

FIRE SERVICES PAGING AND TWO-WAY RADIO COMMUNICATIONS

(draft)

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1.0 OVERVIEW AND BACKGROUND

1.1 Executive Summary

The ability to use reliable and predictable radio communications is critical to the level of the incident response provided by the Fire Services in Grey County. The capability to service any type of fire call while ensuring the firefighters safety is dependent on using industry standard, National Fire Prevention Association (NFPA) 1221, paging and dispatch procedures via dedicated radio resources.

The fire radio communications resources in Grey County are not utilized in a very efficient manner and this contributes to missed communications, cross interference between services and unwarranted complexity in terms of paging and dispatch which, in turn impact the safety of the firefighters.

Because of the service-by-service approach to radio communications the radio licenses requested from Ministry of Innovation, Science and Economic Development Canada (ISED) did not take into consideration the unified needs of the fire services for reliable paging and dispatch functions as well as the operational interoperability required to service larger scale incidents be them structure fires, serious road accidents or major disasters.

The Fire Services have approached Grey County to request assistance to remedy their paging and radio communications shortcomings by making improvements to the radio communications infrastructure. The County commissioned a review of the paging and radio communications capabilities of the fire services in order to identify the issues and propose ways to mitigate them.

The following issues have been identified:

- Multiple fire services are using existing radio frequencies for multiple functions, i.e. paging, dispatch and tactical. This results in overlapping communications, missed communications and interference among the frontline users. It also constrains the operational abilities of the fire services to deliver reliable and predictable performance.
- The fire services could use a radio paging infrastructure that does not impose loading and/or timing constraints on the radio communications infrastructure. They could also use the radio infrastructure in a manner that would separate between dispatch channels, those used for fire dispatch and interoperability, and tactical channels, those used by the fire services to communicate at the site of an incident and with each other.
- The radio coverage available from the present radio towers is not documented and is not, anecdotally, sufficient.
- Owen Sound Police dispatch is responsible to dispatch seven fire services on seven different radio configurations, with various degrees of radio coverage and technical limitations, using seven different dispatch procedures.
- Dispatching fire services in such a constraining environment also poses challenges in terms of proper and completed dispatch processes as well as the required follow up and, if necessary, audit.
- Each fire service is focused in providing paging and radio communications to its respective firefighters. There is a requirement (need) to interoperate but this functionality was not considered in the present systems' implementations. There is no established radio communications procedure for servicing large scale incidents either.

- The scarcity of radio licenses is exacerbated by the present implementation of legacy analog technology for voice communications which does not make optimal use of the frequencies utilized. This is a critical issue as radio licenses are limited and obtaining additional licenses from ISED is a very difficult, time consuming task with no guarantee of success.
- The majority of the mobile and portable radios are capable of analog communications only with some being able to operate in digital modes but not all in the same mode. Although digital technology is more advanced and makes better use of radio licenses to make all radios digitally compatible will require a substantial initial investment.

These issues highlight the limitations a disparate set of radio resources, communications operations and procedures poses to the fire services' operations and firefighters' safety as well as to the ability to manage a large scale, interoperable incident in the County.

There are multiple ways to resolve some or all the above issues and this report includes six possible solution options Grey County may want to consider. They range from resolving the most critical issue, which is the separation of paging and dispatch radio infrastructure, to improving the overall radio fire coverage in the County, to a most comprehensive option of fully integrating fire and police radio infrastructure allowing the adoption of digital radio technologies that allow better use of the allocated radio licenses, provision of County wide interoperability and improved ability to deal with large scale incidents.

In estimated costs they range from \$150,000 to \$850,000 reflecting the larger set of communications improvements that may be implemented. Some of them also require an upgrade of the subscriber radio equipment, mobile and portable radios and vehicular repeaters, to ensure compatibility with the newer digital radio technologies at an additional estimated cost of approximately \$400,000.

The options can be separated into two groups:

Group 1 Solutions for a radio system for the Fire Departments (Solutions 1 to 4)

Group 2 Solutions for an Integrated Police/Fire radio system (Options 5 & 6)

Group 1 can be further divided into two subgroups:

- a. Maintain the present, legacy analog technology (Options 1 & 2)
- b. Upgrade to advanced digital technology (Option 3 & 4)

Options in Group 1a do not facilitate reliable communications between services or remedy current radio coverage deficiencies. Of these two options, **Solution 2**, is the lowest cost at approximately \$275,000. It resolves the paging issue and offers limited improvement to the dispatch capabilities. It does not provide much in the way of interoperability. It does not provide portable radio level coverage.

In Group 1b, **Solution 3** is the preferred solution. The estimated costs of this solution are about \$750,000 (\$350,000 for the radio infrastructure and \$400,000 for the subscriber equipment). It is similar to Solution 2 but provides more capacity to allow for fire services interoperability. The additional \$75,000 in infrastructure cost places the fire services in a good position to plan for future growth and a possible future integration of radio communications infrastructures in the County, including not only public safety (police and paramedic services) but also public works.

Solution 3 is the preferred solution for the upgrade of the radio system for the fire departments.

The solutions in Group 2 are contingent of future operational and funding agreements with Owen Sound Police. In this group, **Solution 5** is the preferred solution. It achieves all that Solution 3 does while providing the ability to integrate with the Police radio infrastructure now. The estimated costs of this solution are about \$850,000 (\$450,000 for the radio infrastructure and \$400,000 for the subscriber equipment).

1.2 Background

There are nine (9) fire services in Grey County: Inter-Township, Chatsworth, Owen Sound, Meaford, West Grey, Hanover, Grey Highlands, Dundalk and The Blue Mountains.

They all have independent radio communications and paging operations and all but two, The Blue Mountains and Hanover, are being dispatched by Owen Sound Police. The Blue Mountains Fire Service is being dispatched by Barrie. The Hanover Fire Service is being dispatched by Tillsonburg.

In terms of maintenance there are four (4) service providers involved: Bearcom for Inter-Township, Chatsworth, Meaford, Hannover, Dundalk and Grey Highlands, Telequip for Owen Sound, Hartman for West Grey and Point to Point in Barrie for The Blue Mountains.

The County and the fire services are concerned with their ability to page volunteer firefighters in a reliable and uniform manner throughout the County and to interoperate and support each other in case of larger incidents as well as with the safety hazards these limitations pose to fire personnel safety. They have approached the Grey County to request assistance to remedy their paging and radio communications shortcomings by making improvements to the radio communications infrastructure.

Grey County has engaged the services of Dan Perlstein, P. Eng. of B.P. Computer Services with a view to:

- Review of existing radio and paging systems, their performance and use of infrastructure assets such as towers and radio frequency licenses, etc.
- Identify possible options to address existing performance issues
- Investigate the support, administration and maintenance options
- Propose a complete radio and paging radio infrastructure conceptual solution that will resolve the identified issues, including the conceptual Scope of Work for the proposed solution
- Estimate the capital and operating costs associated with the procurement of the infrastructure and its support and maintenance services for a 10 years lifecycle
- Engage with stakeholders, both at County as well as the municipal levels
- Define the framework for a Memorandum of Understanding (MOU) outlining the relationship between the County and the radio system stakeholders, in the context of the technical solution proposed, including capital financing, on-going costs of administration, support and maintenance as well as the management of common assets and contracts
- Provide a Report to County Council outlining recommended system changes, the contents of the MOU, the future project benefits and the anticipated costs of the project (capital and operating).

2.0 INPUTS SCOPE AND BENCHMARKING

2.1 Inputs from Grey County Fire services

The following information was requested from the County of Grey, fire services and Owen Sound Police:

- Definition of stakeholders in regards to the paging system and the radio system
- List and copies of radio licenses owned by each fire department
- List, make and model of subscriber equipment, mobile radios, portable radios, vehicular repeaters and pagers owned by each fire department
- List, location/address, and who maintains each radio site in use by the fire services
- List of site leases, if any
- List of radio channels active at each site
- List of existing maintenance contracts, for how long and with whom
- Interoperability: requirements for each agency (who needs to talk to whom and on what channels/talkgroups)

2.2 Activities Undertaken

The following activities were undertaken:

- Gather information from the Grey County Fire services in relationship to their individual radio infrastructure, radio frequency licenses, equipment used by the firefighters as well as details on the service providers and existing support and maintenance arrangements. This has been achieved from a questionnaire sent to the fire services and meetings with ISED and service providers.
- Explore the technologies presently used and technical options that would ensure maximum use of existing subscriber equipment.
- Meet and discuss frequency licensing opportunities in the County with ISED including options to make better use of the existing licenses.
- Meet with County and Police representatives to explore options for a joint approach to a county-wide radio infrastructure.
- Meet with Police Dispatch to measure the present radio channels loading in relationship to the selection of technology options.

2.3 Status of Fire Services Communications and Paging in the Grey County

From the information gathered, the concerns of the fire services regarding the vulnerabilities and limitations of their respective radio communications systems are justified and service limiting and have a direct impact on firefighters' safety.

- Multiple fire services are using existing radio frequencies for multiple functions, i.e. paging, dispatch and tactical. This results in overlapping communications, missed communications and interference among the frontline users. This environment constrains the operational abilities of the fire services to deliver reliable and predictable services.
- The fire services could use a radio paging infrastructure that does not impose loading and/or timing constraints on the radio communications infrastructure. They could also use the radio infrastructure in a manner that would separate between dispatch channels (those used by Owen

Sound Police for fire dispatch), tactical/interoperability channels, and tactical channels (those used by the fire services to communicate at the site of an incident and with each other).

- The radio coverage available from the present radio towers is not documented and is not, anecdotally, sufficient.
- Owen Sound Police dispatch is responsible to dispatch seven fire services on seven different radio configurations, with various degrees of radio coverage and technical limitations, using seven different dispatch procedures.
- This convoluted radio communications environment limits the options for interoperability with some agencies having to resort to exchanging subscriber radios in order to be able to talk to each other.
- Dispatching fire services in such a constraining environment also poses challenges in terms of proper and completed dispatch processes as well as the required follow up and, if necessary, audit.
- Each fire service is focused in providing paging and radio communications to its respective firefighters. There is a requirement (need) to interoperate but this functionality was not considered in the original, existing systems implementations. There is no established operational procedure for servicing large scale incidents either.
- The radio licenses for the operational channels used by the paging and communications infrastructure are utilized on a “best effort” basis while recognizing that interference and lost communications due to channel loading and paging signals operating on the same channels does occur. The limited number of radio licenses, half-duplex and simplex, constrains their use and their uncoordinated reuse has resulted in additional interference and missed messages. Although ISED had originally provided a set of tactical simplex radio channels not all the fire services use them for tactical communications
- The present implementation of legacy analog technology for voice communications does not make optimal use of the frequencies utilized. This is a critical issue as radio licenses are limited and obtaining additional licenses from ISED is a very difficult, time consuming task with no guarantee of success.

Most of the subscriber mobile and portable radios are capable of analog communications only. Some can operate in digital modes but even those cannot operate all in the same mode. Digital technology is more advanced and makes better use of radio licenses.

Taken together, these factors show the limitations a disparate set of radio resources, communications operations and procedures pose to the fire services’ operations and firefighters’ safety as well as to the ability to manage a large scale, interoperable incident in the County.

3.0 DISCUSSION

3.1 General Technical Discussion

There are three elements necessary to enable public safety agencies to provide the required radio-based communications services:

- Technology –includes the architecture of the radio infrastructure, the connectivity between radio sites to provide a complete system including the necessary links to the dispatch centres, the ability of the infrastructure to sustain hardware and software failures as well as the requirements to support and maintain it for the defined lifecycle.
- Radio coverage – refers to the geography where radio communications is available. Within any defined area this cannot ever be 100% due to physical limitations on the radio signal propagation. The most common value is 95% of the service area and that means that, from a statistical perspective, there is a confidence of 99.9% that no more than 5% of the service area will experience radio communications shortcomings. Furthermore, it is expected that these 5% will not be all in one location but, rather be a collection of small sized locations spread throughout the service area.
- Availability of radio frequency licenses - radio licenses are limited resources and they are managed by the Ministry of Innovation, Science and Economic Development Canada (ISED) on behalf of the Federal Government. They are allocated out in a certain priority with the Federal Government and the Military being at the forefront and the private businesses at the end. In this hierarchy the county and municipal governments are located in the lower half. An additional consideration is the size of the agency requesting frequency licenses in terms of radio users rather than population or size.

A radio system implemented around the three elements described above is composed of three (3) subsystems:

- Infrastructure, which includes the radio towers, the equipment installed at each of them and the links that interconnect the towers,
- Dispatch centre, which include the radio dispatch consoles, paging encoders, fire hall alerting (if present), voice logging and any connectivity to Computer Aided Dispatch (CAD) software
- Subscriber equipment, which includes stations, mobile and portable radios, pagers and vehicular repeaters

All the above elements and subsystems contrive, when applied correctly, to make public safety services optimal for the public and safe for the frontline operators and any imbalance may result in limited and/or less than optimal service. Where multiple public safety agencies are involved, the ability of these agencies to operate in a concerted manner, otherwise called interoperability, becomes also a result of the elements and subsystems outlined (see Figure 1 below).

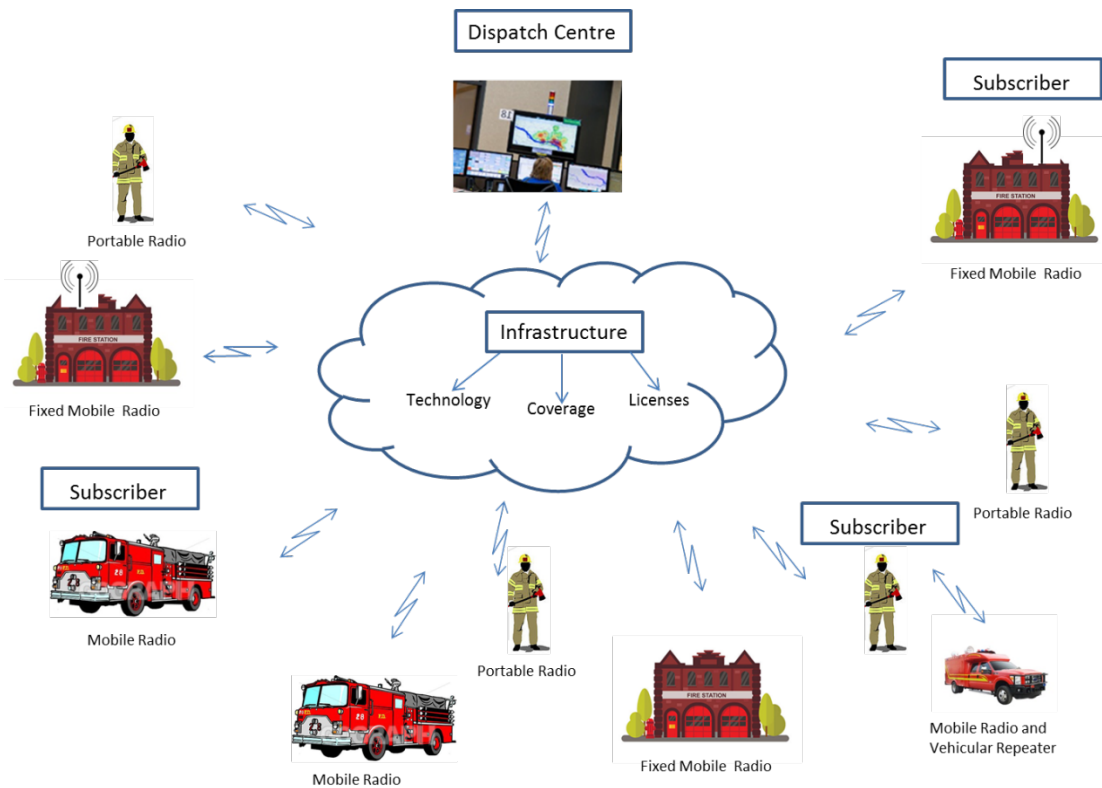


FIGURE 1 – Elements and Subsystems of a Fire Radio System

3.2 Some Technical Terms

Simplex Radio Channel – this is a radio channel that uses one licensed frequency for both transmission and reception. It can be used only in direct mode communications (radio to radio) or as paging channel.

Half-duplex radio channel – this is a radio channel that uses a radio licensed frequency for transmitting and another licensed one for receiving (they are typically licensed in pairs). This type of channel allows the use of radio towers that are able to repeat the original transmission to a receiver that is substantially further away from the transmitting source thereby increasing the radio coverage area.

Analog Radio Communications – this refers to the legacy technology used to facilitate radio communications between dispatchers and field operators. This technology is very simple and reliable but does not utilize the radio spectrum (radio channels) in the most effective manner. Given the high demand for spectrum (i.e. radio channels and licenses) this technology is not often used in new radio system implementations.

Digital Radio Communications – this is a “catch all” terms for a myriad of radio protocols that use advanced technology to improve the radio spectrum utilization as well as add additional radio communications features (i.e. user ID, “man down”/emergency, etc.). The main characteristic of these technologies is that they are able to take a licensed radio channel and virtually or physically divide it into at least two radio channels thereby increasing the radio system’s communications capacity without adding more channels.

Frequency Division Multiple Access (FDMA) – a digital radio technology that is able to divide a licensed physical radio channel into two physical radio channels.

Time Division Multiple Access (TDMA) – a digital radio technology that is able to create two “virtual” radio channels out of one licensed physical radio channel.

Multicast Radio Infrastructure – this type of infrastructure will transmit the same information simultaneously from different sites using a different half duplex channel for each site. The operator or intelligence built into the radio will have to switch channels as the user moves from one area to the next. In the case where the intelligence is built in the radio, as discussed in this report, the field operators affiliate with the most optimal tower in order to communicate with dispatch and each other.

The main advantage of this technology is that it is not very complex. The main drawback of this technology is that, as the radio towers operate independently, require each a deferent radio channel (or channels) thereby increasing the radio frequency licensing requirement.

Simulcast Radio Infrastructure – this type of infrastructure simultaneously transmits the same signal, on the same channel, at the same time from different radio sites. This is a more complex technology that makes much better use of the radio spectrum and requires less radio licenses. This makes it easy for the user to roam from one tower site coverage area to the neighboring one, but the systems are more costly, more prone to self-interference and require more dedicated management and supervision.

Conventional Radio System - Conventional system is the most basic radio communications system. Conventional, as its name implies, refers to a “traditional” method of frequency utilization. Conventional radios operate on fixed channels and each user group is permanently assigned a fixed frequency (simplex) or a set of frequencies (half-duplex). Conventional systems can be either analog or digital.

Trunked Radio System - A trunked radio system is a digital two-way radio system that uses a digital control channel to automatically assign radio channels to groups of users. Trunked radio systems are an advanced and more complex alternative to conventional systems in which the channel selection is done manually.

Backhaul – A set of wireline or wireless links that connects the radio towers and the dispatch centres.

3.3 General System Options

Based on the situations outlined in 2.3, the discussion in 3.1 and the fact that the fire services are looking to the County to consolidate and support their efforts it seems that a County-wide, unified paging and radio system containing two radio infrastructures for the fire services is the natural way to go. It would provide the following benefits:

- Simulcast, analog technology (simple and reliable), County-wide **paging infrastructure** for the use of all fire services. This infrastructure would ensure that volunteer firefighters can be paged irrespective of their location in the County. This approach would also preserve the present investment in volunteer firefighters’ pagers (See Figure 2 below).

It would require only one radio simplex radio channel to cover the County and it would be used in a simulcast mode that ensures that no interference or lost pages can occur due to interference

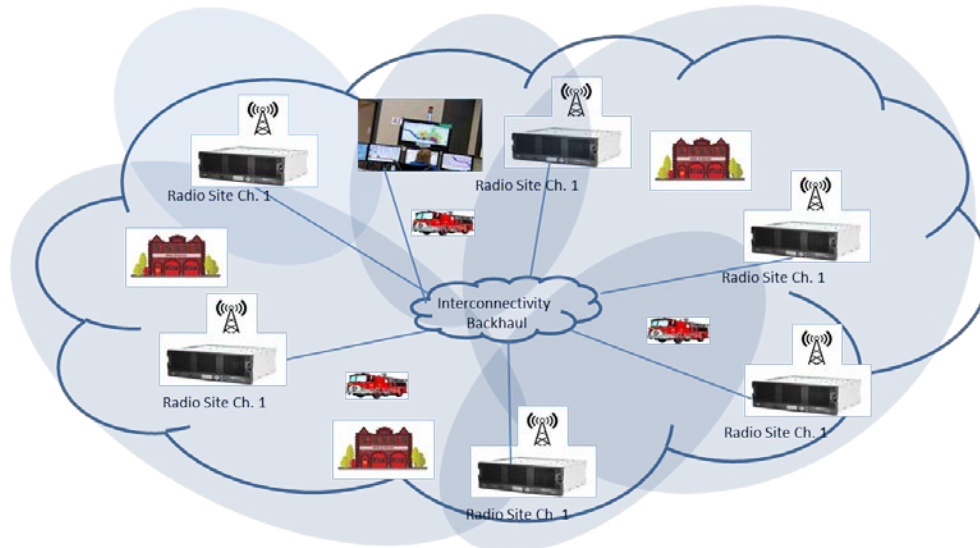


FIGURE 2 - Simulcast, Analog Paging Infrastructure (Concept)
(all radio sites transmit on the same frequency)

- The use of analog or digital technology (see Discussion on Technology Options and Figure 3 below) County-wide **radio communications infrastructure** with sufficient capacity/channels to potentially accommodate dispatching and interoperability of all the County’s fire services (except The Blue Mountains Fire Department). This could provide:
 - uniform and predictable radio coverage and less interference or lost messages due to fire services “stepping on each other”
 - The capability to plan for interoperability channels, if implemented
 - The ability to negotiate preferential subscriber radio pricing based on all fire services using the same class/make of radios
- One integrated project for the County to manage the radio system post implementation, including maintenance of radio infrastructure sites and maintenance and support of the radio infrastructures. This can be done by either internal County resources or by contracting out as part of the implementation process.

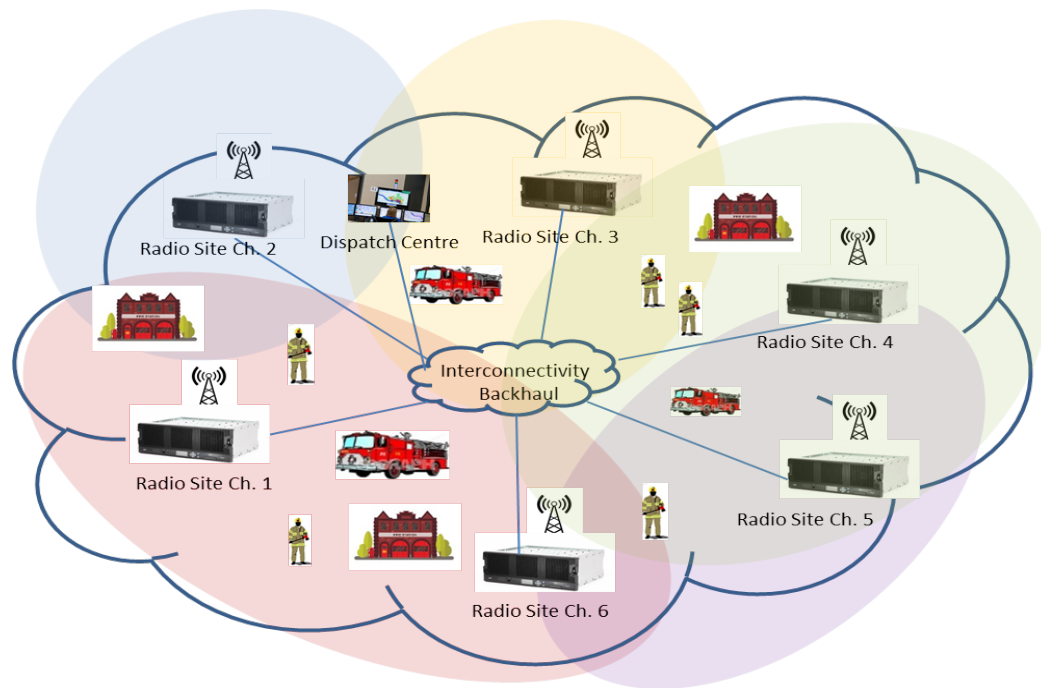


FIGURE 3 – Digital Radio System (Concept)

(radio sites may simulcast or multicast)

This consolidated approach to a system implementation would also result in the provision of enhanced service and support by the system supplier, with committed Service Level Agreements (SLAs) and lifecycle (10 years), at a competitive cost.

3.4 Technology Options

The ubiquitous radio technology used by the Grey County fire agencies is analog technology. This is a legacy technology that has been, and still is, very reliable, easy to support and relatively low cost.

There are, however two modern radio technologies widely used by rural fire services in Ontario and, in fact, across Canada and the US.

One technology is Digital Mobile Radio (DMR) which is supplied by multiple vendors such as Motorola, Harris/Tait, JVC/Kenwood, Hytera, etc. It is based on a standard developed by the European Telecommunications Standards Institute (ETSI) and first ratified in 2005. It has been widely adopted all over the world as a cost effective, reliable and spectrum efficient radio technology, in particular for smaller public safety agencies that wish to enjoy the benefits of a modern digital technology.

DMR belongs to the TDMA family of digital radio technologies (see 3.2 above for TDMA definition)

The other technology is NXDN which is a digital, open standard technology developed by JVC/Kenwood which it markets under the trade name Nexedge. NXDN technology is, in Canada, only supplied by JVC/Kenwood which may restrict the commercial choices as well as the selection of the support and maintenance services supplier. The primary market for NXDN is North America but it has also been used in Europe and elsewhere in the world. Owen Sound Police and Fire use NXDN.

NXDN belongs to the FDMA family of digital radio technologies (see 3.2 above for FDMA definition)

Both technologies are suitable for a County-wide radio system and both have advantages and disadvantages in certain situations.

There are two major differences between them:

- The ability to simulcast, i.e. use the same radio channels at multiple sites in a coordinated manner. While DMR have been offering this capability for many years, NXDN only introduced it this year and there is no recent feedback on its performance. Given the scarcity of radio channel licenses, the option to simulcast may become the principal factor in selecting the preferred implementation technology.
There are only two (2) possible half duplex licenses in Grey County: one is the Mutual Aid channel licensed County-wide and the other is valid in the service area of InterTownship Fire. Their ability to be licensed for the whole County radio coverage needs, however, to be explored with ISED.
- NXDN is FDMA where DMR is TDMA. Although this is not a limiting factor, there has been anecdotal evidence that FDMA technologies provide marginally better audio quality.

If one assumes that this radio infrastructure initiative pertains only to the Grey County fire services then DMR may have an advantage as the more suitable and cost effective/competitive solution.

If, on the other hand, one assumes any level of integration with the Owen Sound Police radio system then NXDN becomes the preferred technology, in terms of the potential ability to deploy some of the radio channels licensed to police at additional radio sites throughout the County for the use of the fire and police services.

NOTE

There are more advanced and very sophisticated digital technologies such as P25 and TETRA but these have been excluded from this Report due to their intended suitability for large and very large, integrated public safety systems that require additional capabilities and features. They are typically very expensive.

3.5 Owen Sound Police Initiative

Owen Sound police is in the midst of an initiative to extend its radio system coverage to Hanover Police and West Grey Police. This would require an upgrade of the police radio system to include the service areas of Hanover and West Grey. Each of the two services has a half-duplex radio channel licensed to it. While this could be a completely separate initiative this may also be an opportunity to consider the possibility of consolidating the police and fire radio infrastructure. In such case there may be some economies of scales in a joint implementation.

As such, consolidation would probably require the fire services to align their radio technology with that of the police (NXDN). This would also mean that the majority of the fire subscriber radios would have to be upgraded. This approach will require a very in-depth coordination with ISED in terms of the ability to reuse licensed frequencies throughout the County.

If such consolidation becomes a real possibility it is proposed that it be included as an option in the RFP for the implementation of the fire radio upgrade and be left to the proponents to approach ISED for radio frequency coordination. This would also allow operational and financial comparison between the non-integrated and the integrated infrastructure options

4.0 CONCEPTUAL RADIO SYSTEM OPTIONS

4.1 Summary of Requirements for Fire Agencies

Based on the information presented in Sections 2 & 3 above we can outline now the upgrade requirements of the fire services in Grey County and a conceptual design that fulfills them. The requirements are (in order of importance):

- Separation of paging and dispatch communications functions – this has been identified as the most important operational issue
- A County-wide paging infrastructure with interconnectivity to Owen Sound and Tillsonburg dispatch centres – this has also been identified as a very important operational issue that would allow volunteer firefighters to be paged anywhere in the County.
- Public safety standard radio coverage of 95% or the County for mobile radios with Vehicular Repeaters support for portable radio communications
- A County-wide dispatch and interoperability infrastructure with sufficient capacity to accommodate the expected radio traffic and provide future options for growth
- Ability to preserve, to the extent possible, the investment in subscriber infrastructure
- Consolidated tactical and interoperability channels
- 10 years minimum lifecycle for the communications infrastructure
- Reliable and predictable infrastructure service and support based on mutually accepted SLAs.

4.2 Proposed Solutions for the Fire Agencies

There are four proposed conceptual solutions for the fire agencies (see TABLE 1 below). They are presented in ascending order in terms of cost and by implication descending order in terms of ability to adopt the requirements outlined above. They are:

1. Implement a County wide analog, VHF, simulcast paging channel and do nothing about radio coverage, dispatch and interoperability. This is the most basic solution that resolves the paging issues associated with paging and dispatch sharing radio resources as well as the interference and missed messages inherent in this situation.
The selection of the paging frequency requires coordination with ISED. This would be the lowest cost solution (see Table 1 below) for a minimum but critical operational improvement.
This solution does not require any upgrade in the subscriber radio fleet
2. Implement a County wide analog, VHF, simulcast paging channel and use three half- duplex dispatch channels on three high towers that anecdotally (supported by proposals submitted by both Hartman Communication and Bearcom Communications) cover the whole County at close to 95% mobile radio coverage level. The portable radio coverage and any localized radio coverage requirement could be achieved with the help of Fixed or Vehicular Repeaters.
Each tower would have an analog simplex. Simulcast paging channel and a half duplex channel in a conventional (see 3.2) configuration. A set of agencies would be allocated to each channel as their permanent dispatch channel. Should a need for interoperability arise the channel that is most appropriate geographically will become the interoperability channel.

Solution 2 is a more advanced solution that improves the functionality of the dispatch and tactical channels in addition to paging. This solution also requires coordination with ISED. It is a higher cost, albeit still low cost, solution that could bring a major improvement to paging and dispatch but limited improvement to interoperability.

This solution does not require any upgrade in the subscriber radio fleet.

3. Similar to Solution 2 in terms of radio coverage but using DMR or NXDN technologies to increase the capacity of the dispatch channels to allow for dedicated interoperability channels. Each half-duplex channel would carry the capacity of two channels, TDMA or FDMA, as outlined in 3.2 above. It is still a solution for mobile radio coverage. If portable radio coverage is required it could be achieved via Vehicular Repeaters.

This Solution allows for increased capacity and as such the ability to designate interoperability channels within the County. Each pair of channels would cover a certain area of the County.

There is an incremental cost in comparison with Solution 2 but so are the benefits.

This solution does require the subscriber radio fleet to be upgraded to the technology selected, DMR or NXDN at an average cost of \$1,250/radio or approximately \$13/radio/month if the capital cost is amortized over 8 years (the industry standard for lifecycle of subscriber equipment).

4. This is the most advanced solution and it entails using approximately 8 radio sites with two channels each in a conventional simulcast configuration. It achieves the capacity of 4 County wide, radio channels via digital technology, DMR or NXDN. It also achieves portable radio coverage at street level with a need to use a Vehicular Repeater only in more difficult buildings. This is also the most expensive Solution and it will also carry a more expensive price tag for maintenance and support.

The subscriber radio fleet will have to be upgraded to the technology selected, DMR or NXDN at an average cost of \$1,250/radio or approximately \$13/radio/month if the capital cost is amortized over 8 years (the industry standard for lifecycle of subscriber equipment).

This solution requires a very extensive effort to coordinate radio frequency licenses and the results of this effort are unknown at this time.

	Fire Only			Police and Fire		
	Solution 1	Solution 2	Solution 3	Solution 4	Solution 5	Solution 6
Infrastructure Cost (CAPEX)	\$150,000.00	\$275,000.00	\$350,000.00	\$750,000.00	\$450,000.00	\$850,000.00
Subscriber Radios Cost (CAPEX)	No Cost	No Cost	\$400,000.00	\$400,000.00	\$400,000.00	\$400,000.00
Maintenance & Support/mo. (OPEX)	\$2,000.00	\$3,000.00	\$4,500.00	\$9,500.00	\$5,500.00	\$7,000.00
# of Radio Paging Sites	8	8	8	8	8	8
# of Radio Dispatch Sites	0	3	3	8	3	8
Paging Technology	Analog, Conventional, Simulcast	Analog, Conventional, Simulcast	Analog, Conventional, Simulcast	Analog, Conventional, Simulcast	Analog, Conventional, Simulcast	Analog, Conventional, Simulcast
Dispatch Technology	N/A	Analog, Conventional	Digital, Conventional, Simulcast Possible if DMR	Digital, Conventional, Simulcast Possible if DMR	Digital, Trunking, NXDN Multicast	Digital, Trunking, NXDN Multicast
Paging Separate From Dispatch	Yes	Yes	Yes	Yes	Yes	Yes
County Wide Paging	Yes	Yes	Yes	Yes	Yes	Yes
Mobile Radio Coverage	N/A	Yes (anecdotal)	Yes (anecdotal)	Yes	Yes	Yes
More Dispatch Channels	No	Yes	Yes	Yes	Yes	Yes
Interoperability Channels	No	No	Yes	Yes	Yes	Yes
Growth Potential	No	No	Yes	Yes	Yes	Yes
Portable Radio Coverage	No	No (via VRs)	No (via VRs)	Yes	No (via VRs)	Yes
Ability to Centralize Recording	No	No	Yes (Not Integrated)	Yes (Integrated)	Yes (Integrated)	Yes (Integrated)
ISED Coordination Required	Yes	Yes	Yes	Critical, not easy	Critical, not easy	Critical, not easy

Table 1 – Solutions Comparison

NOTE

In any of the solutions proposed above it is expected that Owen Sound Fire Service will be able to program their subscriber radios to accommodate any option. This will ensure that Owen Sound Fire is able to participate in any incident outside the city and provide the required interoperability and support.

Further to the four options proposed above there are two additional options that would integrate the radio systems for fire agencies with the one used by Owen Sound Police and Owen Sound Fire as well as, possibly, Hanover Police and West Grey Police.

Solutions 5 & 6

There are several advantages offered by these options both in terms of the ability to manage the radio communications infrastructure and large-scale incidents as well as in terms of future growth. In addition, the system management, maintenance and support are projected to be lower in cost than for Solutions 3 & 4 due to the consolidation of the police and fire radio infrastructure.

The major difference between the two solutions is the extent of radio coverage available throughout the County: mobile radio coverage in Solution 5 and portable radio coverage in Solution 6.

As in Solution 4 these solutions require a very extensive effort to coordinate radio frequency licenses and the results of this effort are unknown at this time.

These solutions require the technology used to be NXDN trunking in order to allow integration with the Owen Sound Police radio infrastructure. Trunking is a more expensive technology solution and hence the difference in price in Table 1 (see Figure 4 below).

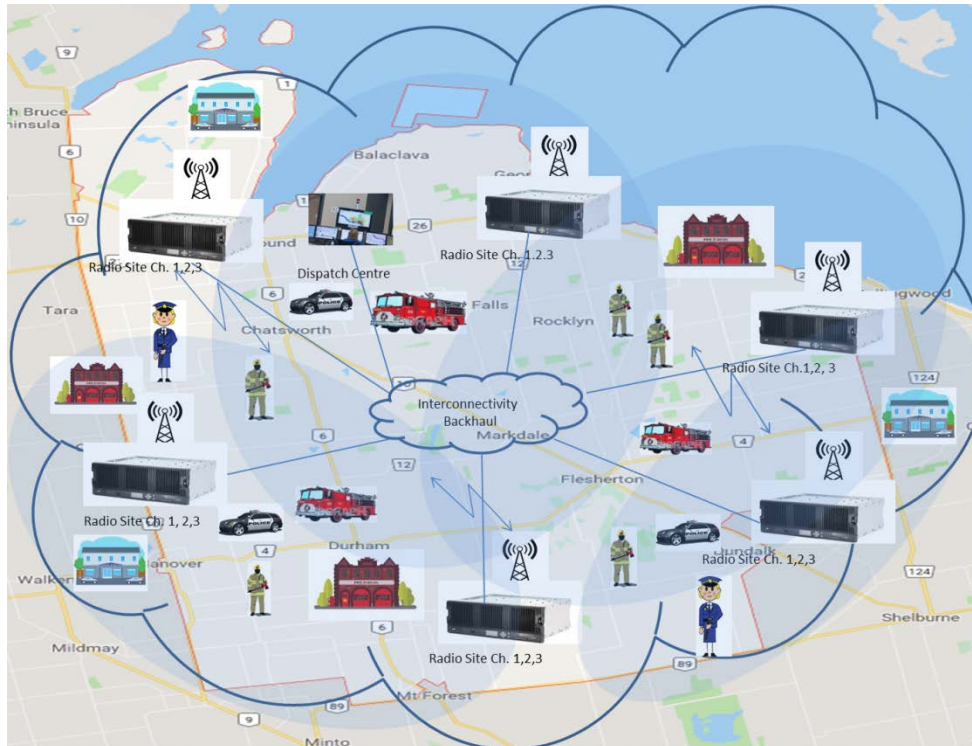


FIGURE 4 – Consolidated, Simulcast Paging and Dispatch System (Concept)

4.3 Cost Considerations and Cost Sharing – Fire Agencies and Police

From a cost perspective the options presented range from \$150,000 to \$850,000 (plus subscriber radios) based on the features implemented and the technological sophistication. This would be the expected Capital Costs Budget.

The above capital could be advanced by the County and/or Owen Sound Police, and recovered on a monthly basis from the participating fire agencies and joining police agencies during its lifecycle. The manner in which this cost is shared need to be agreed in a Memorandum of Understanding (MOU). A proposed framework for a MOU is presented in APPENDIX A below.

Based on past similar situations the sharing should be based on the number of radios (mobiles, portables and VRs) each service owns. A proposed sharing model is presented in APPENDIX B below.

In addition to the capital cost the operating cost of the radio system including internal staff required, contracts for maintenance and support (see 5.0 below) and any other monthly costs should be considered and included in the MOU and the sharing model as part of the Operating Costs Budget.

5.0 MAINTENANCE, SUPPORT AND SYSTEM MANAGEMENT

5.1 Maintenance and Support

The ability to maintain and support the upgraded radio communications system is based on the lifecycle expectations and the mandatory requirements outlined in the Service Level Agreement (SLA) with the service provider. Some of the important consideration that should be included in any proposal to upgrade the system are:

- The service provider should demonstrate a reasonable business stability as to ensure that the system will be maintained in a continuous and predictable way
- The service provider should demonstrate sufficient technical knowledge as to be able to support any necessary system upgrades, hardware or software, required throughout the expected lifecycle
- The service provider should demonstrate a close relationship with the equipment manufacturer as to ensure fluid and continuous transfer of knowledge between them
- The service provider should demonstrate ability to respond to calls for service as per the SLA – typical response times would be 30 min. by phone and 4 hours on site.
- The service provider should demonstrate that it has sufficient staff to ensure that previous requirements are met 7 days/week, 24 hours/day and throughout the entire year.

This is by no means an exhaustive list but, rather, a minimum set of requirements.

5.2 System Management

Once implemented any radio system requires ongoing management to ensure that:

- The system continues to perform at the same level at which it was implemented
- The usage of channels and/or talkgroups conforms with the communications procedures agreed by the stakeholder services
- The demand for radio resources is being monitored and any deviations are analyzed and reacted to accordingly
- The service provider's performance conforms to the SLA
- The radio sites are managed according to the ISED regulations and equipment manufacturer's published specifications
- That reports are generated periodically to reflect the overall state of the system

This activity is usually assumed by the owner of the system or its contracted delegate. It is a critical function that ensures proper and predictable system performance and one that is often at the centre of any incident analysis, request or inquiry. The sharing cost model proposed in Appendix B has included such a line item.

6.0 CONCLUSIONS

The ability to use reliable and predictable radio communications is critical to the level of the incident response provided by the Fire Services in Grey County. The capability to service any type of fire call while ensuring the firefighters safety is dependent on using industry standard, National Fire Prevention Association (NFPA) 1221, paging and dispatch procedures via dedicated radio resources.

The fire radio communications resources in Grey County are not utilized in a very efficient manner and this contributes to missed communications, cross interference between services and unwarranted complexity in terms of paging and dispatch which, in turn impact the safety of the firefighters.

Because of the service-by-service approach to radio communications the radio licenses requested from ISED did not take into consideration the unified needs of the fire services for reliable paging and

dispatch functions as well as the operational interoperability required to service larger scale incidents be them structure fires, serious road accidents or major disasters.

The Fire Services have approached Grey County to request assistance to remedy their paging and radio communications shortcomings by making improvements to the radio communications infrastructure. The County commissioned a review of the paging and radio communications capabilities of the fire services in order to identify the issues and propose ways to mitigate them.

The following issues have been identified:

- Multiple fire services are using existing radio frequencies for multiple functions, i.e. paging, dispatch and tactical. This results in overlapping communications, missed communications and interference among the frontline users. It also constrains the operational abilities of the fire services to deliver reliable and predictable performance.
- The fire services could use a radio paging infrastructure that does not impose loading and/or timing constraints on the radio communications infrastructure. They could also use the radio infrastructure in a manner that would separate between dispatch channels, those used for fire dispatch and interoperability, and tactical channels, those used by the fire services to communicate at the site of an incident and with each other.
- The radio coverage available from the present radio towers is not documented and is not, anecdotally, sufficient.
- Owen Sound Police dispatch is responsible to dispatch seven fire services on seven different radio configurations, with various degrees of radio coverage and technical limitations, using seven different dispatch procedures.
- Dispatching fire services in such a constraining environment also poses challenges in terms of proper and completed dispatch processes as well as the required follow up and, if necessary, audit.
- Each fire service is focused in providing paging and radio communications to its respective firefighters. There is a requirement (need) to interoperate but this functionality was not considered in the present systems' implementations. There is no established radio communications procedure for servicing large scale incidents either.
- The scarcity of radio licenses is exacerbated by the present implementation of legacy analog technology for voice communications which does not make optimal use of the frequencies utilized. This is a critical issue as radio licenses are limited and obtaining additional licenses from ISED is a very difficult, time consuming task with no guarantee of success.
- The majority of the mobile and portable radios are capable of analog communications only with some being able to operate in digital modes but not all in the same mode. Although digital technology is more advanced and makes better use of radio licenses to make all radios digitally compatible will require a substantial initial investment.

These issues highlight the limitations a disparate set of radio resources, communications operations and procedures poses to the fire services' operations and firefighters' safety as well as to the ability to manage a large scale, interoperable incident in the County.

There are multiple ways to resolve some or all the above issues and this report includes six possible solution options Grey County may want to consider. They range from resolving the most critical issue, which is the separation of paging and dispatch radio infrastructure, to improving the overall radio fire coverage in the County, to a most comprehensive option of fully integrating fire and police radio infrastructure allowing the adoption of digital radio technologies that allow better use of the allocated radio licenses, provision of County wide interoperability and improved ability to deal with large scale incidents.

In estimated costs they range from \$150,000 to \$850,000 reflecting the larger set of communications improvements that may be implemented. Some of them also require an upgrade of the subscriber radio equipment, mobile and portable radios and vehicular repeaters, to ensure compatibility with the newer digital radio technologies at an additional estimated cost of approximately \$400,000.

The options can be separated into two groups:

Group 1 Solutions for a radio system for the Fire Departments (Solutions 1 to 4)

Group 2 Solutions for an Integrated Police/Fire radio system (Options 5 & 6)

Group 1 can be further divided into two subgroups:

- a. Maintain the present, legacy analog technology (Options 1 & 2)
- b. Upgrade to advanced digital technology (Option 3 & 4)

Options in Group 1a do not facilitate reliable communications between services or remedy current radio coverage deficiencies. Of these two options, Solution 2, is the lowest cost at approximately \$275,000. It resolves the paging issue and offers limited improvement to the dispatch capabilities. It does not provide much in the way of interoperability. It does not provide portable radio level coverage.

In Group 1b, Solution 3 is the preferred solution. The estimated costs of this solution are about \$750,000 (\$350,000 for the radio infrastructure and \$400,000 for the subscriber equipment). It is similar to Solution 2 but provides more capacity to allow for fire services interoperability. The additional \$75,000 in infrastructure cost places the fire services in a good position to plan for future growth and a possible future integration of radio communications infrastructures in the County, including not only public safety (police and paramedic services) but also public works.

Solution 3 is the preferred solution for the upgrade of the radio system for the fire departments.

The solutions in Group 2 are contingent of future operational and funding agreements with Owen Sound Police. In this group, Solution 5 is the preferred solution. It achieves all that Solution 3 does while providing the ability to integrate with the Police radio infrastructure now. The estimated costs of this solution are about \$850,000 (\$450,000 for the radio infrastructure and \$400,000 for the subscriber equipment).

APPENDIX A – PROPOSED MOA STRUCTURE

Draft Fire Communications MOA

APPENDIX B - PROPOSED COST SHARING MODEL

Grey County Radio System Budget

Sharing Proposal

Users

Subscriber	Number of Subscriber Radios
Chatsworth	
Inter-Township	
Owen Sound	
Meaford	
West Grey	
Hanover	
Dundalk	
Grey Highlands	
Blue Mountains	
Total Subscribers	

Maintenance & System Upgrade

Infrastructure & Maintenance (inc. staff)	Annual Cost	Annual Cost /Subscriber	Comments
Annual Infrastructure Capital			Infrastructure investment over 10 yr amortization
Infrastructure Maintenance Contract			Annual cost including radio sites, network transport and main sites
Utilities etc.			
Telecom/backhaul (if outsourced)			
Leases, security, other monthly costs			
Total Cost/Subscriber (partners)			To be charged back by Grey County to Fire Departments

Other

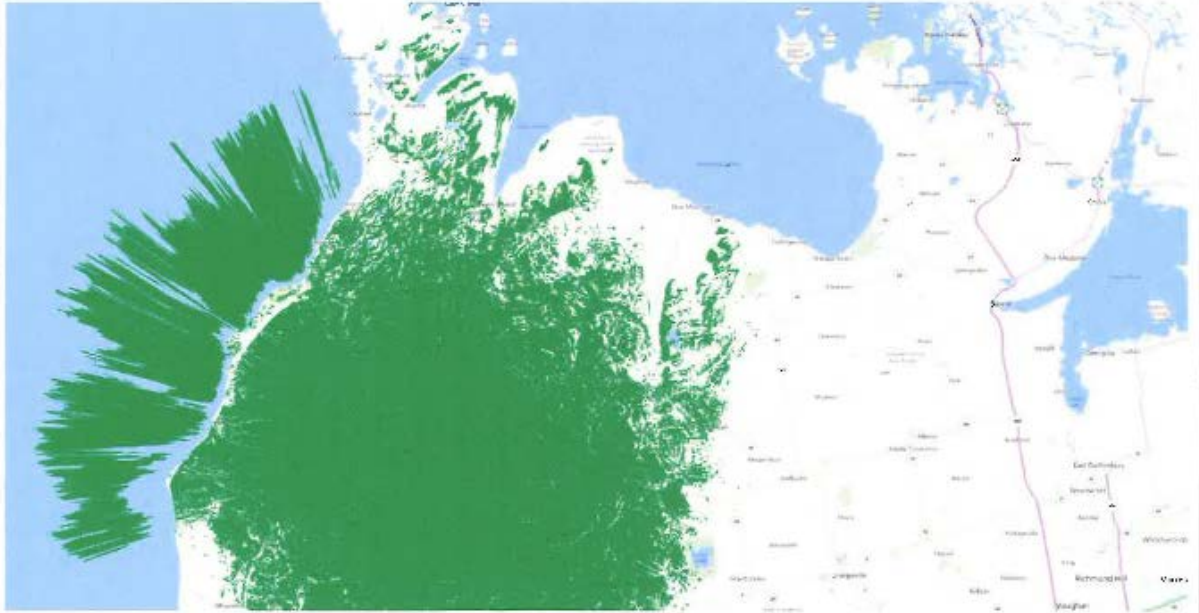
Other System Upgrades	Quantity	Unit Cost	Total Cost	Comments
Paging System				Est. Capital
Programming Tools				Est. Capital
Infrastructure Coverage Related Vehicular Repeaters				Est. Capital
Voice Recording System				Est. Capital
Total Cost/Month/Subscriber (partners)				To be charged back by Grey County to Fire Departments

Totals

Total County of Grey Recoverable/month/subscriber		
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APPENDIX C – Anecdotal 95% Mobile Radio Coverage Provided by Bearcom

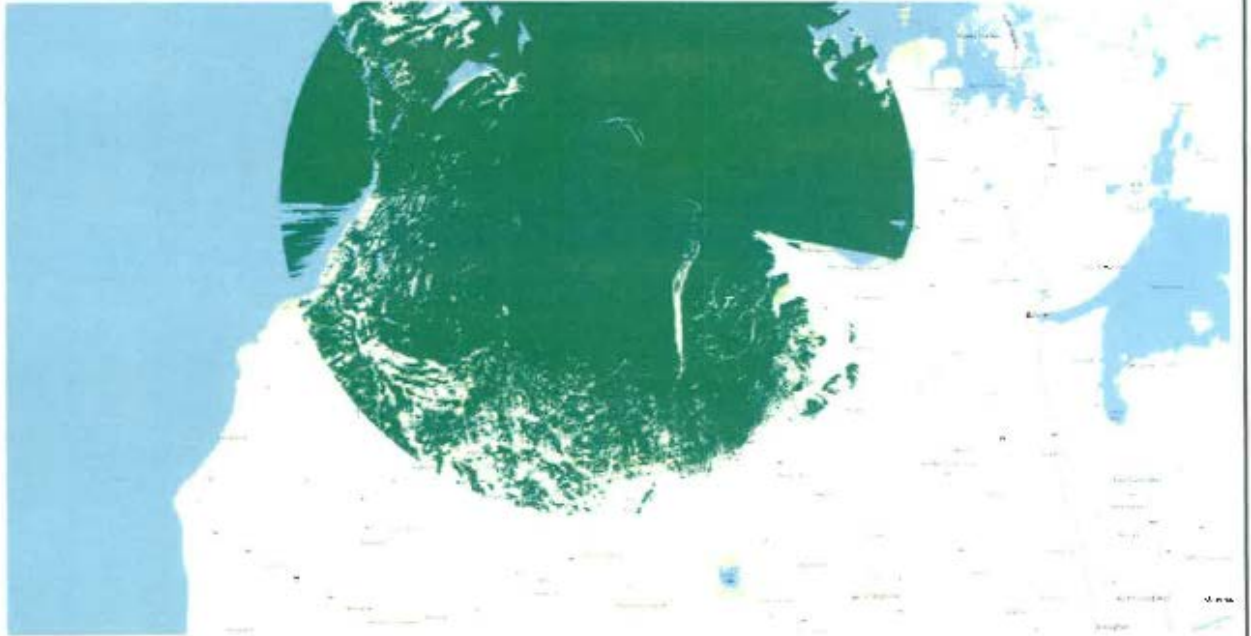
Walkerton Tower



Mobile Talk-in - 95% Coverage

Spectrum Communications		
Gray County Vies Radio System		
Drawn By	Revised	Date
JW	3	24 Oct 2016

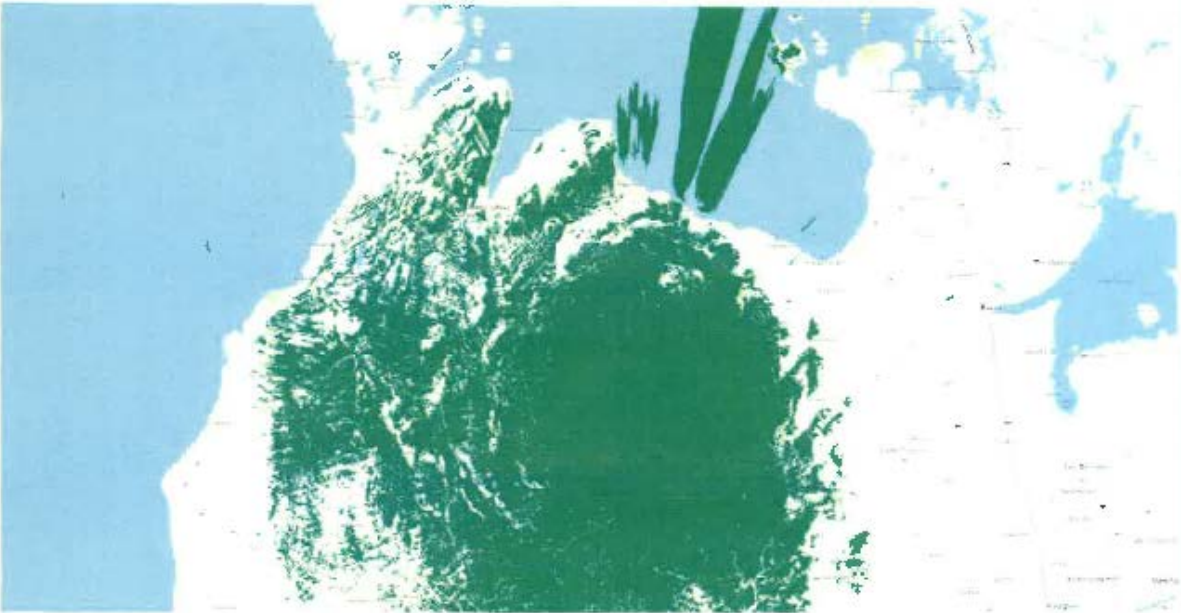
Woodford Tower



Mobile Talk-In - 95% Coverage

Spectrum Communications		
Key County PLAN Mobile System		
Drawing By:	Revision:	Date:
JW	3	24 Oct 2016

Ceylon Tower



Mobile Talk-in - 95% Coverage

Spectrum Communications		
Goway County Fire Radio System		
Transmitting By:	Power:	Date:
JW	3	24 Oct 2016