FIRE CHIEF'S GUIDE FOR DEVELOPMENT DESIGN APPROVAL

Version 1.1

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Introduction

This handbook is a guide for use by Canadian fire chiefs when reviewing housing developments within their communities; it compiles information about standards and opportunities through which fire chiefs can affect development approvals within their community. The content is based on experience, consolidates background information, and explains how the two fit together into a comprehensive program that shapes fire safe communities at the development stage.

This purpose of this guide is to share this knowledge with fire chiefs and their departments such that they can have a greater understanding of their role in shaping fire safety policies in their communities. Some elements in this guide have been extracted from a number of sources including Fire Underwriters Survey (FUS), the National Fire Protection Association (NFPA), and the National Research Council of Canada (NRC) documents. More detailed materials can be found in these cited sources. All mentioned codes and standards are only minimum standards or minimum best practices. Nothing precludes a community from setting higher requirements.

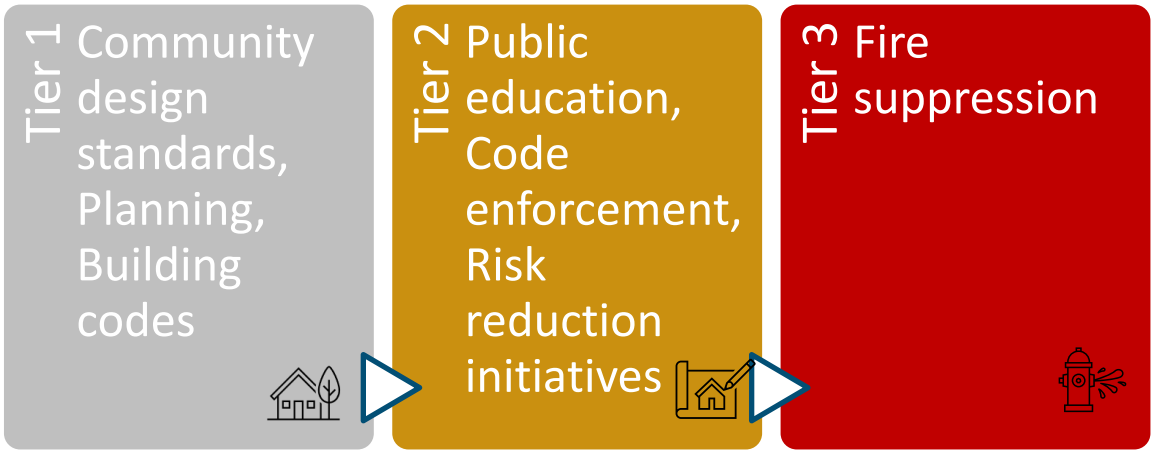
Canada has a loose patchwork of provincial and territorial regulations, codes, standards, and bylaws that creates a system of public fire protection. While some provinces have attempted to guide departments in the application of some elements, there is a lack of comprehensive guidance. This guide attempts to help fire chiefs and those in smaller communities understand their important roles in participating in the design review and approval of subdivision development in the communities they serve.

Your feedback would be appreciated as it is intended that this handbook will be periodically updated as needed.

Fire safety system

Fire chiefs have a key role in providing input into the design standards to be used in the development of their communities; this is a key tenet even found in the assumptions in the National Building Code (NBC) on firefighting capabilities. Ensuring that proper

planning and design of buildings in our communities is the first line of defence in the fire safety system.



The principles found in the fire safety system are:

Tier 1 is the use of codes and standards to ensure buildings are designed and built to proper standards to control the high-risk ignition sources and hazardous processes, and once occupied, are operated and maintained to minimum safe levels. If fires do occur, we rely on fire/smoke detection and suppression systems to alert occupants and suppress or contain the fire. Then we rely on fire compartmentalization to limit the spread of the fire.

Tier 2 relies on public education activities to increase awareness, and code enforcement to identify unsafe practices to prevent fires from occurring and ensure that passive and automatic systems are functioning properly.

When any of the above two fails, communities rely on Tier 3, manual fire suppression resources, to extinguish the fire. The National Building Code is also clear that when fire suppression resources are inadequate in the community then higher design standards can be required.

Firefighting assumptions are found in NBC Division B A-3; this section clarifies that for Part 3 buildings there is an assumption that there is an adequate firefighting force available. The code further states that there is no consistent defined level of what that adequate firefighting service is in defining the requirements of the code.

This implies that the local fire service assesses whether it has adequate resources for the type of building or development being proposed. Fire chiefs therefore need to be engaged in this process as part of the development plan review and approval. Becoming involved in the process is best accomplished by having dialogue and understanding with the building department officials, planning department, members of the building community, and elected municipal leaders about the capabilities and limitations of your fire service.

Modern fires

Building codes have been based on research, much of which has been completed since the 1950s. Many of the fundamental assumptions in our building codes have changed as modern fires have changed. Furnishings have changed from natural fibers to man-made materials. Research has proven that fires in modern structures burn hotter, peak faster, and are more toxic. At the same time, how homes are designed have changed. The public expects large, open rooms. This trend toward open-concept design decreases fire compartmentalization, and results in larger floor spans. Building and fire codes have not kept pace in Canada. Attempts to impose code changes have not been successful due to push back from industry groups, lack of funding for fire research, and other factors. Fire chiefs can influence design within their communities by being engaged in the approval of buildings and subdivisions, especially when their resources cannot arrive in time to these fires to be effective in containing the fires to the initial structure.

Code regulatory framework and standards

This guide also helps fire chiefs understand special provisions found in the NBC. The NBC, in the author's opinion, is not user friendly. Compared to other documents such as the National Fire Protection Association (NFPA) codes, the NBC is not structured

based on occupancy types but rather by building systems. The NBC tells builders and their trades how to erect the buildings. The code clearly has not been written for code enforcement officials. There is no national standard program to adequately educate fire chiefs or fire prevention officers about elements found in the NBC.

Provincial regulations cover the establishment of the fire services and any specific community risk requirements. The provinces and territories have various programs for community risk reduction. As well, some provinces have prepared detailed guides on how to apply elements of the NBC. Provincial regulations obviously must be followed. But in the absence of provincial regulations then fire chiefs must look to industry best practices.

This handbook refers to several NFPA standards. NFPA is not just a U.S. standards body. NFPA follow ANSI for certification of its standards, which means NFPA follows an open and transparent standards development process. In the absence of being adopted into provincial or municipal regulations, the NFPA standards become industry best practices to benchmark local regulations or procedures. Fire chiefs are often asked "If you are not following the NFPA standards, then what other standards are you following?" All NFPA standards can be viewed online for free at www.nfpa.org or on the new codes and standards platform LiNK (Visit www.nfpa.org/LiNK for a free 14-day trial.)

Capability of your fire service

Community risk reduction (CRR)

The fire safety system is put into practice by communities by looking at a community risk reduction framework. Community risk reduction is defined in *NFPA 1300, Standard on Community Risk Assessment and Community Risk Reduction Plan Development*, as a process to identify and prioritize local risks, followed by the integrated and strategic

investment of resources to reduce their occurrence and impact. Steps in this process include:

- Develop a community risk assessment (CRA)
- Develop a community risk reduction plan/standards of cover (SOC)
- Implement the plan
- Evaluate and update the plan

The municipality, along with the fire department other agencies, plus community partners, identify the nature of the community, identify the risks, and then develop a plan to address these risks.

Community risk assessment (CRA)

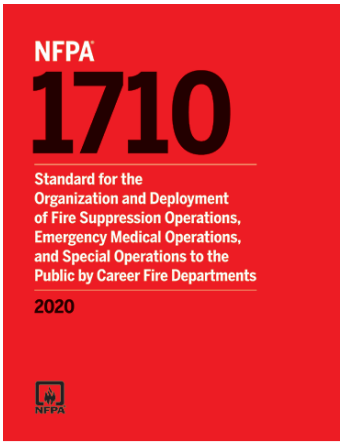
The community risk assessment allows the fire department to evaluate the unique risks that the community faces. What are the unique risks?

- Business lines in the community – especially important for smaller communities dependent on one primary industry.
- Demographics – age and makeup of the population, where they are found, etc.
- Geographical factors – the size and distribution of population.
- Other unique risks such as threat from wildland urban interface fires, incidents and fire loss history, relevant NFPA standards (1300, 1720, 1730, etc.), critical infrastructure.
- Critical infrastructure

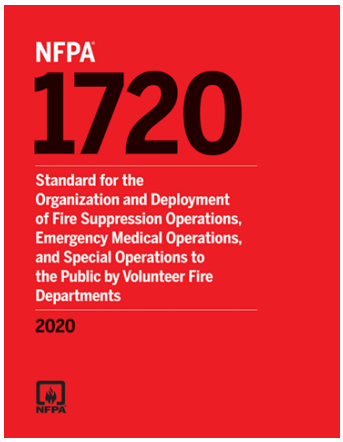
Identifying and describing these risks will assist the elected officials and the public in defining how the fire service should be funded and structured to address these risks. It is essential that a bylaw/contract be prepared that defines the expected services to be provided, the response expectations, and how the community supports these services. A key element of the CRA should be the standards of cover (SOC) document.

Community risk reduction plan/standards of cover (SOC)

One output from the CRR process is the development of plan for the fire service and other agencies will address the risks that have been identified; this is the community risk reduction plan, or the standards of cover. Essentially, this document is the "contract" between the community and the fire department. The SOC identifies the service level standard that the fire service provides to the community and the response time objectives. The SOC should be the basis for the fire department annual report to the elected officials and should include services being provided (exterior fire fighting, interior fire fighting, other specialty services) and response time objectives – number of personnel in an effective response force and the time to arrive on scene. It is important to note that the response time objectives are formally approved by municipal leaders; they represent the municipality's acceptance of the level of risk. Furthermore, it should be made clear that when these objectives (either response time, numbers, or both) cannot be met within a proposed development then an adequate fire department response is not available and therefore as per the NBC higher design standards can and should be required.



As an example of an industry standard benchmark, NFPA 1710 identifies a travel time of 240 seconds for the first arriving apparatus and 360 seconds for the second apparatus for career departments.



NFPA 1720 provides similar examples for non-career departments. The response time objectives are based on the population demographics, i.e., population density; this includes the minimum number of staff and response times in minutes.

It is important that the SOC document include a response coverage map identifying response times across the jurisdiction. Development outside of these response areas, or the stated response requirements, should require special provisions under the building code. The SOC document should also include a 10-minute response time coverage map (total time including call handling, turn out time, and travel time) for limiting distance. (This is a prescriptive performance objective in the NBC for required limiting distances – the distance from a building to a property line; this is addressed specifically in the section on limiting distances below.)

Annex B includes a sample response time objective map for a community. Areas outside of the stated response time objectives would be subject to additional design requirements, beyond the minimum requirements found in the building code, potentially including residential fire sprinklers, increased spatial separations, building fire separations, building materials of a higher fire resistance rating, etc.

Fire chiefs should have clearly identified response-time objectives that have been approved by their elected officials. When development occurs outside of the response times then additional building code provisions can be established as a condition for development approval.

The Fire Underwriters Survey (FUS)

Fire Underwriters Survey is a national organization that represents more than 90 per cent of the private sector and casualty insurers in Canada. The overall intent of the survey is to provide a standardized measurement of the ability of the public fire protection system of a community to prevent and control major fires that may be expected to occur. FUS evaluates in detail the adequacy, reliability, strength, and efficiency of the services and compares the level of protection against the level of risk

in the built environment; this is a key factor used in the development of commercial and personal property insurance rates.

Fire chiefs must know FUS gradings and review major acquisitions or changes for the potential to change the FUS gradings. Municipalities can see their fire gradings through the FUS Municipal Portal at: **Municipal Portal (fireunderwriters.ca)** *Contact your local FUS representative for additional information.*

Building and fire codes

The building code quite simply determines how you must build an individual building within the community. The fire code determines how communities must inspect and maintain the building after it has been approved for occupancy. The codes do not address how communities build and approve subdivisions; this process is left to individual communities to develop. Fire chiefs should participate in the local development approval process as approvals directly relate back to the CCR/CRA, and SOC documents identified previously. There is no requirement for planners to consult with the fire chief in planning and developing communities, but many assumptions made in the design approval stages are based on the capability of the community's fire response. It is up to the fire chief to be engaged in this process as this is the first tier of the fire protection hierarchy.

Part 3 versus Part 9 buildings

According to the NBC, Part 3 buildings are buildings over 600 m^2 (6458 ft^2) in building area or three storeys. The building code assumes that there is an "adequate fire service response." In the assumptions, the code states "If these firefighting capabilities are not available, additional fire safety measures may be required." The code further

states “Although it is reasonable to consider that some level of municipal fire fighting capability was assumed in developing the fire safety provisions in Part 3, this was not done on a consistent or defined basis.”

Under the Notes to Part 3 on firefighting assumptions, the code states:

> *The responsibility for controlling the maximum size of building to be permitted in a municipality in relation to local firefighting capability rests with the municipality. If a proposed building is too large, either in terms of floor area or building height, to receive reasonable protection from the municipal fire department, fire protection requirements in addition to those prescribed in this Code, may be necessary to compensate for this deficiency. Automatic sprinkler protection may be one option to be considered.*

The NBC is silent on what local firefighting capabilities must be met; it specifically states that this is left to the local community to determine. In cases where the standards of cover are not met, higher standards than those found in the building should be required – these could be increased building separations, or even protection by sprinklers, even when the Building Code may not require these. These are conditions the community can place on builders. Some communities have addressed this additional protection-with special bylaws that identify specific areas and the added design requirements such as sprinklers in pre-selected development areas.

The firefighting assumptions above are clear for Part 3 buildings; however, most single-family homes and residential buildings are built under Part 9 of the building codes. For Part 9 buildings, there is no requirement in the code or basis on which to define an adequate fire department! Therefore, homes are being built to the same standards in metropolitan centres with career departments as they are in communities with volunteer first responders. The different response standards must come into play in how communities design developments to prevent building-to-building fire spread. The fire chief must therefore be engaged to look at building separations (limiting distances), water supplies to control exposures, access routes to speed response

– items that are not covered in the building codes but will be discussed in this handbook.

Water supplies for fire fighting

Just because there is a municipal water supply system with fire hydrants does not mean there is adequate firefighting flows! Design for water supplies in communities is based on domestic demand (daily consumer use) and firefighting flow rates. Firefighting flow rates typically far exceed domestic demand. Adequate water supplies are based on having the required flow rates to meet the firefighting demands, maintaining a residual pressure, and having the flow for the required duration.

Water supplies make up 30 per cent of a community's FUS ratings. The ratings are influenced by design and whether supplies address the capability to meet required firefighting flows; the system's adequacy and reliability; redundancy and looping; and hydrant distribution, spacing and maintenance. All these factors point to fire chiefs having a substantial role in reviewing local water supplies with their local water supplier.

The building code also requires that all Part 3 buildings have adequate water supply for firefighting purposes. For Part 9 buildings there is no requirement in the code or basis on which to assume what an adequate fire department is! The assumption is that the arriving fire apparatus have adequate water on board for initial firefighting, i.e., water needed to support interior search and rescue operations and for limited control of fires. The building code does not provide for any water needed for the control of exposures or sustained interior operations that must be provided from additional resources such as a municipal hydrant system, tanker shuttles, cisterns, or other water supply sources. However, FUS calculations for fire flows do consider these additional flow requirements and must be considered for any new development.

In the NBC, Annex A-3.2.5.7. (1) states that the intent is that there "be readily available and sufficient volume and pressure to enable emergency response personnel to control fire growth so as to enable safe evacuation of occupants and to conduct search

and rescue operations, prevent the fire from spreading to adjacent buildings, and provide a limited measure of property protection."

The American Water Works Association (AWWA) standard AWWA M31 Distribution System Requirements for Fire Protection has detailed information on the sizing and design of water supply systems for firefighting flows. The standard states "the governing body must first select a well-documented procedure for determining the fire flow requirement," It then describes several methods for fire flow determination. Some cities in Canada have used Insurance Services Office (ISO) methodology from the United States to determine required flows but most cities have used FUS calculations. The original FUS calculations were based on the ISO calculations. Over time, ISO calculation have become more refined; however, users must be cautious in understanding that ISO usage is based on field examinations and re-inspections by ISO personnel and that these are necessary to get many of the refinements found in the calculations. This is not done in Canada therefore this handbook has a preference for FUS because it is Canadian based and tied to FUS gradings.

The British Columbia government has also prepared a document: *Design Guidelines for Rural Residential Community Water Systems 2012*, which discussed the overall design of water systems and fire flow demand. When designing for a municipal water system, engineers will consider the design for daily and peak demand but must also consider fire flow demand. The latter is the required water to meet the needs for fire fighting. Fire flow demand is generally considerably to be more than domestic demand. Water system designers must also be careful to ensure that residual pressures are maintained so that firefighting pump operations do not overdraw on the municipal system; doing so can create vacuum and/or cavitation and can draw ground water or even sewage into the system, thus contaminating the entire system. It is therefore important that water supplies have adequate pressures and flows for manual firefighting purposes.

The British Columbia guide, as well as most communities surveyed by National Research Council, found that most municipalities use the Fire Underwriters Survey *Water Supply for Public Fire Protection – A Guide to Recommended Practice in Canada* to determine required fire flows. This guide provides detailed information about how to determine the required flow for a specific building, depending on the flow its required duration, and then the number of fire hydrants needed to secure this flow. The FUS calculation method has been undergoing a significant revision and was

released March 28, 2022. Download the guideline at https://fireunderwriters.ca/Downloads

FUS provides very detailed calculation methods to determine the required fire flow rate. A criticism that many water purveyors use against FUS is that they can lead to larger firefighting flow rates (never a bad thing for the fire service) compared to other methods such as ISO.

Water supplies and hydrant systems are based on maintaining a residual pressure - typically 140 kPa. Residual pressure is important to prevent fire apparatus from drawing down the pressure in the system too low or creating negative pressure in the system; this would lead to pipe failures and/or contamination of the water distribution system.

A further factor in determining water supply is the adequacy and reliability. FUS also provides a chart for required fire flow durations based on the rate. For example, a single-family home requiring 8,000 LPM would require that flow for a duration of 2.0 hours. For a subdivision – multiple homes with multiple exposures – the required flow of 16,000 LPM needs to be guaranteed for 3.5 hours. This is evidenced in the fire services' experiences in sustaining multiple hose lines on the fireground for extended periods of time.

Many communities now have detailed computer modelling that can accurately predict firefighting flows at any point in the systems (i.e. available fire flow). The computer model should be regularly validated by verifying the predicted flow rates to annual maintenance flow checks. If pressures correspond with flow checks from the annual flow tests, that is fine. If there are significant deviations the water system should be checked or the model re-evaluated.

A further assessment of a municipality by FUS is the reliability of the water supplies. Is there a program to check hydrants and flow rates? Is there a process in place to verify that the measured flows from these hydrants correspond with the predicted flows from any computer modelling? Are hydrants maintained in accordance with AWWA M17 or NFPA 291?

Firefighting flows for a single-family home/sub-division can be determined through detailed calculations but FUS has also provided simplified calculations found below.

Exposure distance	Required flow rate (LPM)[1,2,3]	
	Wood frame	Masonry or brick
Less than 3.0 m	8,000	6,000
3 - 10 m	4,000	4,000
10.1 - 30 m	3,000	3,000
Over 30 m	2,000	2,000

Table extracted from Fire Underwriters Survey (FUS) – Water Supply for Public Fire Protection

Notes: 1. If sprinkler protected flows can be reduced by 50 per cent but no less than 2,000

2. If all exposures within 30 metres of building are protected by sprinklers than you can reduce flows to 2,000.

3. If all exposing building faces within 10 metres have protected opening or no openings and a minimum of 1 hour fire resistance rating then flows can be reduced by 2,000 to a minimum of 2,000 LPM.

The above chart is limited to one and two-family dwellings. Flows will be larger for multi-family units. Additionally, these flows do not consider increases due to any exposed houses. The amount of water obviously increases depending on how far apart the homes are. When exposures are factored into the single-family home for combustible construction with homes having limiting distance less than 3.0 metres, flow rates can increase to between 10,000 and 14,000 LPM or more.

FUS reduces required firefighting flows by 50 per cent when fire sprinklers are present. Requiring sprinklers can therefore help to reduce needed pressures throughout the system and water main sizes. This can eliminate the necessity to upgrade a system with fire pumps and reduce treatment costs for water.

Number of hydrants and spacing

The design and approval of fire hydrant systems should involve the local fire chief (or a delegated representative). Once the required fire flows are determined it is essential to determine the number of hydrants needed. FUS again determines the number of hydrants for the required fire flows. - SF home 8,000 LPM - would require 2 hydrants

spaced no more than 135 metres apart. If there are exposures the flow rate of 14,000 LPM would require four hydrants at no more than 105 metres apart.

Fire Flow Required (LPM)	Avg Area per hydrant (m2)	Max Recommended Spacing Between Hydrants (m)	Max Distance from any Point on the Street (m)	Minimum number of hydrants
1,800	16,000	180	90	1
2,000	16,000	180	90	1
4,000	15,000	180	90	1
6,000	14,000	150	75	1
8,000	13,000	135	70	2
10,000	12,000	135	70	3
12,000	11,000	120	70	3
14,000	10,000	105	66	4
…	…	…	…	…

Table is a partial extraction from the Table found in Fire Underwriters Survey (FUS) – Water Supply for Public Fire Protection.

Note: this table is not complete. Additional fire flows beyond 14,000 LPM are provided in the FUS guide plus the table does not include additional details on spacing requirements. FUS allows for hydrant spacings to be increased by 25% when the building(s) are protected by an NFPA 13R, or NFPA 13D system and by 50% if protected by an NFPA 13 system.

As an example, a single-family home requiring 8000 LPM would require two hydrants each within 70 metres of the home. A development with exposures requiring 14,000 LPM would require at least four hydrants. It must be stressed that the reason for these higher demand requirements is that the firefighting flows are needed to protect the exposures as well as the dwelling. The NBC fire flows are only concerned with the initial dwelling.

In sprinklered subdivisions an incentive to reduce development costs can include increasing hydrant spacing. Reduced fire fighting flow rates can also reduce the number of hydrants needed.

Sizing of water services to homes

The majority of new homes are provided with a 3/4-inch service from the street; this may be adequate for the domestic demand; however, due to the municipal pressure and the house layout, this is usually inadequate for a residential fire sprinkler system. Only detailed design calculations can verify this. To reduce the cost of upgrading the service at later stages in the development, it is highly encouraged that fire chiefs **insist that all new homes be provided with a 1-in or 1¼-inch service**. At the time of laying in the water service the only added cost is the slightly higher cost for the larger diameter pipe; this allows homeowners to choose sprinklers as an option without having to pay for a storage tank or a curb cut once these utilities are in place.

Having a larger water line often raises concerns about water meter sizes and their accuracy; this has been studied at length and details on addressing these concerns can be found at the Home Fire Sprinkler Coalition Canada website: www.homefiresprinklercanada.ca.

Water supplies in non-hydrant serviced areas

If a development is being planned in an area not serviced by a municipal water supply or cannot support firefighting flows, then additional design review is needed. The fire service will have limited water supplies. The design should be reviewed in accordance with *NFPA 1141: Standard for Fire Protection Infrastructure for Land Development in Wildland, Rural, and Suburban Areas*, and *NFPA 1142: Standard on Water Supplies for Suburban and Rural Firefighting*. Use of these standards can provide an opportunity to require the construction of water supplies such as dry hydrant points or cisterns to support the required flows as a condition for approval of the subdivision.

In non-hydrant serviced areas, the reliability of water supplies, and thus the FUS grading, will depend on how well the fire department can sustain firefighting flows; this is typically done through tanker water shuttle operations. The FUS Superior Tanker Accreditation is offered by FUS and states that the community has been proven to be able to sustain the needed water supplies at a level that meets or exceeds the minimum requirements of a municipal hydrant system.

- For personal lines insurance, the fire department must be able to deliver a flow rate of not less than 950 LPM (200 IGPM) within 5 minutes of arriving at the test site with the first major piece of apparatus (wheel stop) for the required duration of 1-2 hours.
- For commercial lines insurance, the fire department must be able to deliver a flow rate of not less than 1900 LPM (400 IGPM) within 5 minutes of arriving at the test site with the first major piece of apparatus (wheel stop) for the required duration of 1-2 hours.

These numbers are still significantly lower than the flow rates identified by FUS for a single-family dwelling and therefore must be considered when approving subdivisions.

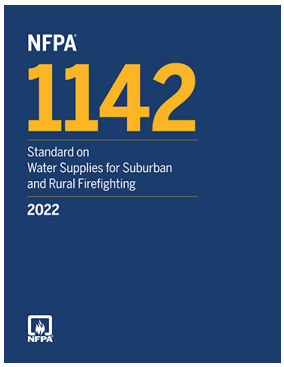
Other resources

Design professionals often attempt to submit water supply calculations based on several other documents that are in the public domain. Due to lack of clarity in the NBC these other documents can be misapplied. It is therefore important to review these plus the fundamental-assumptions upon which they are based to ensure that they are correctly applied.

The ***ONTARIO GUIDELINE OFM-TG-03-1999 Fire Protection Water Supply Guideline for Part 3 in the Ontario Building Code*** is intended to be used to determine sizes for on-site water supplies and then required flow rates from these supplies for Part 3 buildings. If on a municipal hydrant system, the calculations are used to determine minimum flow rates. Minimums are based on required total water supplies needed to be available on site and then determining the needed flow rate i.e. 1800 LPM, 2700 LPM, and 9000 LPM etc. Again, this guide does not address planning for single family homes and their developments.

Alberta Standata 97-DR-027 Water Supply for Fire Fighting is another commonly referenced document; it applies only to Part 3 buildings and not Part 9 buildings; however, most homes are built to Part 9. The document specifically states that "It is assumed that adequate water can be trucked in to deal with a fire in a building smaller than these limits." It is our opinion this is frequently not true when the size and complexity of some Part 9 buildings are considered along with the variety of municipal response levels. The Standata does produce a total for the required water supplies

needed for fire fighting and then a table with two options for minimum flow rates based on the total supply needed.



NFPA 1142: Standard on Water Supplies for Suburban and Rural Firefighting is an excellent resource and provides a basis for determining water supplies needed for fire fighting in non-hydrant areas, areas "that there is no water or inadequate water for firefighting." The standard provides detailed guidance on the sizing of on-site water supplies as well as dry hydrants for community protection.

The standard also gives detailed design calculations for required water supplies for on-site storage, and covers the design and sizing of cisterns, dry hydrants, and alternative water supplies.

Design standards

Building separations – limiting distances

Building separations are addressed in the building codes under limiting distances. The code does not have a defined separation distance but instead talks about what is permitted for percentage openings based on what the limiting distances is.

The history of these limiting distances is from the St. Lawrence Seaway burns of the 1950s. Under this research, a large number of homes were burned to evaluate building-to-building fire spread. The problem with these burns was that they were based on fuel loads found in homes of the 1950s with legacy contents. It is well understood that modern content fires burn hotter and faster than they did in the 1950s. As a result, fire departments in dense urban and suburban

settings are often faced with the need for exposure protection upon arrival. This is addressed in the building codes when you look at limiting distances.

Limiting distance is defined in the NBC as the distance from an exposing building face to a property line, the centre line of a street, lane, or public thoroughfare, or to an imaginary line between 2 buildings or fire compartments on the same property, measured at right angles to the exposing building face. The NBC then places limits on the percentage of unprotected building openings that can be allowed on the exposing face of a building based on these limiting distances.

It can be a very beneficial incentive for developers to consider sprinklers as opposed to increased limiting distances between homes. Often the benefits gained by the developer in the increased number of lots that can be placed into a subdivision, offsets the cost to install the sprinklers throughout the subdivision. The profit from just one added building lot could pay for 20 sprinklered homes.

Fire chiefs need to be concerned that they have the minimum numbers of firefighters arriving on scene along with an adequate water supply to protect these exposures. In 2010 the NBC was amended to include a benchmark response time of 10 minutes which must be met in more than 90 per cent of the fire calls in qualifying for certain allowable limiting distances; this was the time from receipt of notification of a fire by the fire department until the arrival of the first fire department vehicle at the building.

If the fire department response cannot meet these time benchmarks, then the limiting distances need to change. The building codes states in 9.10.15.3:

> 1) Except for the purpose of applying Sentences 9.10.15.2.(2), 9.10.15.4.(3) and 9.10.15.5.(13), a limiting distance equal to half the actual limiting distance shall be used as input to the requirements of this Subsection, where
> a) the time from receipt of notification of a fire by the fire department until the first fire department vehicle arrives at the building exceeds 10 min in 10% or more of all calls to the building, and
> b) any storey in the building is not sprinklered.

If your fire department cannot guarantee its first apparatus can arrive to a residential call in 10 minutes for 90% of its calls, then the limiting distance is reduced by 50%. This seems counter-intuitive, but what it essentially means is that instead of the actual distance being say 1.2 metres you must consider it to be 0.6 metres in all calculations. This has a very serious effect on what can be permitted for construction including the percentage of openings between the homes. The distances are not halved if the building is sprinklered.

These are complex provisions within the NBC. The best advice would be to identify any potential development areas where the 10-minute response time cannot be met. Your local building department should be aware of these areas, and this must then trigger their approval of the more stringent design requirements.

The provisions in the NBC then get very technical in terms of what is required; this includes limitations on the number of openings in the exposing wall, the requirement for non-combustible construction, limitations on projections, and prohibiting of soffits. So, if a department cannot meet the 10-minute response time, and the properties are

not sprinklered, the distance to a lot line increases to 2.4 metres, there can be no openings on the side walls, and there can be no soffits within 0.9 metres.

The 10-minute NBC response coverages are published for all Canadian communities in the FUS Municipal Portal under the Standards of Cover Map options. These are estimates using turn out times of:

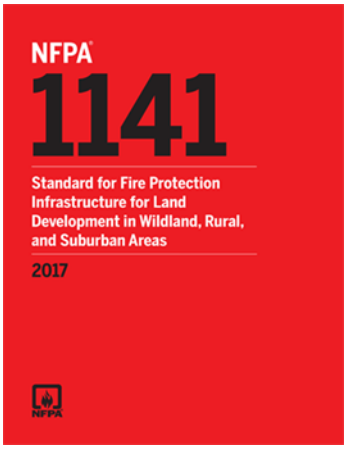
- *2 minutes for career*
- *4 minutes for composite*
- *6 minutes for volunteer / paid on call*

Times on the maps include standard FUS method for travel time correlating to distance traveled. Fire chiefs are encouraged to submit the expected turn out times so that these maps can be updated to reflect actual conditions.

Access Routes

The required number of access routes into a subdivision is not found in the NBC but determined by the community. This should be determined based on the number of households to be built. This is similar to determining the required number of exits from a building in a fire; they must be adequate for the number of people to be evacuated but must also allow for emergency responders to enter unhindered during emergency conditions. Inadequate access routes can delay needed response by increasing travel time. Additionally, think of the harrowing footage of those fleeing recent fires wildland fires in British Columbia, Alberta, and several states. Fire chiefs need to review and approve subdivisions to ensure there are the required number of access routes. Communities with only a single fire route may very well be indefensible in a

wildland/urban interface fire scenario, cutting off the first responders from their own escape routes.



NFPA 1141 as a source identifies the number of access points for a subdivision. In the absence of any other source document or reference standard it does become best practice for the fire service.

Number of households	Number of access routes
0 - 100	1
101 - 600	2
601+	3

Table is found in NFPA 1141 as Table 5.1.4.1(a)

The design of these routes must meet the slope, height clearance, speed limitations, and turn arounds needed for the fire service. These requirements are based on limitations of fire apparatus that are reflected in the apparatus standards. The NBC identifies the design requirements for access routes for the design of individual buildings. These same minimums should apply to road design within the community. Specifically, the NBC states:

> 3.2.5.6. Access route design
> (1) A portion of a roadway or yard provided as a required access route for fire department use shall,
> (a) have a clear width not less than 6 metres, unless it can be shown that lesser widths are satisfactory,
> (b) have a centre line radius not less than 12 metres,
> (c) have an overhead clearance not less than 5 metres,
> (d) have a change of gradient not more than 1 in 12.5 over a minimum distance of 15 metres,

(e) be designed to support the expected loads imposed by firefighting equipment and be surfaced with concrete, asphalt or other material designed to permit accessibility under all climatic conditions,
(f) have turnaround facilities for any dead-end portion of the access route more than 90 metres long, and
(g) be connected with a public thoroughfare.

Communities can indeed have more detailed provisions for municipal design standards based on their apparatus capabilities or requirements. More detailed requirements on route design for subdivisions for the fire service can also be found in NFPA 1141.

When the design requirements cannot be met the fire chief may consider the approval of a subdivision if all the properties have been sprinklered as a condition for approval. Numerous examples can be found of subdivisions approved under these circumstances.

Traffic calming measures are also a major concern because of their ability to delay first-in units and follow-on resources. If traffic calming measures are planned, ensure that the travel time reflects these added delays.

Part 3 Single-family homes

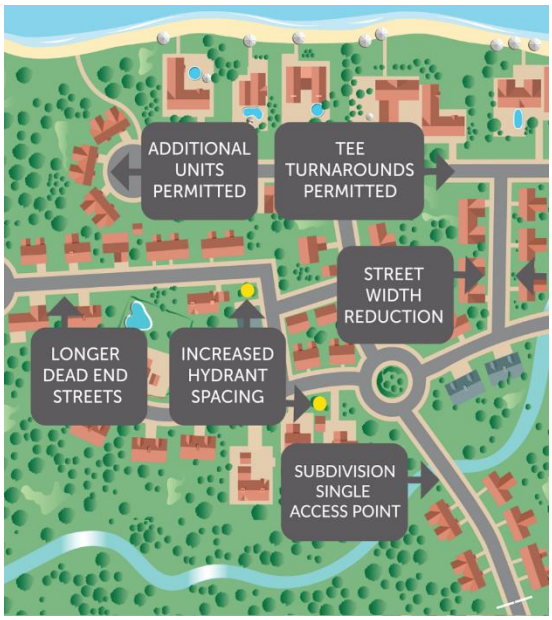
A large home that is would be more than 600 m^2 in floor area or four storeys (including any finished basement spaces) must follow the requirements of Part 3 of the NBC. These individual buildings should be designed by a registered professional due to their complex nature.

These designs would require the following added requirements as per the building code:

- Confirmation of adequate water supplies for firefighting for each structure
- Floor assemblies to be 45-minute rated unless sprinkler protected

RESIDENTIAL FIRE SPRINKLERS IN DEVELOPMENT APPROVALS

The fire chief should work with developers and builders during the pre-approval stages to consider residential fire sprinklers as an option for development approval. Sprinklers can be considered even when there are provincial restrictions against a by-law. More frequently we are seeing subdivision plans being approved at the local level in provinces that restrict sprinkler bylaws because local conditions would require added restrictions on the developer or restrict the proposed development. In such cases, the installation of home fire sprinklers is by mutual agreement among the community, the developers, and the builders as a joint condition for approval of the subdivision plan. In the absence of approval from the builder, then the original restrictions remain in place. The key is to dialogue with builders and work with them as early in the stage as possible and identify sprinklers as options.



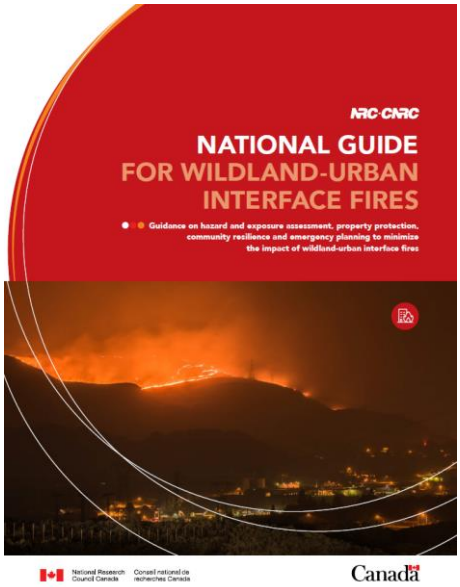
As a result of the life saving features of sprinklers, occupants have more time to safely self-evacuate. Sprinklers therefore are ideal alternatives when the following conditions exist:
- inadequate water supplies for fire fighting
- delayed response times for first responding units and/or effective firefighting force
- inability to meet street width, grade, or lengths of cul de sacs
- inability to meet the number of required egress routes
- construction beginning prior to availability of water supplies or construction of a fire hall.

In locations on well water, the NFPA 13D standard identifies that water supplies can be provided based on the available water in the well and its recharge rate. Furthermore, the amount of water needed can be reduced. If necessary, homes can be equipped with a small storage tank to provide the needed water supplies.

WILDLAND URBAN INTERFACE

Similar to designing for snow load, wind load, or seismic conditions, communities need to consider design requirements for properties in high-risk wildland urban interface (WUI) areas. Attempts to incorporate mandatory design considerations for WUI construction standards into the NBC have been rejected on the basis that individual jurisdiction should determine these requirements. Fire chiefs should therefore evaluate potential developments to see if they fall within high-risk areas as they shall be the ones responding to the risk. These high-risk areas can be identified by provincial agencies.

If properties fall within high-risk areas, they should be designed and maintained following FireSmart™ Canada principles. These principles are based on Canadian- and U.S.-based research and should lead to the increased survivability of homes in the WUI. Furthermore, FireSmart principles help prevent fires that initiate within the home from spreading to the surrounding wildland areas and then exposing other homes. When homes are more defensible, fire services can consider assigning limited resources to protect them during large wildfire scenarios with greater probability of saving the structures and reducing the risk to firefighters and the public.



FireSmart construction principles can be found in **NFPA 1144 Reducing Structure Ignitions from Wildland Fire**. Additionally, the National Research Council of Canada has published a *National Guide for Wildland-Urban Interface Fires*, which can be downloaded at **New National Guide for Wildland-Urban Interface Fires (canada.ca).** Chapter 3 of this document addresses construction measures that can be enforced with local codes depending upon the exposure level of the property.

FireSmart Canada has excellent resources for public education on wildland urban interface issues at: **FireSmart Canada – wildfire preparedness assessments, training and resources**

Several provinces have published detailed maps that show areas of increased wildland urban risk. Annex C of the guide includes an interactive map produced by British Columbia. Interface areas are where homes are constructed in very close proximity to wildland growth.

SAFETY DURING CONSTRUCTION

Homes in our communities are most vulnerable when they are under construction. Buildings do not have their complete fire safety systems in place such as compartmentalization, fired rated assemblies, and fire safety systems. Complicating the matter, calculated required fire flows do not consider this increased demand. Communities are therefore at risk for large conflagrations with large swaths of homes or buildings exposed.

The NBC states in the explanatory notes on limiting distance, A.3.2.3.2.(8) that “For new subdivisions, legal agreements may be made for the construction of fire stations to serve those areas. The fire department response time in those subdivisions may temporarily exceed 10 minutes until the fire station is constructed.” These are explanatory notes and have no enforcement. Fire chiefs should be wary about approving any development plans and permitting their construction and occupancy prior to the construction of the required fire halls as this puts these residents and firefighters at increased risk. Options can include sprinklering these homes or increasing fire resistance ratings of the exposed walls.

The NFC has provisions for construction site safety which would be enforceable at the local level. Ontario, however, does not have these provisions. Individual municipalities should take steps to safeguard constructions sites, including pre-planning by suppression resources, fire prevention code enforcement, requiring hydrants to be in service before the commencement of structural framing, and placing limits on the number of exposed homes. If necessary, further protection can be established by requiring added security provisions on scene.

Some cities, such as Ottawa, place limitation on the number of buildings that can "open" in a subdivision. A plan is needed for the build out of any subdivision, showing the staging of the build and the designation of fire break lots.

Requirements for firebreak lots may vary based on the type of units being constructed and can be determined by the municipal fire service based on its tolerance for risk, the number of firefighters available to respond, and the water supplies available. In Ottawa, these requirements are:

- For townhomes, rowhouses, etc.: A maximum length of 45 meters without a fire break and a maximum of 7 dwelling units; and
- For singles family homes: A maximum of six homes before a fire break – if lots are >12.19 metres wide the fire break lot is one unit. If <12.19 metres wide, then the break is two lots.

Make sure that the fire fighting flows are available before the start of construction due to the high risk of conflagration during the construction stages. Although water supplies for fire fighting are based on finished construction, fire services should still require that fire flows be available before the commencement of construction. This guarantees at least a minimum flow during this most vulnerable stage but also importantly guarantees that the water supplies will be available for fire fighting when the residential units are occupied.

Incentivizing Residential Fire Sprinklers

In 2022 the Canadian Association of Fire Chiefs (CAFC) produced a white paper entitled *Myth Busting and Team Building: A Win-Win Approach to Advancing Residential Fire Sprinklers in Canada*. This paper identified and discussed in detail several incentives that municipalities can pursue with the support of developers, builders and planners that can reduce or eliminate the added costs to home buyers of building homes with sprinklers. The report can be found on the CAFC website at: https://cafc.ca/page/sprinkler-report

Building a working relationship with the building department, developers and builders is very important. All parties want to build safe housing that will sell in their communities. There are many options that can be considered in return for fire sprinklers. Many provisions exist in the code where sprinklers have been approved as

an alternative to prescriptive elements in the code. Numerous examples of communities using fire sprinklers to address fire protection challenges include deficiencies in route access design, number of access routes, and adequate water supplies for firefighting.

The Home Fire Sprinkler Coalition Canada (www.homefiresprinklercanada.ca) has resources to help fire personnel begin this dialogue. As well as public education messaging, access to research, and other tools for consumers, code enforcement officials, and builders.

Conclusion

The fire chief is ideally situated to work with municipal officials, developers, and builders to identify and address the required design of new developments. The first line of fire defense to protect our communities is through their proper design. This handbook has attempted to identify situations in which fire chiefs have an opportunity, and in some cases an obligation, to advise on the planning and design of subdivisions and developments that reflects the local fire service's capabilities.

All standards and references identified in this document are minimum requirements. Nothing precludes a community from setting higher requirements based on local needs.

Feedback or examples on how the improve this guide would be appreciated. Comments or suggestions can be forwarded to stracey1683@gmail.com.

References

Alberta Standata 97-DR-027 Water Supply for Fire Fighting

AWWA M31 Distribution System Requirements for Fire Protection, 4th Edition, 2018, American Water Works Association, **Distribution System Requirements for Fire Protection, Fourth Edition M31 (awwa.org)**

BC Design Guidelines for Rural Residential Community Water Systems 2012 ***https://www2.gov.bc.ca/assets/gov/environment/air-land-water/water/water-rights/water-utilities/design_guidelines_rural_residential_water_mar2012.pdf***

*Myth Busting and Team Building: A Win-Win Approach to Advancing Residential Fire Sprinklers in Canada***,** Canadian Association of Fire Chiefs (CAFC**),** https://cafc.ca/page/sprinkler-report

National Building Code of Canada 2020, **National Building Code of Canada 2020 - National Research Council Canada**

National Fire Code of Canada 2020, **National Fire Code of Canada 2020 - National Research Council Canada**

National Guide for Wildland-Urban Interface Fires, 2021, **New National Guide for Wildland-Urban Interface Fires - National Research Council Canada**

NFPA 291: Recommended Practice for Water Flow Testing and Marking of Hydrants, 2022 Edition

NFPA 1141: Standard for Fire Protection Infrastructure for Land Development in Wildland, Rural, and Suburban Areas, 2017 Edition

NFPA 1142: Standard on Water Supplies for Suburban and Rural Firefighting, 2022 Edition

NFPA 1144: Standard for Reducing Structure Ignition Hazards from Wildland Fire, 2018 Edition

NFPA 1300: Standard on Community Risk Assessment and Community Risk Reduction Plan Development, 2020 Edition

NFPA 1710: Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments, 2020 Edition

NFPA 1720: Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments, 2020 Edition

ONTARIO GUIDELINE OFM-TG-03-1999 Fire Protection Water Supply Guideline for Part 3 in the Ontario Building Code

Water Supply for Public Fire Protection – A Guide to recommended Practice in Canada, Fire Underwriters Survey (FUS) March 28, 2012, **https://fireunderwriters.ca/Downloads**

The author would like to acknowledge and thank the following individuals for their valuable feedback and contributions in the preparation of this handbook:

Fire Chief Stephen Gamble, FIFireE
Fire Chief Ian Josephson
Michael Currie, Fire Underwriters Survey
Shane Mintz, NFPA (retired)
Laura King, NFPA

Annex A - Sample Design Review Template

<table>
<tr><td>City:</td><td></td><td>Date:</td><td></td></tr>
<tr><td>Subdivision Name:</td><td></td><td colspan="2">(Attach proposed plan)</td></tr>
<tr><td>Build out plan:</td><td colspan="3">If multiple units are being constructed - how will the risk of building-to-building fire spread be mitigated?</td></tr>
<tr><td>Are the individual homes Part 9 or Part 3?</td><td></td><td colspan="2">A Part 3 building would be over 3 storeys or 600 m2 (6458 ft2)</td></tr>
<tr><td rowspan="2">Unique Risks:
On municipal hydrant system?
Is there a wildland urban interface risk?
Others?</td><td>List unique risks below</td><td colspan="2">List mitigative measures below</td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td>Will the properties be sprinkler protected?</td><td></td><td colspan="2">Yes or No? Are sprinklers be used as incentives or trade-offs for this project? If so, have these been documented? What are the incentives?</td></tr>
<tr><td>1st Arriving Unit Response Time:</td><td></td><td colspan="2">Note: Response time is based on time from receipt of alarm to first arriving unit 90% of time.</td></tr>
<tr><td>Building Separations:</td><td></td><td colspan="2">What is the limiting distance being applied in the code? Does this meet the 10 min response time as per NBC? - Does this trigger additional design restrictions?</td></tr>
<tr><td>Access Routes/Road Design:</td><td></td><td colspan="2">Adequate number of access routes as per NFPA 1141?
Road design as per NBC for access routes - turning radii, cul de sacs, slope, etc.
0 - 100 1 Route
101 - 600 2 Routes
600+ 3 Routes
Check turn radii to your apparatus to width of roads, and load capabilities.</td></tr>
<tr><td>What is availability and reliability of Water Supplies?</td><td></td><td colspan="2"><table><tr><th>Exposure Distance</th><th colspan="2">Required Flow Rate (LPM)</th></tr><tr><td></td><td>Wood Frame</td><td>Masonry or Brick</td></tr><tr><td>Less than 3.0 m</td><td>8,000</td><td>6,000</td></tr><tr><td>3 - 10 m</td><td>4,000</td><td>4,000</td></tr><tr><td>10.1 - 30 m</td><td>3,000</td><td>3,000</td></tr><tr><td>Over 30 m</td><td>2,000</td><td>2,000</td></tr></table>Or use detailed FUS Calculations.
If exposures are present increase calculations by 50%
If non-hydrant served? Will cisterns or other water supplies be provided?
Is this covered by a FUS Superior Tanker Accreditation?</td></tr>
<tr><td>Check number of fire Hydrants and distance to project?</td><td></td><td colspan="2">Determine the number of fire hydrants that are needed based on distances and available flow rates as per FUS.<table><tr><td>Fire Flow Required (LPM)</td><td>Max Recommended Spacing</td><td>Minimum number</td></tr></table></td></tr>
</table>

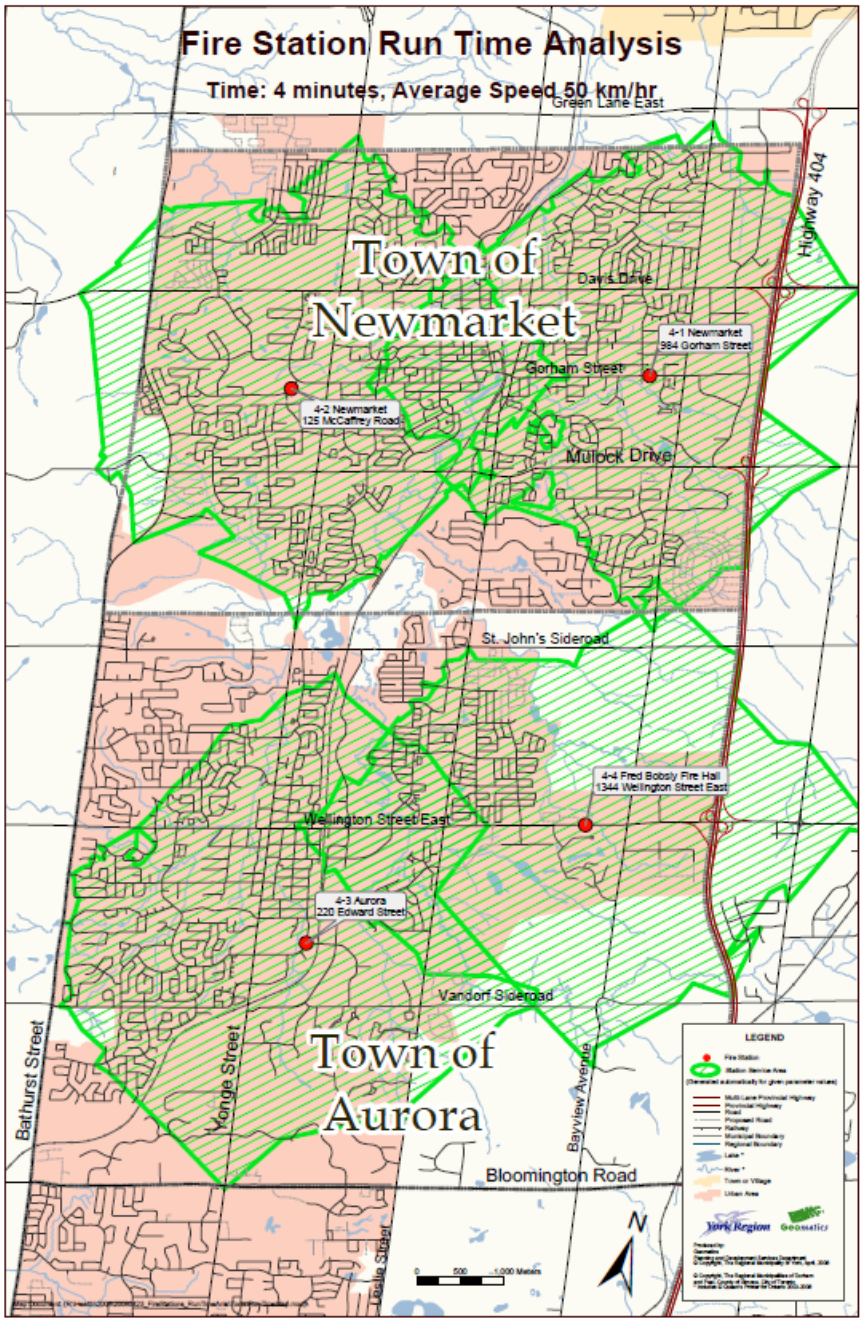
<table>
<tr>
<td></td>
<td></td>
<td>
<table>
<tr><td></td><td>Between Hydrants (m)</td><td>of hydrants</td></tr>
<tr><td>2,000</td><td>180</td><td>1</td></tr>
<tr><td>6,000</td><td>150</td><td>1</td></tr>
<tr><td>8,000</td><td>135</td><td>2</td></tr>
<tr><td>10,000</td><td>135</td><td>3</td></tr>
<tr><td>12,000</td><td>120</td><td>3</td></tr>
<tr><td>14,000</td><td>105</td><td>4</td></tr>
</table>
Notes: Actual fire flows may be reduced based on your community's flow models. Check FUS manual for more detailed notes and table.
</td>
</tr>
<tr>
<td>Will water supplies be in place before commencement of construction?</td>
<td></td>
<td>Yes or no? If not what mitigative measures have been conveyed to the developer?</td>
</tr>
<tr>
<td>Other Notes/Factors in Approving this development?</td>
<td colspan="2"></td>
</tr>
</table>

Reviewed by: _____

Approved by: _____

(Fire Chief)

Annex B - Example of a Standards of Cover Map Showing Response Times



Annex C - Extract from a Provincial Wildland Urban Interface Hazard Analysis Map

Screen capture from the province of British Columbia's Interactive Wildland Urban Interface Hazard Analysis Map. Available at: **Download the WUI Files - Province of British Columbia (gov.bc.ca)**