	Technical judgment.	

SITE CLASSIFICATION WORKSHEET

(Instructions: Document site information, assign score, provide rationale behind score and indicate source of information in the spaces provided.)

I. CONTAMINANT(S) CHARACTERISTICS   SCORE

A. • Degree of Hazard

List possible contaminants and estimated concentrations: CONTAMINANTS FOUND IN AMMUNITION (TNT, RDX, HMX)
-> ENERGETIC MATERIALS

Scoring Rationale & Information Source: ________ **11**

B. • Contaminant Quantity

Estimated or measured areal volume of contaminated zone: NO RECORD OF UNEXPLODED SHELLS OR ORDANCES BEFORE 1995
AREA 7 : 26,2074 KM^2 AREA 8: 30,1715 KM^2
VOLUME OF CONTAMINANTS ESTIMATED BY THE AREA OF THE RANGE

Scoring Rationale & Information Source: ________ **10**

C. • Physical State of Contaminant

Does the site contain:
a) Predominantly liquids/gases ________
b) Primarily sludges ________
c) Primarily solids TNT, RDX, HMX

Scoring Rationale & Information Source: ________ **3**

• Special Considerations

Document any other important contaminant characteristics not addressed above: ________

Scoring Rationale & Information Source: ________ **-**

Site Identification: ________

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways	A. Groundwater 1. Known contamination at or beyond property boundary • Groundwater significantly exceeds Canadian Drinking Water Guidelines (CDWG) by >2x or known contact of contaminants with groundwater • Between 1 and 2x CDWG or probable contact with groundwater • Meets Canadian Drinking Water Guidelines	 11 6 0	The legislative basis for most jurisdictions is to prevent off-site migration of contamination.	Review chemical data and evaluate groundwater quality. If contamination at or beyond the property boundary exceeds Canadian Drinking Water Guidelines (CDWG) or applicable provincial/territorial guidelines or policies, or if contaminants are known to be in contact with groundwater, then evaluate the site as high.	Canadian Water Quality Guidelines; Provincial/ Territorial Water Quality Guidelines or policies; Guidelines for Canadian Drinking Water Quality.
	2. Potential for groundwater contamination (a) Engineered subsurface containment • No containment • Partial containment • Full containment	 4 2 0	Well contained sites have minimal potential for pollution. Potential for pollution decreases with increasing containment.	Review the existing engineered systems and relate these structures to hydrogeology of the site and determine if full containment is achieved. Full containment is defined as an engineered system, monitored as being effective, which provides for the capture and treatment of contaminants. If there is no system, this factor is evaluated high. If there is less than full containment or if uncertain then evaluate as medium. Typical engineered systems include leachate collection systems and low permeability liners.	
	(b) Thickness of confining layer over aquifer(s) of concern • 3 m or less • 3 to 10 m • >10 m	 1.5 1 0	The thickness of a confining layer (e.g., clay, shale, etc.) between contaminants and any aquifers of concern will affect the attenuation of contaminants and hence the quantity and quality of contaminants reaching the aquifers.	Measure or estimate thickness of any confining layer (e.g., clay, shale, etc.) over all aquifers of concern from existing well records or from a general knowledge of local conditions. If possible, an estimate of the continuity of the confining layer should be made from borehole well record information. Note: an aquifer is defined as a geologic material that will yield groundwater in usable quantities.	Historical geologic maps, well records, government hydrogeologist or local consultants.
	(c) Hydraulic conductivity of the confining layer • $>10^{-4}$ cm/sec • 10^{-4} to 10^{-6} cm/sec • $<10^{-6}$ cm/sec	 1.5 1 0.5	The rate at which contaminants migrate through the confining layer will affect attenuation and the contaminant loading to the aquifers.	Determine the nature of geologic materials and estimate hydraulic conductivity from published material (or use "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Apppendix D). Clays, granite, shales should be scored low. Silts etc. should be scored medium. Sand, gravel, and limestone should be scored high.	Freeze and Cherry, 1979, and other groundwater texts.

II. EXPOSURE PATHWAYS

SCORE

A. Groundwater

1. • Known Groundwater Contamination

Document information on known groundwater contamination: ______________________

Scoring Rationale & Information Source: ______________________ [—]

2.a • Engineered Subsurface Containment

Document engineered systems protecting groundwater: NO ENGINEERED SYSTEM

Scoring Rationale & Information Source: ______________________ [6]

2.b • Thickness of Confining Layer Over Aquifer(s) of Concern

Document local geological conditions: BEDROCK (LIMESTONE, MINOR DOLOSTONE, SHALE, SANDSTONE) EXPOSURES OVERLAIN AT SOME PLACE BY THIN AND DISCONTINUOUS DRIFT COVER.

Identify water-bearing zones used for water supply: GRAVEL, GRAVELLY SAND AND SAND, (GLACIOFLUVIAL ICE-CONTACT STRATIFIED DEPOSITS AND DELTAID DEPOSITS)
NO CONFINING LAYER

Scoring Rationale & Information Source: ______________________ [1.5]

2.c • Hydraulic Conductivity of the Confining Layer

Estimate hydraulic conductivity of any confining layer: NO CONFINING LAYER

Scoring Rationale & Information Source: ______________________ [1.5]

Site Identification: ______________________

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	A.2. (d) Annual Rainfall • >1000 mm • 600 mm • 400 mm • 200 mm	 1 0.7 0.6 0.4 0.2	The quantity of rainfall affects the quantity of leachate produced. Higher leachate quantities have a higher impact on the environment.	Refer to Environment Canada rainfall records for relevant areas. Use 30-year average rainfall for evaluation purposes. Divide rainfall by 1000 and round to nearest tenth (e.g., 667 mm = 0.7 score)	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	(e) Hydraulic conductivity of aquifer(s) of concern • $>10^{-2}$ cm/sec • 10^{-2}-10^{-4} cm/sec • $<10^{-4}$ cm/sec	 3 1.5 0.5	Aquifers with high hydraulic conductivity can transport contaminants at high velocity over great distances, e.g., solution limestones, highly fractured rocks or gravel deposits.	Determine the nature of geologic materials and estimate hydraulic conductivity of all aquifers of concern from published material (refer to "Range of Values of Hydraulic Conductivity and Permeability" figure at end of Appendix D).	Freeze and Cherry, 1979.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) :			
Solubility (S) : • low (S/standard = 10^1) • medium (S/standard = 10^2) • high (S/standard = 10^3)	 -4/3* 0 4/3*	* The weighting suggested is valid if there are no points affected to other special considerations.	
Retardation factor (R) : • important delay ($R / R_{Cl} = 10^2$) or ($K_d = 12{,}51$) • delayed ($R / R_{Cl} = 10^1$) or ($K_d = 1{,}14$) • little or no delay ($R / R_{Cl} = 10^0$) or ($K_d = 0$)	 -4/3* 0 4/3*	N.B. : the R calculation was done using n = 0,33 et ρ_b = 1,75 g/cm^3 ; if the studied soil is neither sand, silt or clay, the R factor must be recalculated because n et ρ_b change. ($R_{Cl} = 1$)	
Biodegradation (μ) : • observed • non observed • non biodegradable	 -4/3* 0 4/3*		
Other special considerations	(-4 à 4)	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS (cont'd) **SCORE**

A. Groundwater (cont'd)

2.d • Annual Rainfall

Document rainfall data: BETWEEN 1950 AND 1981 ≃ 700 mm

Scoring Rationale & Information Source: CLIMATIC ATLAS - CANADA [0.7]

2.e • Hydraulic Conductivity of Aquifer(s) of Concern

Estimate hydraulic conductivity of relevant aquifer(s): HYDRAULIC CONDUCTIVITY RANGING FROM 10^{-2} cm/s TO 10^{2} cm/s

Scoring Rationale & Information Source: [3]

3. • Special Considerations

Document any other important ground water issues not addressed above:
SOLUBILITY (S/STANDARD = 130/0.12) => 4/3
RETARDATION FACTOR (Ko ≃ 1.5) => 0
BIODEGRADATION (NOT OBSERVED) => 0

Scoring Rationale & Information Source: [4/3]

Site Identification: ____________

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	B. Surface Water 1. Observed or measured contamination of water/effluent discharged from site • Known or strongly suspected to exceed Canadian Water Quality Guidelines (CWQG) by >2x • Known or strongly suspected to be between 1 - 2x CWQG • Meets Canadian Water Quality Guidelines	 11 6 0	The legislative basis in all jurisdictions is not to contaminate surface water beyond established limits.	Collect all available information on quality of surface water near to site. Evaluate available data against Canadian Water Quality Guidelines (select appropriate guidelines based on local water use, e.g., recreational, irrigation, freshwater aquatic life, etc.) and relevant provincial/territorial water quality objectives.	CCME Canadian Water Quality Guidelines; Relevant provincial /territorial and federal legislation and regulations.
	2. Potential for surface water contamination a) Surface Containment • No containment • Partial containment • Full containment	 5 3 0.5	The level and type of engineered containment will affect the potential for contaminants to be released to surface water.	Review the existing engineered systems and relate these structures to site conditions and proximity to surface water and determine if full containment is achieved; e.g., evaluate low if there is full containment such as capping, berms, dikes; evaluate medium if there is partial containment such as natural barriers, trees, ditches, sedimentation ponds; evaluate high if there are no intervening barriers between the site and nearby surface water.	Site inspection reports, air photos, etc.
	b) Distance to perennial surface water • 0 to <100 m • 100 to 300 m • >300 m	 3 2 0.5	The distance to surface water will affect the probability of contaminants reaching the watercourse. The Ontario Ministry of the Environment has established a classification for immediate impact zone at 50 m. For conservatism, this zone has been broadened to 100 m.	Review available mapping and survey data to determine distance to nearest surface water bodies.	
	c) Topography • Contaminants above ground level and slope is steep • Contaminants at or below ground level and slope is steep • Contaminants above ground level and slope is flat • Contaminants at or below ground level and slope is flat	 1.5 1.2 0.8 0	Water can run off (and therefore potentially contaminate surface water) with greater ease from elevated sites on slopes.	Review engineering documents on the topography of the site and the slope of surrounding terrain. • steep slope = >50% • flat slope = <5% Note: Type of fill placement (e.g., trench, above ground, etc.)	

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS (cont'd) **SCORE**

B. Surface Water

1. • Observed or Measured Contamination

Document information on surface water contamination: NO RECORD

Scoring Rationale & Information Source: —

2.a • Surface Containment

Review and document engineered or natural systems protecting surface water: THERE ARE TREES SURROUNDING THE MAJOR IMPACT ZONES

Scoring Rationale & Information Source: 3

2.b • Distance to Perennial Surface Water

Estimate distance from site to nearest stream or other water body: PETAWAWA RIVER BETWEEN BOTH AREAS. BIGGAR LAKE, SURVEY LAKE AND COLIN LAKE WITHIN AREA 8, MILITARY LAKE, CENTRE LAKE AND LONG LAKE WITHIN AREA 7. THERE ARE ALSO MANY CREEKS AND MARSHES

Scoring Rationale & Information Source: 3

2.c • Topography

Document terrain conditions: MOSTLY HILLS

Document position of contaminants (are they above ground or buried?) AT OR BELOW GROUND LEVEL.

Scoring Rationale & Information Source: TOPOGRAPHIC MAP MCE 132 Ed 8 TR 99 1.2

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	B. 2. d) Run-off potential (see nomograph, end of Appendix D) • >1000 mm rainfall and low permeability surface material • 500 to 1000 mm rainfall and moderately permeable surface material • <500 mm rainfall and highly permeable surface material	1 0.52 0.6 0.2	Run-off transports contaminants into water bodies. Water run-off is a function of precipitation and the rate of infiltration (less permeable soils will allow greater run-off).	Refer to Environment Canada precipitation records for relevant areas. Use 30-year average precipitation for evaluation purposes. Determine factor score using "Run-Off Potential Nomograph" figure at end of Appendix D.	Hydrological Atlas of Canada (Fisheries and Environment Canada, 1978).
	e) Flood potential • 1 in 2 years • 1 in 10 years • 1 in 50 years	0.5 0.3 0.35 0.1	The potential for large quantities and concentrations of contaminants to be released to surface water courses over a short period of time will be affected by the flood potential of a water course near the site.	Review published data such as flood plain mapping or flood potential (e.g., spring or mountain run-off) and Conservation Authority records to evaluate flood potential of nearby water courses both up and down gradient. Rate zero if site not in flood plain.	Established flood plain guidelines/maps; provincial/territorial soil survey maps.
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) : Solubility (S) : • low (S/standard ≈ 10^1) • medium (S/standard ≈ 10^2) • high (S/standard ≈ 10^3)	 -2* 0 2*	* The weighting suggested is valid if there are no points affected to other special considerations.	
Biodegradation (μ) : • observed • non observed • non biodegradable Other special considerations	 -2* 0 2* (-4 à 4)	N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS (cont'd) SCORE

B. <u>Surface Water</u> **(cont'd)**

2.d • Run-off Potential

Document geological and rainfall conditions: ANNUAL RAINFALLS ≈ 700 mm
PERMEABILITY : 10^{-2} cm² TO 10^{+2} cm²

Scoring Rationale & Information Source: SEE P. 35 — 0.31

2.e • Flood Potential

Estimate flood frequency of nearby water courses or water bodies: NO ~~MAJOR~~ FLOOD IN THE LAST 50 YEARS BUT RIVERS, LAKES AND CREEKS MIGHT LOCALLY INUNDATE

Scoring Rationale & Information Source: — 0.25 ?

23

3. • Special Considerations

Document any other important surface water conditions not addressed above: SOLUBILITY (100/0.12) => 2
BIODEGRADATION (NOT OBSERVED) => 0

Scoring Rationale & Information Source: — 2

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
II. Exposure Pathways (cont'd)	C. Direct Contact 1. Known contamination of media off-site • Known contamination of soil, sediment or air off-site due to contact with contaminated soil, dust, air, etc. (vector transported should also be considered). • Strongly suspected contamination of media off-site • No contamination of media off-site	11 6 0	Known or measured contamination off-site is an important consideration for determining impact of contaminants.	Record known or measured contamination of soil, sediment or air on or off-site. Note any presence of soil gas, such as methane, associated with site.	
	2. Potential for direct human and/or animal contact a) Airborne Emissions (gases, vapours, dust, etc.) • Known or suspected airborne emissions impacting on neighbouring properties • Airborne emissions generally restricted to site • No airborne emissions	5 3 0	If air emissions are evident off-site, there is a great hazard for direct contamination of neighbouring biota and/or resources.	Review available site information to determine if there have been complaints off-site (due to vapours, gas, dust, etc). Reports for these problems are not likely available for most abandoned sites. Review regulatory site inspection reports. If airborne emissions are known to be impacting neighbouring properties and possibly endangering the public, some immediate action (including characterization of emissions) should be initiated to curtail hazardous emissions or otherwise reduce or eliminate exposure.	Site inspection reports, etc.
	b) Accessibility of Site (ability to contact materials) • Limited or no barriers to prevent site access; contaminants not covered • Moderate accessibility or intervening barriers; contaminants are covered • Controlled access or remote location and contaminants are covered	4 3 0	The greater the accessibility to a site and to contaminants, the greater the chance for contamination of human and animal life by direct contact.	Review location and engineering of the site and determine if there are intervening barriers between the site and humans or animals. A low rating should be assigned to a (covered) site surrounded by a locked chain link fence or in a remote location, whereas a high score should be assigned to a site that has no cover, fence, natural barriers or buffer.	
	c) Hazardous soil gas migration • Contaminants are putrescible and soil permeability is high • Soil contaminants are putrescible but soil permeability is low and/or groundwater is <2 m from surface • No putrescible contaminants at the site.	2 1 0	Methane gas migration has been known to cause explosions adjacent to abandoned landfills.	Consider presence of organic material on site, the depth to water table, soil hydraulic conductivity, vegetative stress, odours, etc.	
	3. Special Considerations	-4 to +4	(See 3.7.3 in text)	Technical judgment.	
	3. Special considerations (detailed) : Vapor pressure : • < 0,1 kPa • 0,1 à 0,5 kPa • 0,5 à 1,5 kPa • > 1,5 kPa Powderiness : • < 0,1 % • 0,1 à 1 % • 1 à 10 % • > 10 % Other special considerations	-2* -2/3* 2/3* 2* -2* -2/3* 2/3* 2* (-4 à 4)	(N.B. : vapor pressure limits are valid at a 20°C temperature) * The weighting suggested is valid if there are no points affected to other special considerations. (i.e. the sample % with a grain size ≤ 45 µm) N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.		

SITE CLASSIFICATION WORKSHEET - cont'd

II. EXPOSURE PATHWAYS (cont'd) SCORE

C. Direct Contact

1. • **Known Contamination Off-site:**

Document reports of off-site contamination due to contact with contaminated soil, dust, air, etc.: NO RECORD

Scoring Rationale & Information Source: -

2.a • **Airborne Emissions**

Document incidents or complaints about fumes, gases, dust, odours, etc.: POSSIBLE BUT UNKNOWN

Scoring Rationale & Information Source: 2.5 ?

25

2.b • **Accessibility of Site**

Review and document avenues of site access by humans and animals: MODERATE ACCESS BY PETAWAWA RIVER
CONTAMINANTS NOT COVERED

Scoring Rationale & Information Source: 3

2.c • **Hazardous Soil Gas Migration**

Review potential for hazardous soil gas production and migration from site: NO PUTRESCIBLE CONTAMINANTS

Scoring Rationale & Information Source: 0

3. • **Special Considerations**

Document any other conditions whereby humans/animals could contact contamination: VAPOR PRESSURE : 1.45×10^{-9} ATM AT 30 °C => -2
POWDERINESS => 2/3 → ARBITRARY VALUE

Scoring Rationale & Information Source: -4/3

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors	A. Human and Animal Uses 1. Known adverse impact on humans or domestic animals as a result of the contaminated site • Known adverse effect on humans or domestic animals • Strongly suspected adverse effect on humans or domestic animals	 18 15	Contamination from a site that causes a measurable impact on humans is a great concern.	Review and evaluate reports of impact(s) of site contamination (e.g., increased heavy metal levels measured in blood of nearby residents as a result of site contamination). Any site assigned 15 or more points for this factor should automatically be classified as Class 1. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980)	
	2. Potential for impact on humans or animals a) Drinking water supply i) Known impact on drinking water supply Drinking water supply is known to be adversely affected as a result of site contamination • Known contamination of drinking water supply to levels above CDWG • Strongly suspected contamination of drinking water supply • Drinking water supply is known not to be contaminated	 9 7 0	Water used for drinking should be protected against contamination from any site.	Review available site data (inspection reports, assessment documentation) to determine if drinking water (groundwater, surface water, private, commercial or municipal supply) is known or suspected to be contaminated above Guidelines for Canadian Drinking Water Quality or applicable provincial/territorial guidelines or policies. If drinking water supply is known to be contaminated above these guidelines, some immediate action (e.g., provision of alternate drinking water supply) should be initiated to reduce or eliminate exposure.	Guidelines for Canadian Drinking Water Quality; other drinking water guidelines developed by recognized agencies (e.g., other Health and Welfare Canada guidelines, U.S. EPA, etc.).
	ii) Potential for impact on drinking water supply • Proximity to drinking water supply • 0 to <100 m • 100 to <300 m • 300 m to <1 km • 1 to 5 km	 6 5 4 3	The nearer a drinking water well is to a contaminant source, the greater the potential for contamination. Well water used for irrigation/agricultural purposes should also be included as it may be used for human consumption.	Review provincial/territorial base mapping or air photos and measure the distance to the nearest resident or drinking water supply. Judge whether the water is being used as a drinking water source. Commonly rural areas use groundwater for drinking purposes. For urban sites, contact the local Public Utilities Commission to determine water source and location.	
	• "Availability" of alternate drinking water supply • Alternate drinking water supply is not available • Alternate drinking water supply would be difficult to obtain • Alternate drinking water supply available	 3 2 1.5 0.5	This factor takes into account the availability of replacement water supplies, and is used in the technical sense as a factor to indicate the degree of urgency, not as a sociopolitical consideration.	Determine availability of alternate drinking water supply or distance to alternate source.	

III. RECEPTORS

SCORE

A. Human and Animal Uses

1. • Known Adverse Impact on Humans or Domestic Animals

Record known or suspected adverse effects on humans or domestic animals: NO RECORD

Scoring Rationale & Information Source: —

2.a.i • Known Contamination of Drinking Water Supply

Record known or suspected incidents of contamination of drinking water: NO RECORD

Scoring Rationale & Information Source: —

2.a.ii.°• Distance to Nearest Drinking Water Supply(s)

Identify nearest drinking water well and measure distance to site: SOME CABINS 1 KM SOUTH OF IMPACT AREA B

Scoring Rationale & Information Source: 3

2.a.ii.°°•Availability of Alternate Drinking Water Supply

Document availabiilty of alternate sources of drinking water and ease of implementation: UNKNOWN, BUT QUANTITY OF WATERCOURSE

Scoring Rationale & Information Source: 1.5 ?

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	A.2. b) Other Water Resources i) Known impact on used water resource Water resource (used for recreational purposes, commercial food preparation, livestock watering, irrigation or other food chain uses) is known to be adversely affected as a result of site contamination		The water used for these purposes (groundwater or surface water) should be protected against contamination.	Review documentation for reported or suspected contamination of water used for recreation or food chain uses, and refer to Canadian Water Quality Guidelines or other relevant guidelines (select appropriate guidelines based on local water use) to determine if supply is considered contaminated.	CCME Canadian Water Quality Guidelines; provincial/ territorial water quality guidelines and objectives; etc.
	• Water resource is known to be contaminated above CWQG	4			
	• Water resource is strongly suspected to be contaminated above CWQG	3			
	• Water resource is known not to be contaminated	0			
	ii) Potential for impact on water resources • Proximity to water resources used for activities listed above		The nearer a water resource is to a site, the greater the risk of contamination.	Determine distance from the site to the nearest recreational or food chain used water resource.	
	• 0 to <100 m	2			
	• 100 to <300 m	1.5			
	• 300 m to <1 km	1			
	• 1 to 5 km	0.5			
	• Use of water resources - if multiple uses, give highest score (use following table)	0.2 2	Potential for impact due to use of water resource is related to the type and frequency of use. Human uses are of the highest concern.	Assess water users adjacent to the site from maps and directories.	

Water Use	Frequency of Use: Frequent	Frequency of Use: Occasional
Recreational (swimming, fishing)	2	1
Commercial food preparation	1.5	0.8
Livestock watering	1	0.5
Irrigation	1	0.5
Other domestic or food chain uses	0.5	0.3
Not currently used but likely future use	0.5	0.2

SITE CLASSIFICATION WORKSHEET - cont'd

III. RECEPTORS (cont'd) **SCORE**

A. <u>Human and Animal Uses</u> (cont'd)

2.b.i • Known Impact on Used Water Resource

Record information on water resource that is or is potentially affected by site contamination: NO RECORD

Scoring Rationale & Information Source: -

Score: [ ]

2.b.ii.°• Proximity of Water Resources to Site

Locate and measure nearest water resource areas to site:
PETAWAWA RIVER, BETWEEN BOTH SITES
MONTGOMERY LAKE
BARRON RIVER

Scoring Rationale & Information Source:

Score: 2

2.b.ii.°°• Water Uses

Record uses of nearby water resources:
FISHING
SWIMMING

Scoring Rationale & Information Source:

Score: 2

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	A. 2. c) Direct human exposure i) Known contamination of land used by humans • Known contamination of land used for agricultural or residential/parkland/school purposes above AG or R/P EQC values • Known contamination of land used for commercial or industrial purposes above C/I EQC values • Land is known not to be contaminated	 5 3.5 0	Hazards associated with soil contamination are directly related to land use.	Review zoning and land use maps for lands adjacent the site. Evaluate levels of soil contamination against Canadian Environmental Quality Criteria (EQC) for Contaminated Sites (AG = agricultural level; R/P = residential/parkland level; C/I = commercial/industrial level). If soil is known to be contaminated above these levels and possibly endangering public health, some immediate action (e.g., fencing the area, limiting public access, etc.) should be initiated to reduce or eliminate the exposure.	CCME Canadian Environmental Quality Criteria for Contaminated Sites.
	ii) Potential human exposure through land use • Use of land at and surrounding site (use following table; give highest score to worst case scenario) Distance from Site Land Use (current or future) — 0 - 300m — 300m - 1km — 1 - 5km Residential — 5 — 4.5 — 3 Agricultural — 5 — 4 — 2.5 Parkland/School — 4 — 3 — 1.5 Commercial/Industrial — 3 — 1 — 0.5	0.5 - 5 3	Hazards associated with soil contamination are directly related to land use and distance of the used land from the site. Residential and agricultural land uses are of highest concern because humans are situated at these locations for longer periods.	Review zoning and land use maps over the distances indicated. If the proposed future land use is more "sensitive" than the current land use, evaluate this factor assuming the proposed future use is in place (indicate in the worksheet that future land use is the consideration). Agricultural land use is defined as uses of land where the activities are related to the productive capability of the land or facility (e.g., greenhouse) and are agricultural in nature, or activities related to the feeding and housing of animals as livestock. Residential/Parkland land uses are defined as uses of land on which dwelling on a permanent, temporary, or seasonal basis is the activity (residential), as well as uses on which the activities are recreational in nature and require the natural or human designed capability of the land to sustain that activity (parkland). Commercial/Industrial land uses are defined as land on which the activities are related to the buying, selling, or trading of merchandise or services (commercial), as well as land uses which are related to the production, manufacture, or storage of materials (industrial).	
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	

3. Special considerations (detailed) : People affected by contamination : • ≤ 250 • 250 à 1000 • > 1000 Type of person using the site : • Workers • Adults • Children and seniors Other special considerations	 0 1,5* 3* 0 1* 2* (-5 à 5)	* The weighting suggested is valid if there are no points affected to other special considerations. N.B. : if the user believes that important elements have been neglected, he can change the internal weighting of the special considerations and assign a score to the section "Other special considerations" that will take in account the new weighting. However, the total of points allowed must not exceed the prescribed limit.	

SITE CLASSIFICATION WORKSHEET - cont'd

III. RECEPTORS (cont'd) SCORE

A. Human and Animal Uses (cont'd)

2.c.i • **Known Contamination of Land Used by Humans**

Record land use type (current or proposed) and level of contamination for land known to be contaminated due to site: NO RECORD

Scoring Rationale & Information Source: —

2.c.ii • **Land Use at and Adjacent to the Site**

Document land uses (current and proposed) for up to 5 km from the site: MILITARY EXERCISES BIVOUAC AREA

	N	E	S	W
0 - <300 m	PETAWAWA	IMPACT AREAS	TRAINING AREA	TRAINING
300 m - <1 km	RESEARCH FOREST	5 & 6	R	AREA
1 km - 5 km				P & Q

Scoring Rationale & Information Source: 1

3. • **Special Considerations**

Document any other important human or animal use information, including details of air contamination if known: PEOPLE AFFECTED < 250 => 0

SITE IS USED BY MILITARY PEOPLE

Scoring Rationale & Information Source: 0

Site Identification:

CATEGORY	EVALUATION FACTOR	SCORING GUIDELINE	RATIONALE	METHOD OF EVALUATION	SOURCES OF INFORMATION
III. Receptors (cont'd)	B. Environment 1. Known adverse impact on a sensitive environment as a result of the contaminated site • Known adverse impact on sensitive environment • Evidence of stress on aquatic species or vegetative stress on trees, crops or plant life located on properties neighbouring the site • Strongly suspected adverse impact on sensitive environment	 16 14 12	The environment should be protected against site contamination. Evidence of impact(s) shows that protection is lacking.	Review records for evidence of vegetative stress or impairment of any nearby sensitive environments. A sensitive environment is defined as a sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc. An adverse effect is considered to be any one or more of the following: i) impairment of the quality of the natural environment for any use that can be made of it, ii) injury or damage to property or to plant or animal life, iii) harm or material discomfort to any person, iv) impairment of the safety of any person, v) rendering any property or plant or animal life unfit for use by humans, vi) loss of enjoyment of normal use of property, and vii) interference with the normal conduct of business (from Ontario Environmental Protection Act, 1980).	
	2. Potential for impact on sensitive environments a) Distance from site to nearest sensitive environment (e.g., sensitive aquatic environment, nature preserve, habitat for endangered species, sensitive forest reserves, national parks or forests, etc.) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km	 10 6 2 0.5	It is considered that within approximately 1 km of the site there is immediate concern for contamination. Therefore, an environmentally sensitive area located within this area of the site will be subject to concern. It is also generally considered that any sensitive area located greater than 10 km from the site will not be impacted.	Review Conservation Authority mapping and literature. Also review Ministry of Natural Resources records and Federal Land Capability maps. Identify provincial/territorial and federal designated environmentally sensitive areas.	Relevant provincial /territorial and federal maps of sensitive environments.
	b) Groundwater - distance to important or susceptible groundwater resource(s) • 0 to <500 m • 500 m to <2 km • 2 to <5 km • 5 to 10 km	 6 4 2 1	The closer a site is to a discharge or recharge area, the greater the potential for contamination of a groundwater or surface water resource.	Review groundwater contour maps, if available, and other available reports. Otherwise use established hydrogeologic principles.	Local groundwater maps, etc.
	3. Special Considerations	-5 to +5	(See 3.7.3 in text)	Technical judgment.	

SITE CLASSIFICATION WORKSHEET - cont'd

III. RECEPTORS (cont'd) SCORE

B. <u>Environment</u>

1. • **Known Adverse Impact(s) on Sensitive Environment**

Record known impact(s) on any sensitive biological environment at and/or around the site: NO RECORD

Scoring Rationale & Information Source: —

2.a • **Distance from Site to Nearest Sensitive Environment**

Document location, distance, type and details of any nearby sensitive environments or habitats: NUMEROUS MARSHES WITHIN AREA 8

Scoring Rationale & Information Source: 10

2.b • **Groundwater**

Measure distance to major recharge or discharge area: MOUTAINS AND OUTCROPS -> RECHARGE ZONE
PETAWAWA RIVER -> DISCHARGE ZONE

Scoring Rationale & Information Source: 6

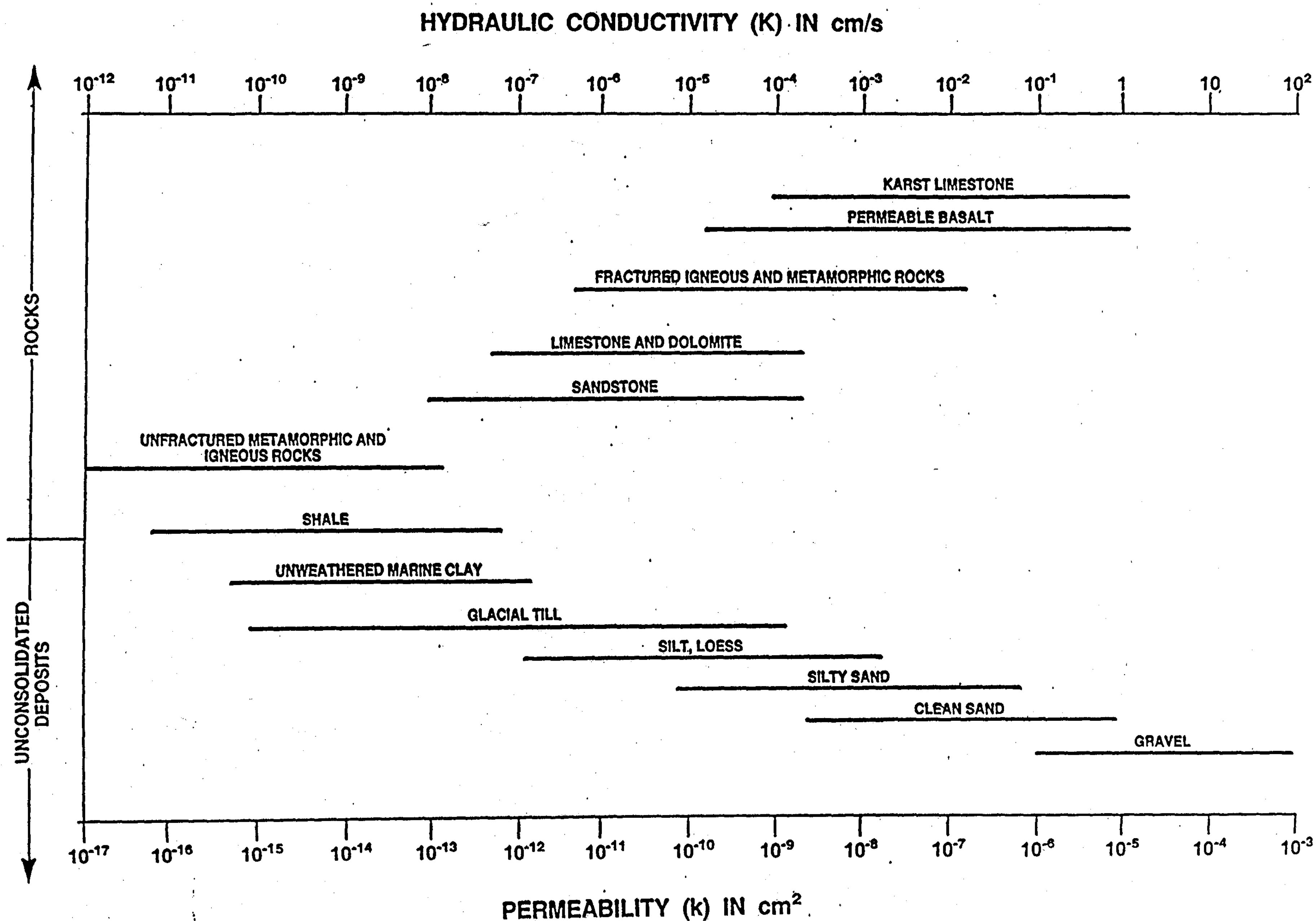
3. • **Special Considerations**

Document any other important impacts on the environment not addressed above:

Scoring Rationale & Information Source: —

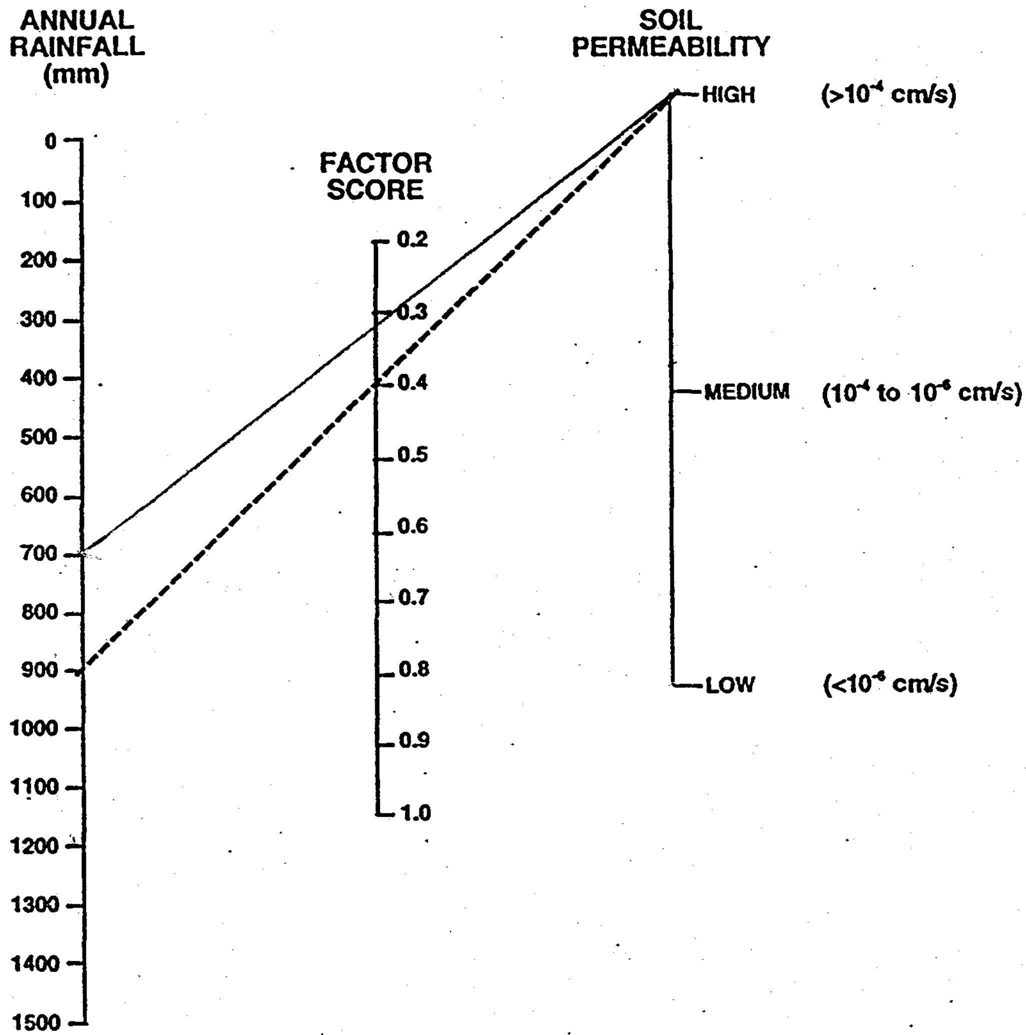
Site Identification:

RANGE OF VALUES OF HYDRAULIC CONDUCTIVITY AND PERMEABILITY



MODIFIED FROM FREEZE AND CHERRY, 1979 AND TODD, 1959

RUN-OFF POTENTIAL NOMOGRAPH
(FACTOR II B 2 d)



To determine the factor score, use a ruler and join the annual rainfall value (mm) with the soil permeability data; take the factor score from the middle line.

For example, if rainfall is 900 mm and soil permeability is high, the score would be 0.4.

Compounds	Abbreviations	Solubility	T	Vapour pressure	T	Degradation	Degradation constants (mu)			Kd	Toxicity	'EPA drinking water standard"	MEF water quality criteria	Drinkability standard	Danger criteria (Daniels)	Danger criteria (Rouisse)	References
							Sand	Silt	Clay								
Units		(mg/L)	(C)	(atm)	(C)		(/hr)	(/hr)	(/hr)	(L/kg)		(mg/L)	(mg/L)	(ppb-ug/L)	(mg/K)	(mg/Kg)	
2,4,6 trinitrotoluene	2,4,6 TNT	150	25	7,25E-09	25	Mostly anaerobic					Possibly toxic	0,02					(1)
		130	20	1,45E-09	20									1	0,3	0,024	(2)
		150	25	9,49E-09	25												(3)
		130	20	4,61E-09	20												(3)
				1,66E-09	20												(4)
							3,20E-03	1,40E-01	8,30E-02								(5)
										Ottawa sand: 1,5							(6)
										Silt: 4,5							(6)
										Clay: 10							(6)
													0,12*				(7)
2,4 dinitrotoluene	2,4 DNT	280	25	2,86E-07	25	Aerobic and anaerobic					Possibly carconogenous						(1)
		270	22	2,89E-07	20									5			(2)
				3,17E-08	25												(3)
		270	20	1,61E-08	20												(3)
													1,10E-04				(7)
2,6 dinitrotoluene	2,6 DNT	208	25	7,46E-07	25	Aerobic and anaerobic											(1)
		206	25	7,46E-07	20									5			(2)
													0,93*				(7)
cyclo - 1,3,5 - triméthylene - 2,4,6 - trinitramine	RDX	45	25	5,30E-12	25	Anaerobique					Possibly carconogenous	0,1					(1)
		42	20	5,53E-12	20									2	0,3	0,00024	(2)
(or hexahydro - 1,3,5 - trinitro - 1,3,5 - triazine, or		50	20	2,56E-12	20												(3)
							0	6,50E-03	1,40E-02								(5)
										0,1 à 13,26							(6)
cyclo - 1,3,5,7 - tetramethylene - 2,4,6,8 - tetranitramine	HMX	5	25	4,38E-17	25	Anaerobique						nd		400	1,7	2,2	(1)
(or octahydro - 1,3,5,7 - tetranitro - 1,3,5,7 - tétrazocine)		5	25	4,34E-17	20												(2)
										0,2 à 4,2							(6)
							0	3,60E-03	3,20E-02								(5)

(1) McGrath, 1995
(2) Thiboutot *et al*, 1998
(3) Pheelan and Webb, 1997
(4) Hayes, 1992
(5) Myers *et al*, 1996
(6) Townsend *et al*, 1996
(7) http://www.mef.gouv.qc.ca/fr/environn/criteres_eau

* Provisory criteria for aquatic life (surface water)

Conversion table for pressure units

	atm	mm Hg	torr	kPa	bar
1 atm =	1	760	760	101,3	1,013250274
1 mm Hg =	0,00131579	1	1	0,13328947	0,001333224
1 torr =	0,00131579	1	1	0,13328947	0,001333224
1 kPa =	0,00987167	7,50246792	7,50246792	1	0,010002471
1 bar =	0,986923	750,06148	750,06148	99,9752999	1

Appendix C – Physical and chemical properties and environmental criteria related to energetic materials

Physical and chemical properties and environmental criteria related to energetic materials

Compounds	Abbreviations	Solubility	T	Vapour pressure	T	Degradation	Degradation constants (mu)			Kd			Toxicity	EPA drinking water standard	MEF water quality criteria	Drinkability criteria	Danger criteria [2] (Daniels)	Danger criteria [2] (Rouisse)	References
							Sand	Silt	Clay	Sand	Silt	Clay							
Units		(mg/L)	(C)	(atm)	(C)		(/hr)	(/hr)	(/hr)	(L/kg)	(L/kg)	(L/kg)		(mg/L)	(mg/L)	(ppb-ug/L)	(mg/K)	(mg/Kg)	
2,4,6 trinitrotoluene	2,4,6 TNT	150	25	7.25E-09	25	Mostly anaerobic							Possibly toxic and carcinogenic	0.02					(1)
		130	20	1.45E-09	20												0.3	0.024	(2)
		150	25	9.49E-09	25														(3)
		130	20	4.61E-09	20														(3)
				1.66E-09	20														(4)
							3.20E-03	1.40E-01	8.30E-02										(5)
										1,5 [3]	4.5	10							(6)
										0.47	2.23								(6)
										6,8 [4]	2.8	11							(6)
															0,12 [1]				(7)
																1			(8)
2,4 dinitrotoluene	2,4 DNT	280	25	2.86E-07	25	Aerobic et anaerobic							Possibly carcinogenic						(1)
		270	22	2.89E-07	20														(2)
				3.17E-08	25														(3)
		270	20	1.61E-08	20														(3)
															1.10E-04				(7)
																5			(8)
2,6 dinitrotoluene	2,6 DNT	208	25	7.46E-07	25	Aerobic et anaerobic													(1)
		206	25	7.46E-07	20														(2)
															0,93 [1]				(7)
																5			(8)
cyclo - 1,3,5 - trimethylene - 2,4,6 - trinitramine	RDX	45	25	5.30E-12	25	Anaerobic							Possibly carcinogenic	0.1					(1)
(or hexahydro - 1,3,5 -		42	20	5.53E-12	20												0.3	0.00024	(2)
trinitro - 1,3,5 - triazine		50	20	2.56E-12	20														(3)
							0	6.50E-03	1.40E-02										(5)
										0,1 à 13,26	0,1 à 13,26	0,1 à 13,26							(6)
										0.29	1.20								
																2			(8)
cyclo - 1,3,5,7 - tetramethylene - 2,4,6,8 - tetranitramine	HMX	5	25	4.38E-17	25	Anaerobic								nd			1.7	2.2	(1)
(ou octahydro - 1,3,5,7		5	25	4.34E-17	20														(2)
tetranitro - 1,3,5,7 -										0,2 à 4,2	0,2 à 4,2	0,2 à 4,2							(6)
tetrazocine)							0	3.60E-03	3.20E-02										(5)
											0,12 [5]	12,1 [6]							
																400			(8)

(1) McGrath, 1995
(2) Thiboutot *et al*, 1998
(3) Pheelan and Webb, 1997
(4) Hayes, 1992
(5) Myers *et al*, 1996
(6) Townsend *et al*, 1996
(7) http://www.mef.gouv.qc.ca/fr/environn/criteres_eau
(8) Walsh *et al*, 1995
(9) Brannon and *al*, 1992
(10) Pennington and Patrick, 1990
(11) Brannon and al, 1999

[1] Temporary criteria for aquatic life (surface water)
[2] Human health danger criteria
[3] Ottawa sand
[4] Joliet sand
[5] Grange Hall silt
[6] Yokena clay

Conversion table for pressure units

	atm	mm Hg	torr	kPa			bar
1 atm =	1	760	760	101.3			1.013250274
1 mm Hg =	0.001316	1	1	0.133289			0.001333224
1 torr =	0.001316	1	1	0.133289			0.001333224
1 kPa =	0.009872	7.502467917	7.5024679	1			0.010002471
1 bar =	0.986923	750.06148	750.06148	99.9753			1

Appendix D – Training Area authorisation forms

MINISTERE DE LA DEFENSE NATIONALE
DEPARTMENT OF NATIONAL DEFENCE
Gouvernement du Canada / Government of Canada

SISEFC | CFRIS

FORMULAIRE D'AUTORISATION DE SECTEUR
RANGE / TRAINING AREA AUTHORIZATION FORM

Code de secteur: / Range Id: **RA697**   Nom de secteur: / Range Name: **ROCKET LAUNCHER RGE**

Locale / Location: CFB PETAWAWA   Type / Type: ANTI-ARMOUR

Base / Base: CFB PETAWAWA

Commandement / Command: Director Land Forces Readiness

État / Status: Actif   Active   Grandeur / Size: 1,000.00 Metres

Feuille de carte / Map Sheet: MCE132 TR 89 ED 7   GR157953   Allées / Lanes: 0

ARMES / WEAPONS	MUNITIONS / AMMUNITION
RIFLE (SNIPER) C3 7.62mm	CTG 7.62mm
LAW M72	CTG 7.62mm Match
MAW GUN 84mm (CG)	RKT 66mm HEAT(M72)
	CTG 84mm HEAT FFV 551
	CTG 84mm HEPD FFV 502
	CTG 84mm TP/T

RESTREINTS: / RESTRICTIONS

Sécurité / Safety: No movement forward of the firing points without authorization from CFB Petawawa.

Autre / Other: None

Date autorisé / Authorized Date: 18/06/1998   Autorisé par: MWO G.H. BERGERON

Commandement / Command: Director Land Forces Readiness   Authorized By: DLFR6-6-3

Date inspectée / Inspected Date: 17/11/1997   Central Area   Par / By: LFCA MWO RD

SISEFC

FORMULAIRE D'AUTORISATION DE SECTEUR
RANGE / TRAINING AREA AUTHORIZATION FORM

CFRIS

Code de secteur: / Range Id: **RA720** Nom de secteur: / Range Name: **DEMOLITION RANGE**

Locale / Location:	CFB PETAWAWA	Type / Type:	DEMOLITION
Base / Base:	CFB PETAWAWA		
Commandement / Command:	Director Land Forces Readiness		
État / Status:	Actif Active	Grandeur / Size:	1,000.00 Metres
Feuille de carte / Map Sheet:	MCE132 TR 89 ED 7 GR057833	Allées / Lanes:	0

ARMES / WEAPONS	MUNITIONS / AMMUNITION
	EXPLOSIVES

RESTREINTS: / RESTRICTIONS

Sécurité / Safety: None

Autre / Other: None

Date autorisé / Authorized Date:	22/06/1998	Autorisé par:	MWO G.H. BERGERON
Commandement / Command:	Director Land Forces Readiness	Authorized By:	DLFR6-6-3
Date inspectée / Inspected Date:	18/11/1997 Central Area	Par / By:	LFCA MWO RD

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FORMULAIRE D'AUTORISATION DE SECTEUR
RANGE / TRAINING AREA AUTHORIZATION FORM

Code de secteur: / Range Id: **RA611** Nom de secteur: / Range Name: **PETAWAWA GRENADE RGE**

Locale / Location: **CFB PETAWAWA, ONT** Type / Type: **GRENADE RANGE**

Base / Base: **CFB PETAWAWA**

Commandement / Command: **Director Land Forces Readiness**

État / Status: **Actif** **Active** Grandeur / Size: **200.00** Metres

Feuille de carte / Map Sheet: **MCE132 TR 89 ED 7** **GR188883** Allées / Lanes: **4**

ARMES / WEAPONS	MUNITIONS / AMMUNITION
GRENADES FRAG	GREN FRAG M67
PYROTECHNICS	GREN FRAG M61
	PYROTECHNICS

RESTREINTS: RESTRICTIONS

Sécurité / Safety: None

Autre / Other: None

Date autorisé / Authorized Date: 18/06/1998 Autorisé par: / Authorized By: MWO G.H. BERGERON DLFR6-6-3

Commandement / Command: Director Land Forces Readiness

Date inspectée / Inspected Date: 18/11/1997 Central Area Par / By: LFCA MWO RD

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FORMULAIRE D'AUTORISATION DE SECTEUR
RANGE / TRAINING AREA AUTHORIZATION FORM

CFRIS

Code de secteur: Range Id: **RA614**

Nom de secteur: Range Name: **IMPACT AREA A**

Locale / Location: CFB PETAWAWA, ONT

Type / Type: IMPACT AREA

Base / Base: CFB PETAWAWA

Commandement / Command: Director Land Forces Readiness

État / Status: Actif Active

Grandeur / Size: 5.00 Acres

Feuille de carte / Map Sheet: MCE132 TR 89 ED 7

Allées / Lanes: 0

ARMES WEAPONS

MG .50in
MG C5 7.62mm
MG C6 7.62mm
MAW GUN 84mm (CG)
RIFLE C7 5.56mm
RIFLE (CARABIN) C8 5.56mm
MG C9 5.56mm
MORTAR 60mm
MORTAR 81mm
GUN 105mm TK
GUN 105mm HOW
GUN 40mm BOFFIN
GUN 106mm
GUN 76mm (COUGAR)
PISTOL 9mm
RIOT GUN 38mm
PYROTECHNICS
PISTOL .38

MUNITIONS AMMUNITION

CTG .38
CTG 5.56mm
CTG 9mm
CTG 7.62mm
CTG .50
CTG 60mm MOR HE
CTG 60mm MOR SMK WP
CTG 60mm MORIII
CTG 81mm MOR HE
CTG 81mm MOR SMK WP
CTG 81mm MOR III
RKT 66mm HEAT(M72)
CTG 84mm HEAT FFV 551
CTG 84mm TP/T
CTG 105mm HE PD (HOW)
CTG 105mm ILL (HOW)
CTG 105mm SMK (HOW)
PROJ 155mm HE M107
PROJ 155mm ILL
PROJ 155mm SMK
PROJ 155mm SMK WP
CTG 76mm HESH
CTG 76mm SH/P
CTG 38mm SPEDEHETE CS
CTG 38mm FLITERITE CS
PYROTECHNICS

RESTREINTS: RESTRICTIONS

Sécurité / Safety: None

Autre / Other: None

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FORMULAIRE D'AUTORISATION DE SECTEUR
RANGE / TRAINING AREA AUTHORIZATION FORM

Code de secteur: / Range Id: **RA614** Nom de secteur: / Range Name: **IMPACT AREA A**

Date autorisé / Authorized Date:	18/06/1998	Autorisé par:	MWO G.H. BERGERON
Commandement / Command:	Director Land Forces Readiness	Authorized By:	DLFR6-6-3
Date inspectée / Inspected Date:	20/11/1997 Central Area	Par / By:	LFCA MWO RD

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FORMULAIRE D'AUTORISATION DE SECTEUR
RANGE / TRAINING AREA AUTHORIZATION FORM

CFRIS

Code de secteur: / Range Id: **RA682** Nom de secteur: / Range Name: **IMPACT AREA N**

Locale / Location: CFB PETAWAWA
Type / Type: IMPACT AREA
Base / Base: CFB PETAWAWA
Commandement / Command: Director Land Forces Readiness
État / Status: Actif Active
Grandeur / Size: 5.00 Acres
Feuille de carte / Map Sheet: MCE 132 TR 89 ED 7
Allées / Lanes: 0

ARMES WEAPONS

GUN 105mm TK
GUN 105mm HOW
GUN 155mm HOW
GUN 76mm (COUGAR)

MUNITIONS AMMUNITION

CTG 105mm HE PD (HOW)
CTG 105mm HE PLGD (HOW)
CTG 105mm MTSQ (HOW)
CTG 105mm ILL (HOW)
CTG 105mm HESH L43A1 (HOW)
CTG 105mm SH\P (HOW)
CTG 105mm SMK WP (HOW)
CTG 105mm SMK (HOW)
PROJ 155mm HE M107
PROJ 155mm ILL
PROJ 155mm SMK
PROJ 155mm SMK WP
CTG 76mm HESH
CTG 76mm SH/P
CTG 76mm SMK BE
CTG 105mm HESH (TK)
CTG 105mm APCS/T (TK)
CTG 105mm APFSDS (TK)
CTG 105mm SMK HCBE (TK)
CTG 105mm SMK WP (TK)
CTG 105mm TPFSDS/T (TK)
CTG 105mm SH/PT C109 (TK)

RESTREINTS: RESTRICTIONS

Sécurité / Safety: Ricochet area for area 2 and small arms ranges Q, X, and Y.

Autre / Other: None

Date autorisé / Authorized Date: 18/06/1998
Autorisé par: / Authorized By: MWO G.H. BERGERON DLFR6-6-3
Commandement / Command: Director Land Forces Readiness
Date inspectée / Inspected Date: 20/11/1997 Central Area
Par / By: LFCA MWO RD

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Imprimé par / Printed by: MWO BERGERON, GILLES G

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FORMULAIRE D'AUTORISATION DE SECTEUR
RANGE / TRAINING AREA AUTHORIZATION FORM

Code de secteur: / Range Id: **RA681**

Nom de secteur: / Range Name: **DZ ANZIO AREA 1**

Locale / Location: **CFB PETAWAWA**

Type / Type: **IMPACT AREA**

Base / Base: **CFB PETAWAWA**

Commandement / Command: **Director Land Forces Readiness**

État / Status: **Actif** **Active**

Grandeur / Size: **5,000.00** Metres

Feuille de carte / Map Sheet: **MCE132 TR 89 ED 7**

Allées / Lanes: **0**

ARMES / WEAPONS	MUNITIONS / AMMUNITION
RIFLE C1 7.62mm	CTG 5.56mm
MG .50in	CTG 9mm
MG C5 7.62mm	CTG 7.62mm
MG C6 7.62mm	CTG .50
RIFLE C7 5.56mm	CTG 38mm SPEDEHETE CS
RIFLE (CARABIN) C8 5.56mm	CTG 38mm FLITERITE CS
MG C9 5.56mm	PYROTECHNICS
PISTOL 9mm	BLANK AMMUNITION
RIOT GUN 38mm	CS Riot Gas
PYROTECHNICS	

RESTREINTS: **RESTRICTIONS**

Sécurité / Safety:
1. No vehicle movement off roads.
2. No impact of dud producing ammunition.
3. Ricochet area for arty and armd wpns subject to clearance.

Autre / Other: None

Date autorisé / Authorized Date: 18/06/1998

Autorisé par: Authorized By: MWO G.H. BERGERON DLFR6-6-3

Commandement / Command: Director Land Forces Readiness

Date inspectée / Inspected Date: 18/11/1997 Central Area

Par / By: LFCA MWO RD

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FORMULAIRE D'AUTORISATION DE SECTEUR
RANGE / TRAINING AREA AUTHORIZATION FORM

CFRIS

Code de secteur: Range Id: **RA683**   Nom de secteur: Range Name: **IMPACT AREA D**

Locale / Location: **CFB PETAWAWA**   Type / Type: **IMPACT AREA**

Base / Base: **CFB PETAWAWA**

Commandement / Command: **Director Land Forces Readiness**

État / Status: **Actif** **Active**   Grandeur / Size: **5.00** Acres

Feuille de carte / Map Sheet: **MCE132 TR 89 ED 7**   Allées / Lanes: **0**

ARMES / WEAPONS	MUNITIONS / AMMUNITION
RIFLE C1 7.62mm	CTG .38
RIFLE (SNIPER) C3 7.62mm	CTG 5.56mm
MG .50in	CTG 9mm
Rockets 2.75in	CTG 7.62mm
MG C5 7.62mm	CTG .50
MG C6 7.62mm	CTG 60mm MOR HE
LAW M72	CTG 60mm MOR SMK WP
MAW GUN 84mm (CG)	CTG 60mm MORIII
RIFLE C7 5.56mm	CTG 81mm MOR HE
RIFLE (CARABIN) C8 5.56mm	CTG 81mm MOR SMK WP
MG C9 5.56mm	CTG 81mm MOR III
MORTAR 60mm	RKT 21mm SUB-CAL(M72)
MORTAR 81mm	CTG 84mm HEAT FFV 551
GUN 105mm TK	ATGM BGM 71AE HE (TOW)
GUN 105mm HOW	CTG 84mm TP/T
GUN 155mm HOW	CTG 105mm HE PD (HOW)
GUN 40mm BOFFIN	CTG 105mm ILL (HOW)
GUN 106mm	CTG 105mm SMK WP (HOW)
GUN 76mm (COUGAR)	CTG 105mm SMK (HOW)
PISTOL 9mm	PROJ 155mm HE M107
RIOT GUN 38mm	PROJ 155mm ILL
MISSILE TOW	PROJ 155mm SMK
MISSILE BLOWPIPE	PROJ 155mm SMK WP
PYROTECHNICS	CTG 76mm HESH
PISTOL .38	CTG 76mm SH/P
	CTG 76mm SMK BE
	CTG 105mm SMK HCBE (TK)
	CTG 105mm SMK WP (TK)
	CTG 38mm SPEDEHETE CS

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FORMULAIRE D'AUTORISATION DE SECTEUR
RANGE / TRAINING AREA AUTHORIZATION FORM

Code de secteur:
Range Id: **RA683**

Nom de secteur:
Range Name: **IMPACT AREA D**

CTG 38mm FLITERITE CS
RKT 2.75in HE
PYROTECHNICS
MISSILE BLOWPIPE
BLANK AMMUNITION
CS Riot Gas

RESTREINTS: **RESTRICTIONS**

Sécurité / Safety: DZ dives crossing in area D, UXO producing ammunition fired only on authority of Comd CFB Petawawa.

Autre / Other: None

Date autorisé / Authorized Date:	18/06/1998	Autorisé par:	MWO G.H. BERGERON
Commandement / Command:	Director Land Forces Readiness	Authorized By:	DLFR6-6-3
Date inspectée / Inspected Date:	20/11/1997 Central Area	Par / By:	LFCA MWO RD

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FORMULAIRE D'AUTORISATION DE SECTEUR
RANGE / TRAINING AREA AUTHORIZATION FORM

CFRIS

Code de secteur: / Range Id: **RA684**

Nom de secteur: / Range Name: **IMPACT AREA B**

Locale / Location:	CFB PETAWAWA	Type / Type:	IMPACT AREA
Base / Base:	CFB PETAWAWA		
Commandement / Command:	Director Land Forces Readiness		
État / Status:	Actif Active	Grandeur / Size:	5,000.00 Metres
Feuille de carte / Map Sheet:	MCE132 TR 89 ED 7	Allées / Lanes:	0

ARMES / WEAPONS	MUNITIONS / AMMUNITION
RIFLE C1 7.62mm	CTG .38
RIFLE (SNIPER) C3 7.62mm	CTG 5.56mm
MG .50in	CTG 9mm
MG C5 7.62mm	CTG 7.62mm
MG C6 7.62mm	CTG .50
LAW M72	CTG 60mm MOR HE
MAW GUN 84mm (CG)	CTG 60mm MOR SMK WP
RIFLE C7 5.56mm	CTG 60mm MORIII
RIFLE (CARABIN) C8 5.56mm	CTG 81mm MOR HE
MG C9 5.56mm	CTG 81mm MOR SMK WP
MORTAR 60mm	CTG 81mm MOR III
MORTAR 81mm	RKT 21mm SUB-CAL(M72)
GUN 105mm TK	CTG 84mm TP/T
GUN 105mm HOW	CTG 105mm HE PD (HOW)
GUN 155mm HOW	CTG 105mm HE PLGD (HOW)
GUN 40mm BOFFIN	CTG 105mm ILL (HOW)
GUN 106mm	CTG 105mm SMK WP (HOW)
GUN 76mm (COUGAR)	CTG 105mm SMK (HOW)
PISTOL 9mm	PROJ 155mm HE M107
RIOT GUN 38mm	PROJ 155mm ILL
PYROTECHNICS	PROJ 155mm SMK
PISTOL .38	PROJ 155mm SMK WP
	CTG 105mm SMK HCBE (TK)
	CTG 105mm SMK WP (TK)
	CTG 38mm SPEDEHETE CS
	CTG 38mm FLITERITE CS
	PYROTECHNICS
	BLANK AMMUNITION
	CTG 105mm HE M1

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FORMULAIRE D'AUTORISATION DE SECTEUR
RANGE / TRAINING AREA AUTHORIZATION FORM

Code de secteur: / Range Id: **RA684**

Nom de secteur: / Range Name: **IMPACT AREA B**

CS Riot Gas

RESTREINTS: | **RESTRICTIONS**

Sécurité / Safety: None

Autre / Other: None

Date autorisé / Authorized Date:	18/06/1998	Autorisé par:	MWO G.H. BERGERON
Commandement / Command:	Director Land Forces Readiness	Authorized By:	DLFR6-6-3
Date inspectée / Inspected Date:	17/11/1997 Central Area	Par / By:	LFCA MWO RD

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FORMULAIRE D'AUTORISATION DE SECTEUR
RANGE / TRAINING AREA AUTHORIZATION FORM

CFRIS

Code de secteur: / Range Id: **RA600** Nom de secteur: / Range Name: **BURWASH GRENADE RANGE**

Locale / Location: **CFTA BURWASH ON** Type / Type: **GRENADE RANGE**

Base / Base: **CFB PETAWAWA**

Commandement / Command: **Director Land Forces Readiness**

État / Status: **Actif** **Active** Grandeur / Size: **300.00** Metres

Feuille de carte / Map Sheet: **DELAWARE 4-1/2 CONISTON GR139232** Allées / Lanes: **0**

ARMES / WEAPONS	MUNITIONS / AMMUNITION
GRENADES FRAG	GREN FRAG M67 GREN LAUNCHER 40mm PRAC

RESTREINTS: RESTRICTIONS

Sécurité / Safety: Sentries to be installed at Gr14332322,13482279,13602314. Sentries must have communicationwith Range RSO

Autre / Other: None

Date autorisé / Authorized Date: 18/06/1998 Autorisé par: MWO G.H. BERGERON

Commandement / Command: Director Land Forces Readiness Authorized By: DLFR6-6-3

Date inspectée / Inspected Date: 23/10/1997 Central Area Par / By: LFCA MWO RD

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Imprimé par / Printed by: MWO BERGERON, GILLES G

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FORMULAIRE D'AUTORISATION DE SECTEUR
RANGE / TRAINING AREA AUTHORIZATION FORM

CFRIS

Code de secteur: Range Id: **RA613**   Nom de secteur: Range Name: **BLOWPIPE RGE**

Locale / Location: **CFB PETAWAWA, ONT**   Type / Type: **AIR DEFENCE WEAPONS**

Base / Base: **CFB PETAWAWA**

Commandement / Command: **Director Land Forces Readiness**

État / Status: **Actif**   **Active**   Grandeur / Size: **5,000.00** Metres

Feuille de carte / Map Sheet: **MCE132 TR 89 ED 7**   **GR063919**   Allées / Lanes: **0**

ARMES / **WEAPONS**	**MUNITIONS** / **AMMUNITION**
MISSILE BLOWPIPE	Missile Javelin S15
MISSILE JAVELIN	MISSILE BLOWPIPE

RESTREINTS: **RESTRICTIONS**

Sécurité / Safety: None

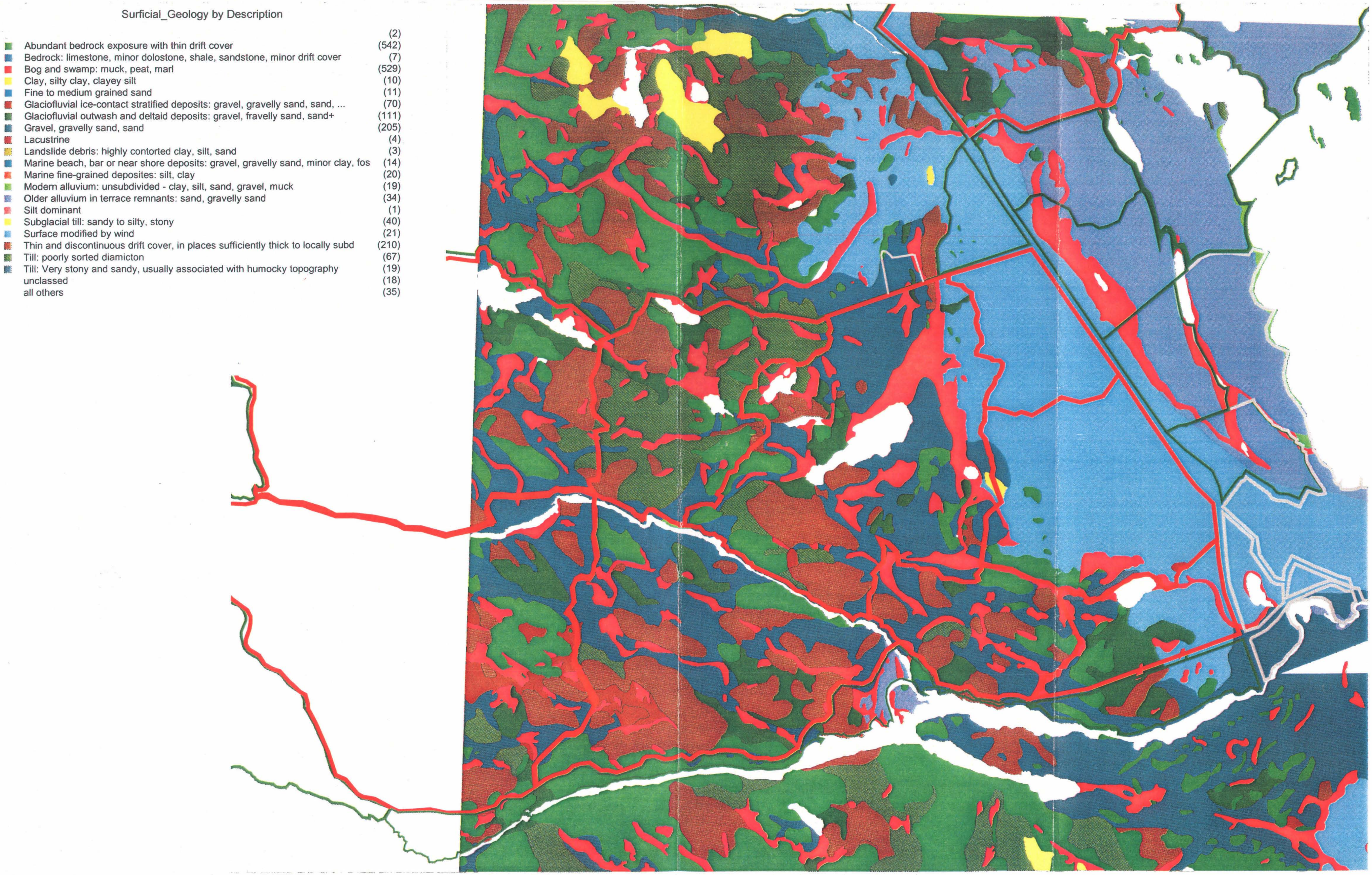
Autre / Other: None

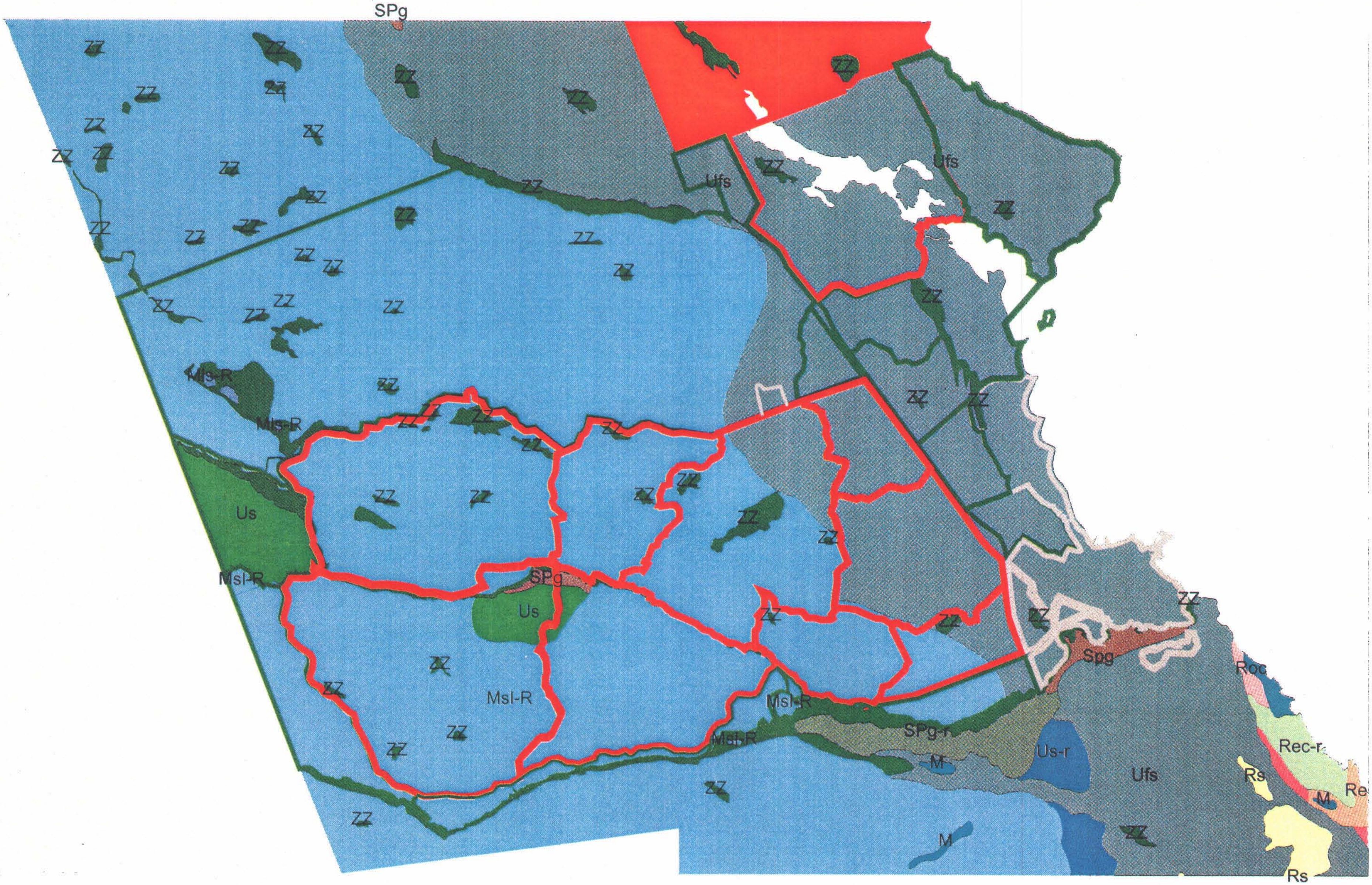
Date autorisé / Authorized Date: 14/08/1992   Autorisé par: MWO JA LARADE

Commandement / Command: Director Land Forces Readiness   Authorized By: DLFR6-6-3

Date inspectée / Inspected Date: 11/02/1997   Central Area   Par / By: LFCA HQ   WO DEVEREA

Appendix E – Topographic and surface deposits maps


Surficial_Geology by Description
(2)
Abundant bedrock exposure with thin drift cover (542)
Bedrock: limestone, minor dolostone, shale, sandstone, minor drift cover (7)
Bog and swamp: muck, peat, marl (529)
Clay, silty clay, clayey silt (10)
Fine to medium grained sand (11)
Glaciofluvial ice-contact stratified deposits: gravel, gravelly sand, sand, ... (70)
Glaciofluvial outwash and deltaid deposits: gravel, fravelly sand, sand+ (111)
Gravel, gravelly sand, sand (205)
Lacustrine (4)
Landslide debris: highly contorted clay, silt, sand (3)
Marine beach, bar or near shore deposits: gravel, gravelly sand, minor clay, fos (14)
Marine fine-grained deposites: silt, clay (20)
Modern alluvium: unsubdivided - clay, silt, sand, gravel, muck (19)
Older alluvium in terrace remnants: sand, gravelly sand (34)
Silt dominant (1)
Subglacial till: sandy to silty, stony (40)
Surface modified by wind (21)
Thin and discontinuous drift cover, in places sufficiently thick to locally subd (210)
Till: poorly sorted diamicton (67)
Till: Very stony and sandy, usually associated with humocky topography (19)
unclassed (18)
all others (35)



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SPg-r
Us-r
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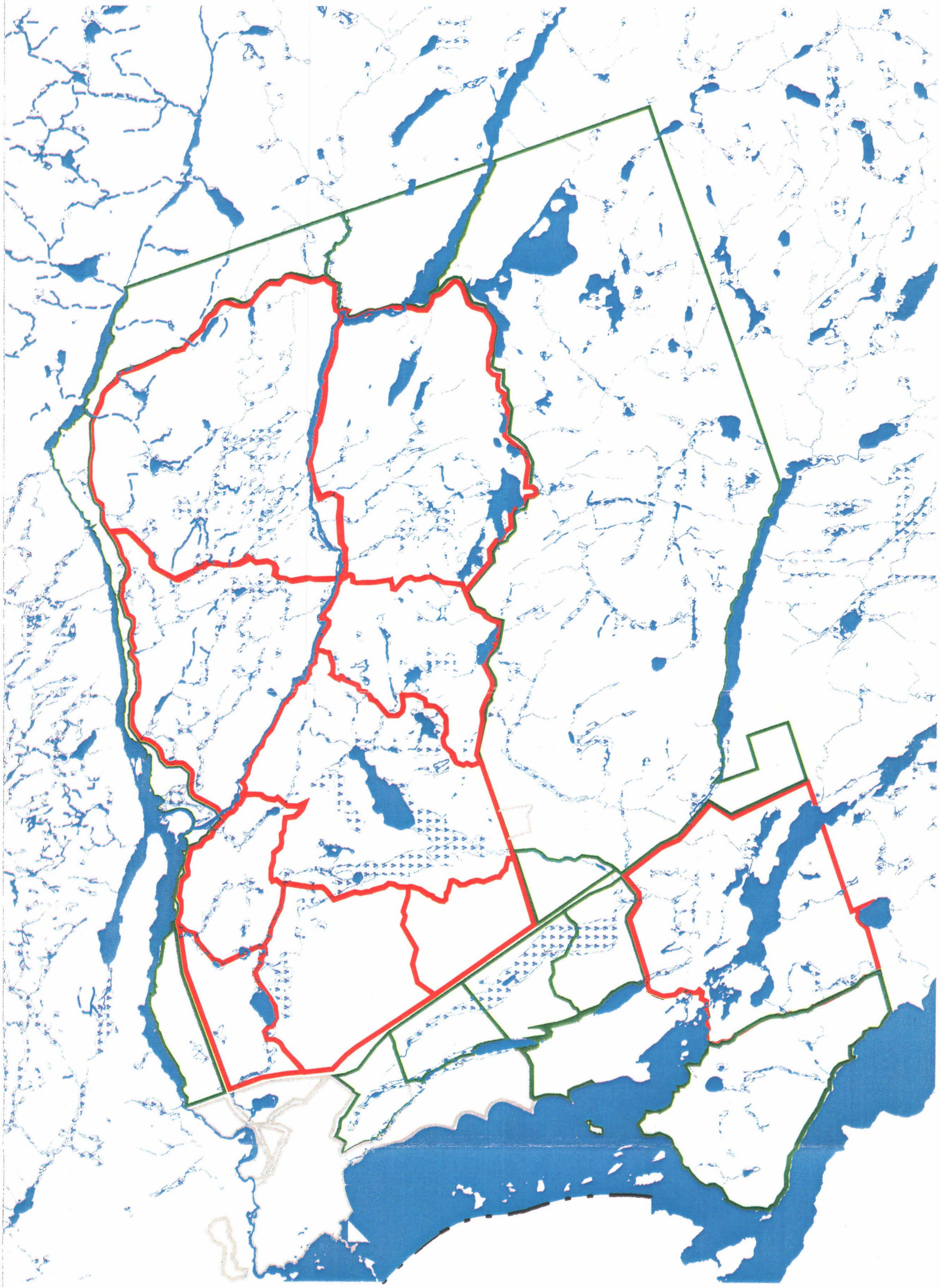
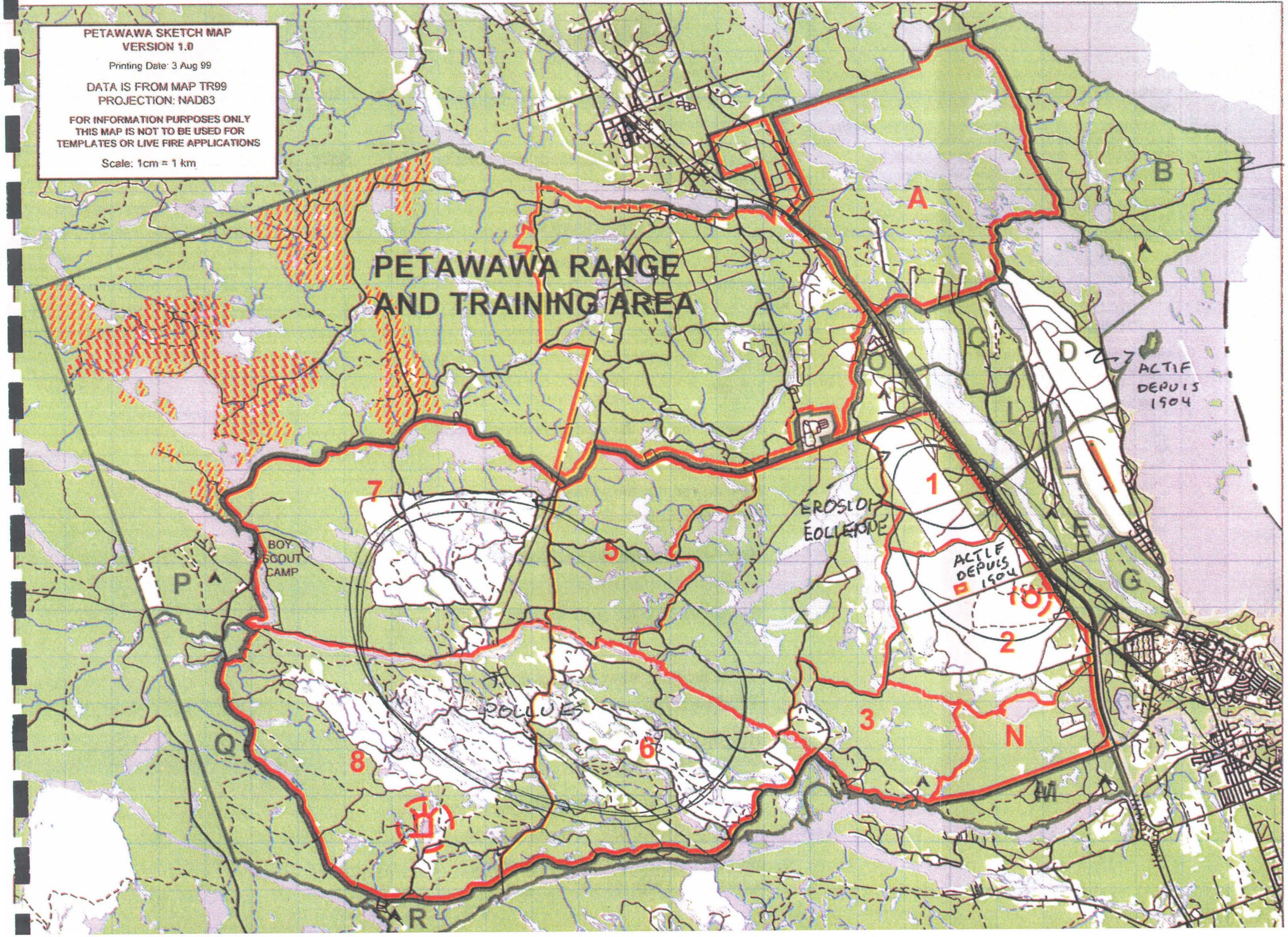
Spg
Roc
Rec-r
Rs





NOTES

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~~DEPUIS~~
~~1904~~

-> DS 6, 7, 8

- INCENDIE IL Y A 3 ANS A PROVOQUÉ QUELQUES EXPLOSIONS
- DERNIER NETTOYAGE : ANNÉES 80 -> LIMITÉ À QUELQUES ENDROITS
- OBUS EXPLOSÉS SUR PLACE

LEGEND

TRANSPORT

- Access Road
- Transmission Line
- Rail Line
- Road - Centreline
- Road Edge
- Trail Portage
- Boundary - Interprovincial

TRAINING AREA BOUNDARIES

- All vehicles to stay on gravel roads. Foot patrolling with less than 40 persons
- Driving on trails and foot patrolling are permitted
- Dry Training Area
- Garrison
- Live Fire
- Out of Bounds
- Bivouac Site

WETLANDS

- Stream
- Stream - Intermittent
- Island
- Lake
- Marsh/Fen
- River

Training and the Environment

CFB Petawawa / CFTA Burwash

NOTE: This guide does not replace Range Standing Orders

TRAINING AREAS

√ Authorisation for any tree cutting must be obtained from BCE Natural Resources through Range Control.
  - Use Camouflage netting instead of branches
  - Use branches from logging slash piles whenever possible

√ Police all garbage and trash on a regular basis. On-base users will return garbage and recyclables to their unit lines. Off base users must arrange access to garbage and recycling facilities through Range Control.

√ Do not burn or bury any trash.

√ An inspection by Range Control is REQUIRED for training area/range clearance.
  - Remove all wire, trash and tactical obstacles
  - Collect spent shell casings to the extent practical
  - Fill in and mound ALL excavations

VEHICLE MOVEMENT

√ Speed limit in the Training Area is 50 km/hr

√ Stick to trails if the ground is saturated with water

√ Wheeled vehicles are to have tire air pressures lowered to off-road settings before leaving hard packed trails.

√ Off road traffic on DZ Anzio will stick to established trails unless permitted by Range Control.

CFTA BURWASH - SPECIAL PROCEDURES

√ Range Control MUST be contacted in advance and advised of unit identity, nature of training, number of personnel and departure time. Units MUST have an operating cellular telephone while at Burwash.

√ FIRE - Between 1 April and 1 October, Units MUST advise Ontario Ministry of Natural Resources Fire Operations Centerat (705) 564-6000 of deployment, departure date and time before starting training. Call them for any fire fighting assistance.

CFB PETAWAWA - PETAWAWA RESEARCH FOREST

This is Canada's oldest research forest. Some experiments have been ongoing for over eighty years. Disturbance of any experiments will harm our national heritage and carry severe consequences.

√ Dry training only, live fire is not permitted.

√ No travel through PRF townsite at any time.

√ No off-road vehicle movement without authorisation from Range Control

√ See sketch map (reverse side) for special restrictions

√ ALL ACCESS TO THE AREA including recces, must be cleared through Range Control in advance. Range Control will liase with Research Forest Manager.

POL & HAZMAT - SPILL PREVENTION & RESPONSE

√ For any group activity involving five vehicles or more, the group must have spill response capability in the amount of one spill kit for every five vehicles.

√ POL pts and field refuelling operations will not occur closer than

√ Action in event of spill - prevent spill from entering water and cleanup.

√ Contaminated materiel must be disposed of through Base Supply R&D during normal hours, or 2 Svc Bn after hours.

√ Spills beyond Unit capability - slow, divert or contain the discharge, call for assistance through Range Control. Range Control will activate Base Spill team through the Fire Hall and notify Base Environmental Officer.

√ Report all spills through Range Control with the following information:
  - Any injuries,
  - Assistance required (Y/N)
  - Identity and amount of materiel spilled,
  - Location of spill (Grid Ref),
  - Name and contact person for the unit,
  - Did spill enter water?

CONTACT NUMBERS (613) 687-5511

√ Base Operations - Training Coordination loc 6403/6762
√ Range Control - RCO and RSO loc 5181/5477
√ Range Control Duty NCO loc 5203
√ Base Environmental loc 6572
√ Base Duty Center loc 5439/5611
√ BCE Fire Hall loc 5222 or (613)687-2222
√ Base General Safety loc 6385
√ Base Ammunition Section loc 5429
√ Base Accommodation loc 5937/5153
√ Base Hospital loc 7056/5392 (24hrs)
√ Base Military Police loc 5444 or 687-4444 (24hrs)

Range Control

Customer Survey

Please help us improve our services by completing the following survey.

Please rate the services received for each question (on a scale 0 to 5)

0 = Not at all satisfied
5 = Very satisfied
NA = Not assessed

(Optional)
Rank ____________
Name ____________
Unit ____________
Area Used ____________
Date of use ____________

1. How do you rate the services received overall? ____
2. How do you rate the procedure for range bookings? ____
3. How do you rate the march off procedures? ____
4. How do you rate the range standing orders? ____
5. Do the facilities allow you to achieve your training goals? ____
6. How do you rate the deportment of the Range Control Staff? ____
7. Are you satisfied with the communications in the field (Safety net)? ____
8. Are you satisfied that the training can be achieved in a safe manner? ____
9. Please feel free to add any comments that could help the quality of services offered:

OBUS VIEUX DE WWII