Radio Interference Analysis

Kaimai Wind Farm

June 2018

Update for Revised Turbine Definitions

Introduction

Kaimai Wind Farm Limited is proposing to construct a wind farm on a ridgeline that straddles both the Hauraki and Matamata-Piako Districts. The wind farm will consist of multiple towers for mounting wind turbines. As part of the resource application for the wind farm, Lambda Communications has been asked to assess the effects that the construction of the wind farm might have on existing radio communications services in the area. The solid towers that support the wind turbines and the rotating blades on the turbines have the potential to both obstruct and reflect radio signals. These effects can potentially degrade radio reception by both reducing the strength of the wanted signal and also by resulting in reflected signals that can cause interference.

Lambda Communications is a radio communications consultancy company based in Auckland and Hamilton. The company has been in operation since 1994 working with a range of clients including utility companies, Government Departments including MBIE, local authorities with respect to smart city developments and also private network providers. Recently Lambda has provided consultancy advice to the Ministry of the Environment in relation to changes to the National Environmental Standards (NES) for telecommunications facilities. Lambda has also extensive experience in preparing NES Reports required for the installation of any new radio transmitter.

This report was originally prepared in December 2016 and then updated in December 2017 for the final turbine locations. This update in June 2018 only considers the latest changes to the turbine definitions in relation to the previous searches of licenced radio spectrum usage, and doesn't involve a new search of the register of radio licences.

The new turbine dimension scenarios, as of May 2018, are as follows

a. Upper Ridge(18-24):
   - (i) 112m Hub Height, 136m rotor diameter, 180m tip height (as before)
   - (ii) 107m Hub Height, 146m rotor diameter, 180m tip height
   - (iii) 98m Hub Height, 146m rotor diameter, 171m tip height

b. Lower Ridge(1-17):
   - (i) 132m Hub Height, 150m rotor diameter, 207m tip height (as before)
   - (ii) 128m Hub Height, 160m rotor diameter, 207m tip height
   - (iii)110m Hub Height, 160m rotor diameter, 190m tip height

As of May 2018 no changes are proposed to the location of turbines or to the base arrangements.

Radio Propagation Effects

In its series on radio wave propagation, the International Telecommunication Union (ITU) identified six mechanisms that impact on the progress of a radio wave travelling through the earth's atmosphere;

"The propagation loss on a terrestrial line-of-sight path relative to the free-space loss is the sum of different contributions as follows:

- attenuation due to atmospheric gases;
- diffraction fading due to obstruction or partial obstruction of the path;
- fading due to multipath, beam spreading and scintillation;
- attenuation due to variation of the angle-of-arrival/launch;
- attenuation due to precipitation;
- attenuation due to sand and dust storms." – ITU-R P.530.14

The addition of a wind turbine or multiple turbines will only affect the second and third of these points, specifically diffraction and multipath caused by reflections.

Diffraction

In the vacuum of space a radio wave will travel in a perfectly straight line, but for terrestrial based systems the path of a radio wave is affected by the atmosphere. This is because the density of the atmosphere changes with altitude, at low altitudes the density is greater than at higher altitudes were the atmosphere is thinner. As the atmospheric density changes it causes the radio wave to be refracted or bent in such a way that it tends to follow the curvature of the earth.

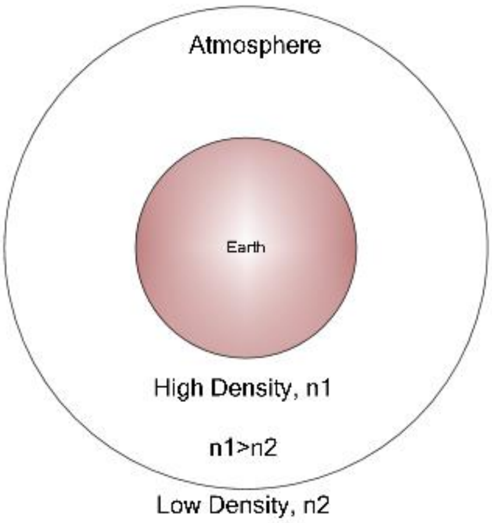


Figure 1

It is this effect that allows radio waves to propagate over a visible horizon, the effect being more pronounced at lower frequencies. When a radio path is obstructed or there is an object close to the direct line of sight, such that the space between transmitter and receiver is partially obstructed, then the refraction of the radio wave by the atmosphere becomes critical. The difference between an unobstructed signal and the refracted signal that reaches a receiver is called the diffraction loss.

However the atmosphere is a dynamic environment and the amount of refraction that a radio wave is subject to changes with time. The amount of atmospheric refraction is defined in propagation calculations by a term call the k-factor, which for a "standard atmosphere" is measured at '4/3'or

'1.33'. This term is also referred to as the effective earth radius when referenced to the path of the radio wave, i.e. the earth's radius is effectively 33% larger or in affect it appears flatter than it would if the wave wasn't refracted. As the atmosphere changes over time, the k-factor can increase (super-refraction) and also decrease (sub-refraction), changing the effective radio path. Critically for sub-refraction, objects that weren't previously obstructing the radio path may obstruct the new effective radio path that isn't refracted or bent to the same extent.

As refraction is also frequency dependent, it is possible to relate changes in the k-factor to another frequency dependent concept in radio propagation, known as the first Fresnel zone, which describes an ellipsoid in space between a transmitter and receiver. This provides a way of defining the required clearance of possible obstructions, including the ground, to account for variations in levels of atmospheric refraction;

"Diffraction theory indicates that the direct path between the transmitter and the receiver needs a clearance above ground of at least 60% of the radius of the first Fresnel zone to achieve free-space propagation conditions." – ITU-R P.530.14

The radius of the first Fresnel ellipsoid at any point between the transmitter and receiver is given by the equation;

$$R = 17.3\sqrt{\frac{d_1 \ x \ d_2}{f \ x \ d}}$$

Where R is the radius in metres of the ellipsoid at the point where d_1 is the distance to one end and d_2 is the distance to the other end, f is the frequency in GHz and d is the between both ends in kms.

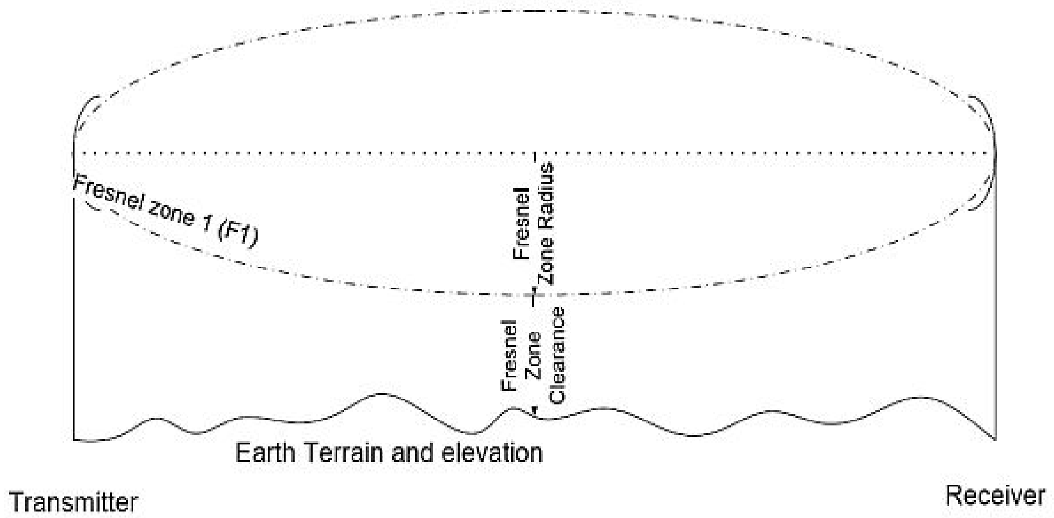


Fig. 2

It is therefore important that any radio path that crosses the wind farm clears the top of the wind turbines by an amount that is at least 60% of the first Fresnel ellipsoid, if the radio path is to remain as clear line of sight with no additional diffraction loss.

Reflections and Multipath

The other potential for radio interference due to the presence of large structures in the vicinity of a radio path is the possibility of reflections off the structure causing a second time delayed signal reaching the receiver. Because the reflected signal travels further than the direct signal in reaching the receiver it is delayed in time, which when combined with the direct signal in the receiver adds either constructively or destructively depending on the amount of delay. Where the two signals add destructively this causes fading in the combined signal and a potential loss of communications. Often there is more than one reflected signal reaching the receiver and in this situation the effect is known as multipath fading.

Whether the direct signal and the reflected signal add destructively or not is dependent on the additional distance travelled by the reflected signal, as measured in relation to the wavelength of the signal. When the reflected signal is half a wavelength behind, it is referred to as being 'out of phase' and will add destructively, conversely if the reflected signal is a full wavelength behind, it is referred to as being 'in phase' and will add constructively. In addition to the extra distance travelled by the reflected signal that results in a phase difference, when the signal is reflected it is also shifted in phase by half a wavelength.

The combination of these two factors determines the total amount of phase difference between direct and reflected signals at the receiver. A series of ellipsoids can then be drawn between a transmitter and receive that represent every possible point where a signal reflected at any point that co-insides with the surface of each ellipsoid will arrive at the receiver in phase. This is the definition of a Fresnel zone, the first in the ever outwardly expanding series, being the first Fresnel ellipsoid that is also used as a reference for assessing diffraction effects.

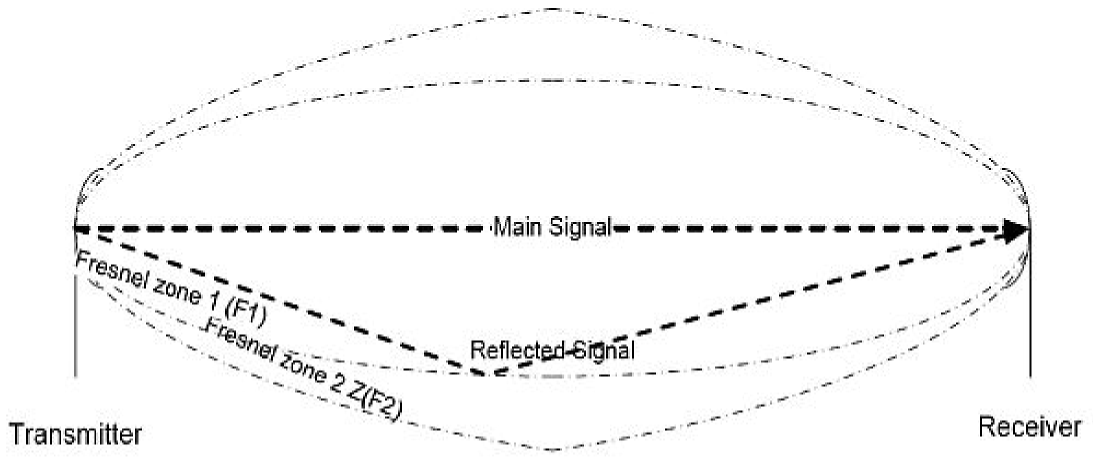


Fig. 3

Because the frequency and wavelength of radio signal are directly related the size of the Fresnel zone is directly proportional to frequency, with the lower frequency signals having a larger radius to each Fresnel zone. For a reflection off a flat surface it is possible to raise or lower an antenna at one end of a link to change the path length of the reflected signal and affect how the direct and reflected signal combine in a receiver. Normally there is more than one reflection reaching a receiver or the reflecting surface moves in time like reflections off bodies of water and simply moving the antenna isn't sufficient to counter the fading effect. In this situation using two or more antennas at each end and selecting the signal from the antenna with the lowest fade can account for more dynamic reflection issues.

In the case of a windfarm, the towers used for mounting the turbines are generally a solid cylindrical structure that being curved will reflect a radio signal in all directions. As there are also multiple towers spaced across the windfarm, a receiver that has line of sight to at least part of the windfarm will likely see reflections off more than one of the towers. In this case it is possible for the multiple reflections, each travelling a different path over different distances, to cancel each other out at the receiver and have minimal effect of the receive signal. Because of the complexities of accounting for multiple paths, particularly for reflections off turbine blades which are moving and therefore changing with time, the only practical method for assessing multipath fading is on a statistical basis. It is standard practice in radio engineering to allow sufficient fade margin in any link design to allow for a sustainable amount of multipath fading for a defined percentage of time. Typically this is described in terms of the links availability, with critical links being designed for availability in the order of 99.99% of the time.

Local Communication Services

Cellular and Mobile Radio Services

Spark, Vodafone and Two Degrees all have cellular communications sites within a 10km radius of the windfarm. Kordia also have a radio base station on Mt Te Aroha for their Korkor digital mobile radio service that operates at frequencies similar to cellular communications. The cell sites are all located close to the population centres of Paeroa and Te Aroha, as well as within the Karangahake Gorge to provide coverage for the road through the gorge. Because of their close proximity to these towns, cellular services in these areas are unlikely to be affected by the establishment of the windfarm. In the case of State Highway 26 between Paeroa and Te Aroha, overlapping coverage from northern sites near Paeroa and sites from the south near Te Aroha, will ensure coverage is unaffected for the full length of this section of highway.

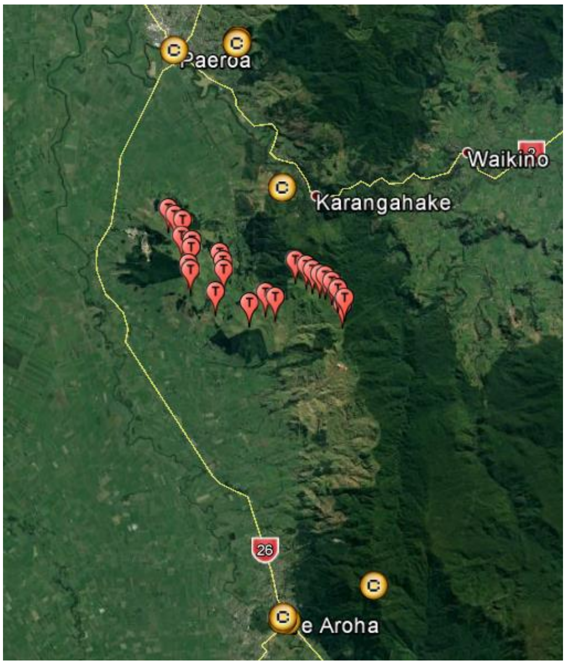


Figure 4 – Cell Site Locations

The Kordia Korkor radio base station doesn't have the overlapping coverage that the other cellular services have, but the radio base station is located at a very high site on the top of Mt Te Aroha. This extra height means that the signal for the Korkor Service will propagate over the top of the windfarm and the construction of the windfarm will have minimal effect on existing coverage. See Appendix A for a coverage map of the Korkor Service in the Waikato Region.

A similar situation applies to other private mobile radio repeaters situated on the top of Mt Te Aroha, in that they benefit from the height differential to the windfarm minimising any effect the windfarm might have on their coverage. The following table lists all of the organisations that have a mobile radio base station or repeater on the top of Mt Te Aroha. In the case of Teamtalk, their mobile radio installation on Mt Te Aroha will likely be used to provide services for private third party organisations and also to support their Fleetlink service, see Appendix A for a coverage map for this service.

Table of Mobile Radio Base Stations at Mt Te Aroha:

Licence Holder	Band of Operation	Service
DEPARTMENT OF CONSERVATION	ESB Band	Government Services
MARITIME NEW ZEALAND	Maritime Mobile Band	DISTRESS AND CALLING
NZME. RADIO LIMITED	Order wire	RADIO REPORTER SERVICE
POWERCO LIMITED	E Band	Private Mobile Radio
POWERCO LIMITED	D Band	Private Mobile Radio
PUSH WIRELESS LIMITED	TD Band	Trunked Mobile Radio
TEAMTALK LTD	TD Band	Trunked Mobile Radio
KORDIA LIMITED	TS Band	Trunked Mobile Radio

In the case of the Maritime New Zealand coastal radio service, the windfarm is to the north of the Mt Te Aroha Station in the direction of the Coromandel Peninsular. From the perspective of Mt Te Aroha, this direction is completely over land until you reach Thames, see figure 4a, a distance of over 40kms. The path profile from Mt Te Aroha to Thames, shown in figure 4b, illustrates that at this distance the radio signal travels well above the windfarm putting it well beyond the extend of any shadowing effect. Consequently the windfarm would have no effect on the coastal radio service.

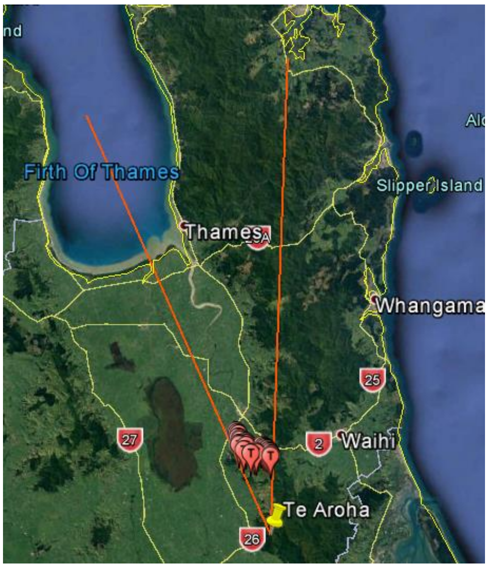


Figure 4a – Mt Te Aroha Looking North

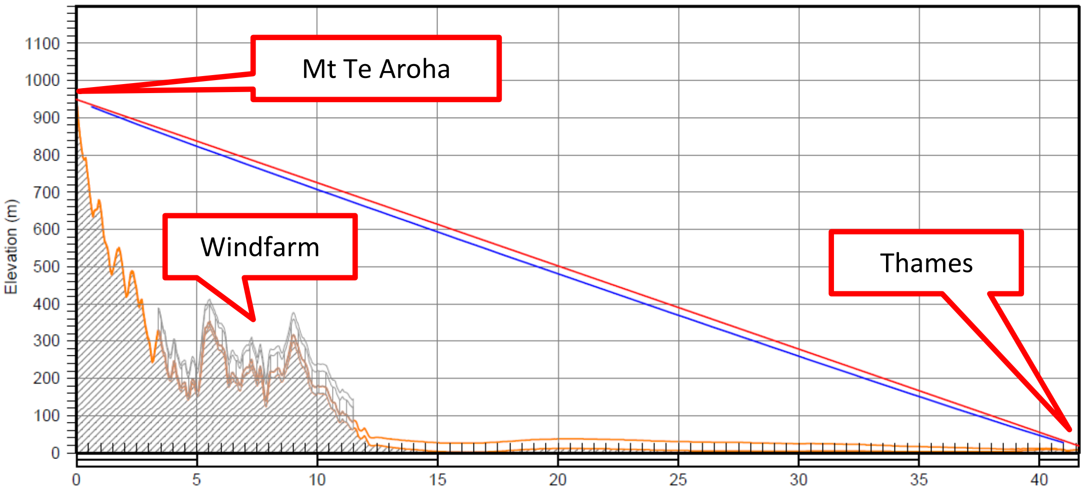


Figure 4b

Fixed Link Services

The Ministry of Business Innovation and Employment (MBIE) licences fixed link radio services in a number of bands across frequencies ranging from VHF, to UHF and microwave. By plotting these links on a map of the area it can be seen that while there are a significant number of links in the area only a very few actually cross the windfarm itself. Figure 5 shows all of the lower frequency VHF and UHF fixed link services in the vicinity of the windfarm (red markers labelled 'T' show the turbine locations, the yellow circles show radio transmitter locations and the white lines the radio paths). As can be seen, none of the radio links at these lower frequencies cross the windfarm, the closest being just to the north.

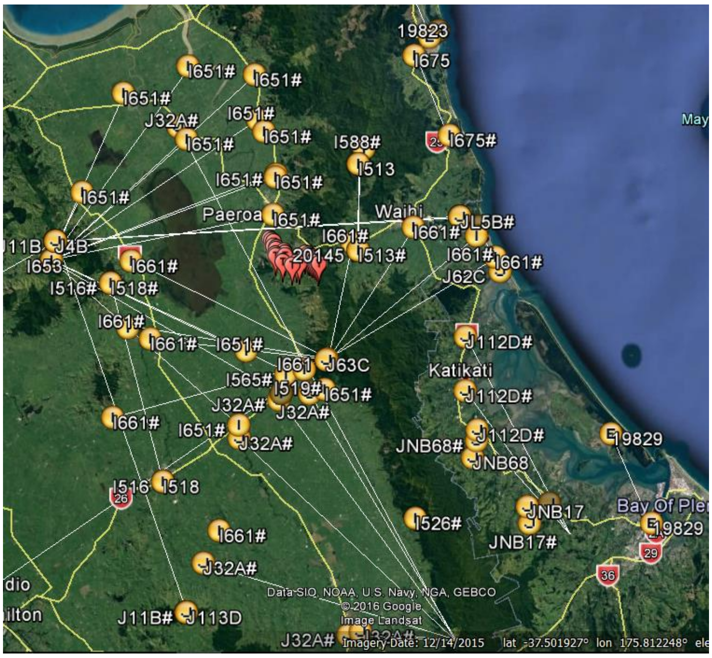


Figure 5 – VHF and UHF Services

Figure 6 shows all of the radio links at the very top of the UHF bands and the lower frequency microwave bands. Again it can be seen that none of the links in these frequency bands cross the windfarm.

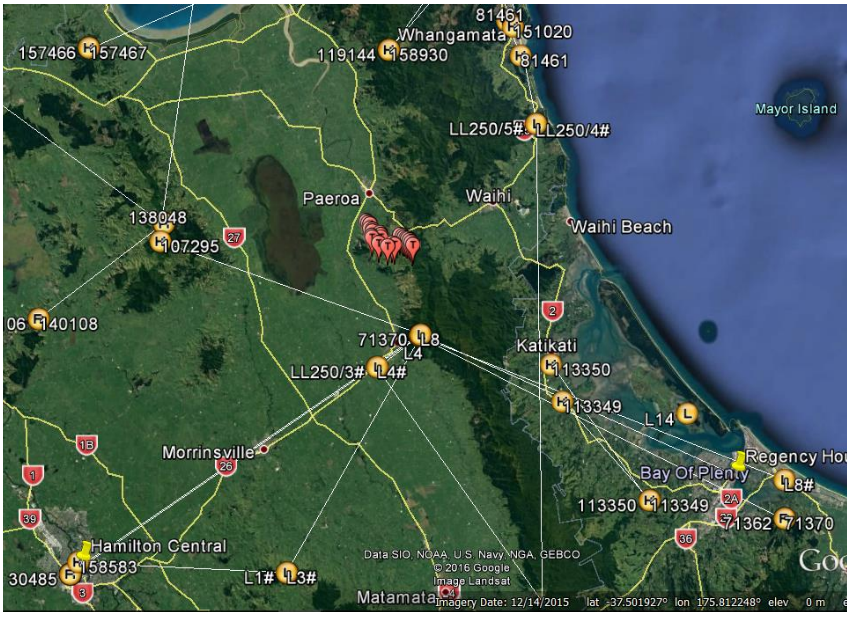


Figure 6 - Links 1 to 7GHz

It is in the midrange microwave frequencies, from 7GHz up to 13GHz, where three links are found to cross the windfarm, see figures 7 and 8. All three of these links emanate from the major radio installation on the top of Mt Te Aroha and track north to sites around Paeroa and Kopu.

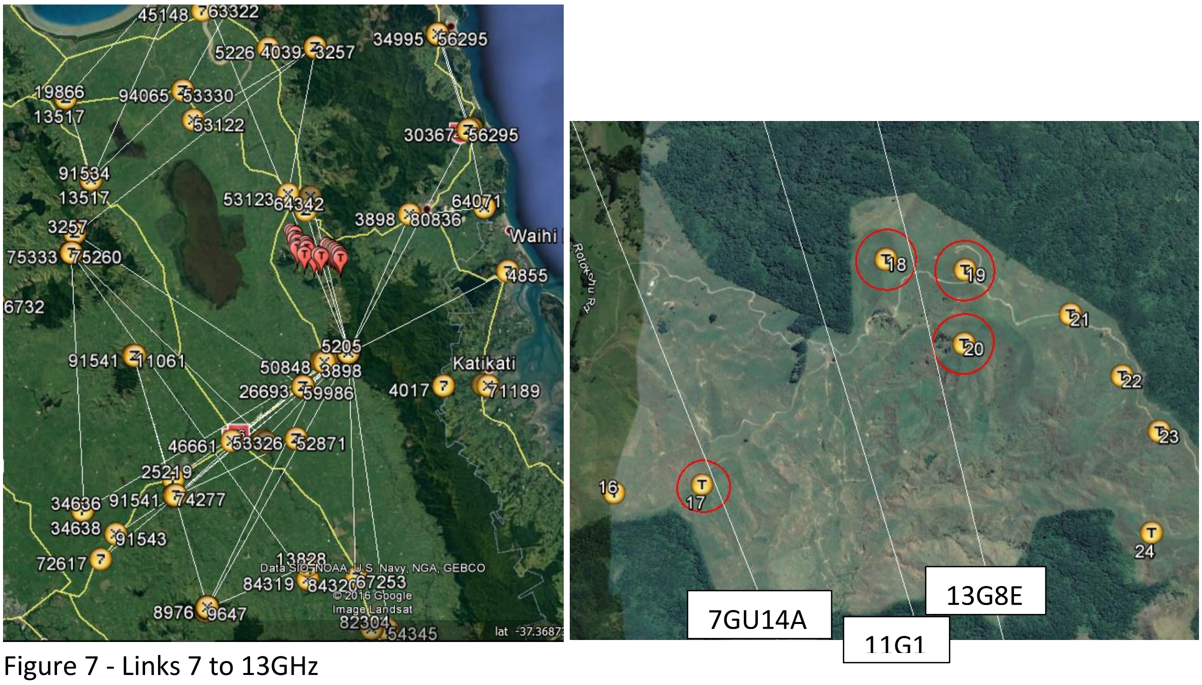


Figure 7 - Links 7 to 13GHz

Details for the three links that cross the windfarm are provided in the following table and path profiles for each link are included in Appendix B.

Radio Links Across the Windfarm:

Licencee	Channel	Terminal A	Terminal B
Kordia Limited	7GU14A	Mt Te Aroha	56 Kopu Road, Kopu
Kordia Limited	11G1	Mt Te Aroha	Silver Fern Factory, Waihi Rd, Paeroa
Vodafone NZ Limited	13G8E	Mt Te Aroha	Aorangi Road, Paeroa (cell site)

The link to the Silver Fern Farms Factory in Paeroa, marked as 11G1 in Figure 7, crosses the windfarm but appears to pass between wind turbine locations. The path profile for this link, see Appendix B, also shows the radio path (red line) to be passing above the area where the windfarm will be constructed, shown as the grey shaded section. The blue line in the path profile shows the first Frensel zone for this link, which is also shown to be well above the region of the windfarm. On this basis, the link to the Silver Fern Farms Factory is unlikely to be affected by the establishment of the windfarm.

In the case of Vodafone's link from Mt Te Aroha to their cell site at Aorangi Road near Paeroa, marked as 13G8E in Figure 7, the radio path passes much closer to two of the proposed wind turbine locations (turbine No18 & No20). Figure 8 shows the approximate radio path, which has been projected down to ground level (grey shading), allowing the height of the radio path above ground level to be visualised. The red cylinders depict a conservative buffer zone of 300m in diameter (twice the length of the turbine rotor) around the turbine locations, rising to a height of 200m above ground level.

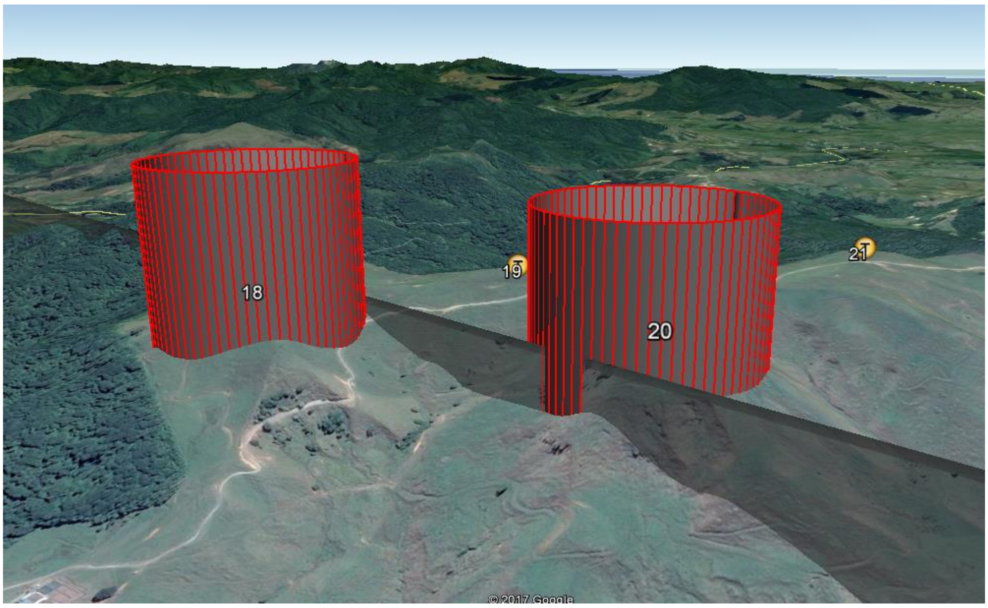


Figure 8a

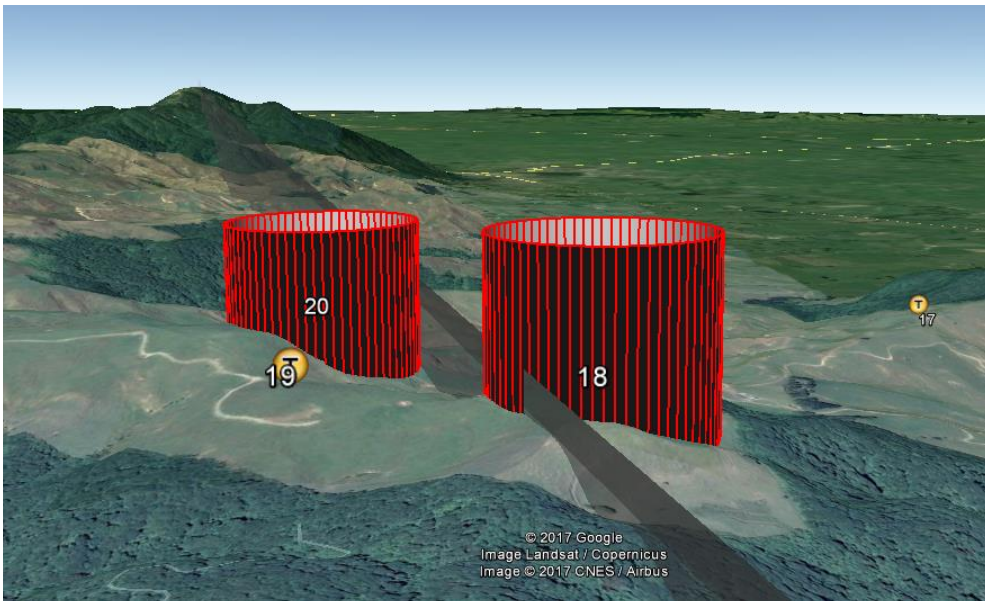


Figure 8b

Due to small inaccurancies in the coordinate data recorded on radio licences a physical survey would need to be carried out to assertain with a high level of confidence whether a wind turbine might obstruct this radio path. **Note: This is no longer required as Vodafone cancelled the licence for this microwave radio link in 2017 and hasn't replaced it with another radio link.** This reduces the number of microwave links, in the 7GHz up to 13GHz range, that cross the windfarm from three down to two.

The third fixed link that crosses the windfarm, runs from Mt Te Aroha to an industrial area in Kopu. Where it crosses the windfarm it appears to come close to a wind turbine location, but passes to the side of the closest turbine with slightly less than 100m of horizontal clearance. However, as this link is considerably longer than the other links and consequently isn't angled so steeply downwards from Mt Te Aroha, the radio path travels well above the windfarm, see Figure 9 and Appendix B.

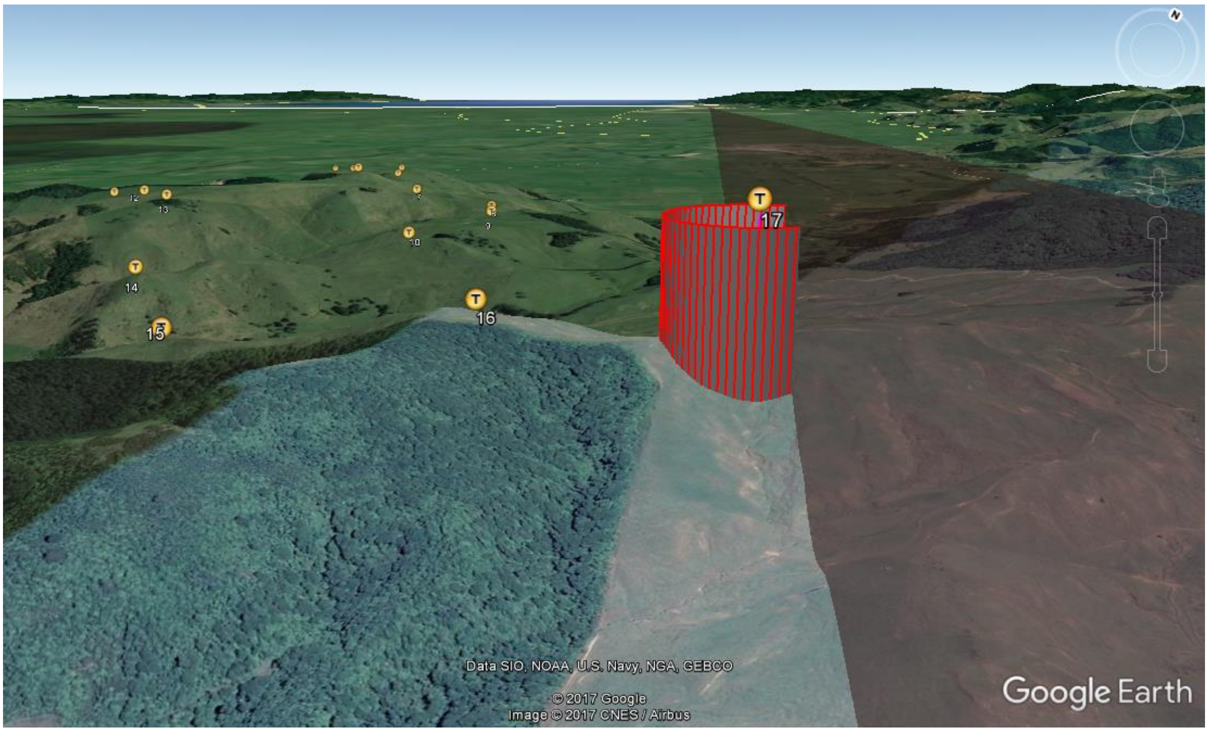


Figure 9

In Figure 9 the approximate radio path has been projected down to ground level (grey shading), allowing the height of the radio path above ground level to be visualised. The red cylinder depicts a conservative buffer zone of 272m in diameter (twice the length of the turbine rotor) around turbine No17's location, rising to a height of 180m above ground level. This would indicate that there is ample vertical clearance of Turbine No17 by the radio path and means this link is unlikely to be affected by the construction of the windfarm.

At the higher end of the microwave frequencies, from 18GHz and higher, the links are more susceptible to rain fade events and as a result tend to be used for shorter hops. In this case no microwave links in this range were found to cross the windfarm, see Figure 10.

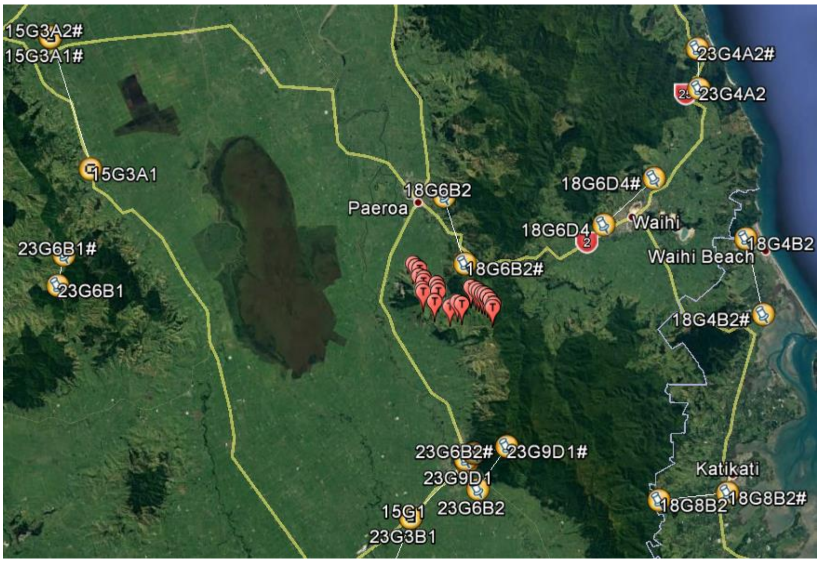


Figure 10 – Links 18GHz plus

Broadcast Services

Approximately 10kms from the proposed windfarm location, on the top of Mt Te Aroha, is the main terrestrial television transmitter for the Waikato and Hauraki regions, see Appendix C for a regional coverage map. With the windfarm being in a relatively narrow arc to the north of Mt Te Aroha, the possible shadowing effect of the wind turbines is contained to the area within the red lines shown in figure 10. Although only a very small part of the area within these red lines would be affected.

Figure 11 – TV Coverage from Mt Te Aroha

The extent of the area that would be in the shadow of the windfarm is greatly limited due to the windfarm being at a considerably lower altitude than the television transmitter on the top of Mt Te Aroha. This height difference means the shadow to the television coverage would be relatively short and only affect receivers immediately below the hill on which the wind turbines are situated.

Paeroa is the closest population centre within the red lines shown in figure 11, but as can be seen in path profile from Mt Te Aroha to Paeroa, included in Appendix B, the television signal travels well above the windfarm. This means that Paeroa will be well outside of the windfarms shadow for television reception and so will all locations to the north of Paeroa including Thames.

Television transmission now uses a digitally encoded signal that has the benefit of making the service more impervious to noise and interference issues. For previous analogue broadcast services reflected signals often resulted in an effect known as 'ghosting' where a second image was seen on the screen that was slightly offset to the first. These types of issues aren't generally a problem for digital services unless the reflected signal is very strong. Terrestrial television transmissions are also broadcast at a lower frequency than satellite delivered television services and so aren't as affected by rain fade issues. This means terrestrial receive signal levels, from transmitters like Te Aroha, tend to be more stable over time and require less of a fade marge to provide a reliable service.

Conclusion

Within the vicinity of the Kaimai Wind Farm, the single largest radio communications site is on the top of Mt Te Aroha at an elevation of 940 metres. This places the radio transmitters on Mt Te Aroha at a considerably greater elevation than the turbines for the wind farm. It is this height differential that would greatly minimises the effect of the windfarm on radio communications services emanating from Mt Te Aroha. This remains the case for the latest turbine size and height definitions as revised in May 2018.

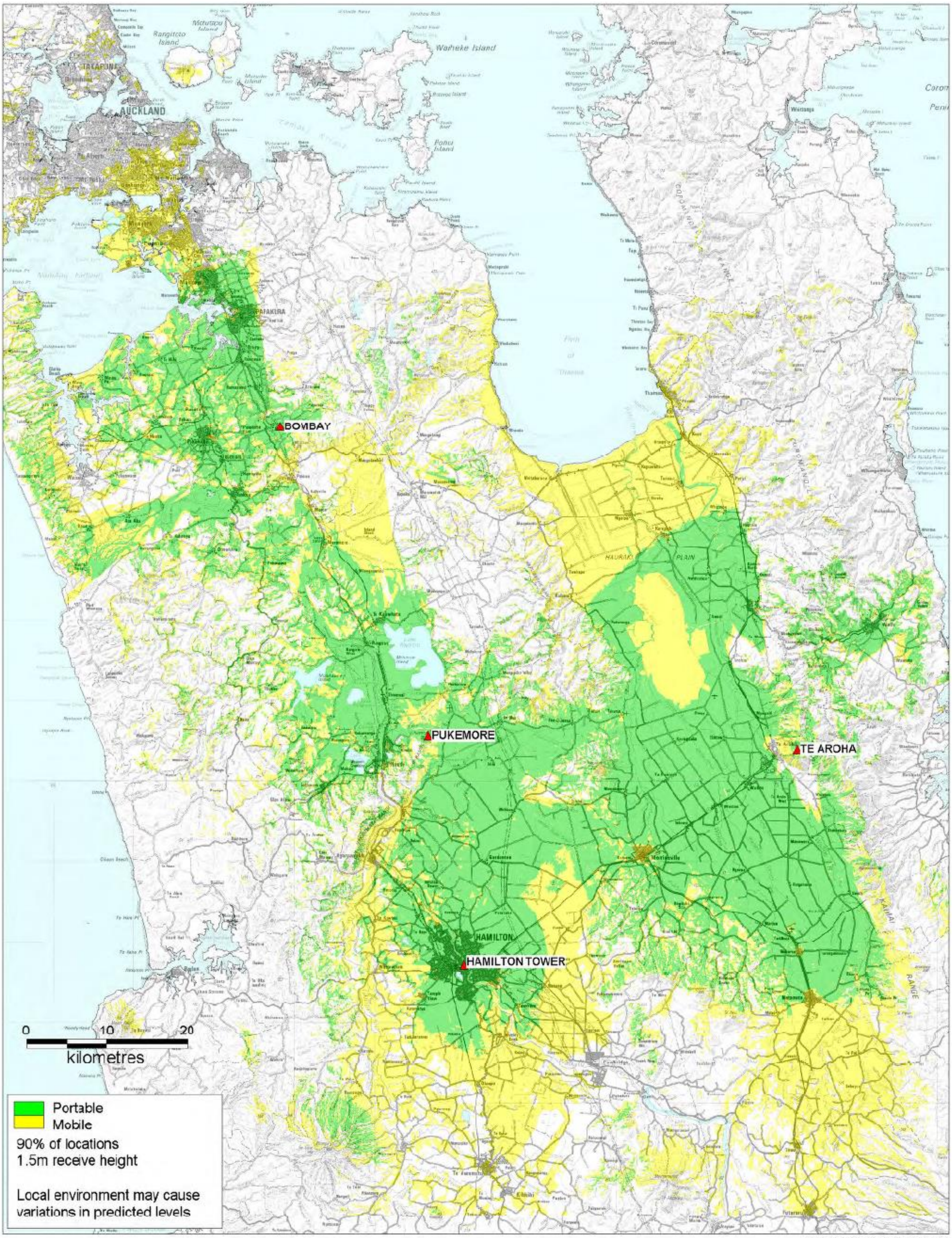
In the case of cellular services, the cellular base stations in the area of the wind farm are at an equivalent or lower elevation to the windfarm, but are situated close to main population centres and major highways and as such aren't generally obstructed by the windfarm. For State Highway 26 between Paeroa and Te Aroha which runs alongside the windfarm, the cellular providers have overlapping coverage from cell sites to the north and south, which will minimise any effects from the presence of the windfarm.

Given the windfarms location on the Kaimai Ranges separating the Waikato from the Bay of Plenty, there are a significant number of fixed point-to-point radio services in the area. However due to the wind farms relative position in relation to Mt Te Aroha, the major repeater site for fixed services, almost all fixed service don't cross the over the windfarm and will therefore be unaffected. The exception to this is for three links, that go between Mt Te Aroha and remotes site near Paeroa and Kopu. In the case of the Kopu link, the link is long enough that the elevation of the radio path passes well over the top of the windfarm and so will be unaffected. For one of the two Paeroa links an initial desktop analysis would indicate that the radio path for these two links will also pass between the wind turbine locations. It would still be avisable to to confirm this analysis through a physical line of sight check at the time of construction. The other Paeroa link has since been decommissioned and is therefor no longer an issue.

Mt Te Aroha is also the main terrestial television translator for the Waikato and northern Bay of Plenty. While the wind turbines might have a limited shadowing effect in a northerly direction from the windfarm, the significant height differential between the windfarm and Mt Te Aroha means this shadowing effect will be resticted to the immediate area below the hills where the windfarm is situated. The shadowing effect is unlikely to extend to the closest township to the north of the wind farm, being Paeroa where television reception should be largely unaffected. The relatively close proximity of Paeroa to Te Aroha means the area already has good coverage and diffraction of the television signals around the turbines should also help to mitigate the shadowing affect.

On balance the affect of the proposed wind farm on radio communications services in the area will be minimal and in most cases there will be no impact at all. It should also be recognised that some level of noise or interference is present in all terrestrial communication links due to the dynamic nature of the environement through which radio signals are propogated. As part of any good radio design, these factors should always be allow for to ensure a service meets an acceptable level of reliability. In almost all cases, the establishment of the wind farm should not significantly change the radio environment to such an extent that existing radio services can't accommodate the change. Only those services that are directly obstructed by the wind turbines might experience any noticable affects and from the analysis completed as part of this report, there are few if not any links that are obstructed in this way.

Appendix A – Kordia (Korkor) Mobile Radio Coverage



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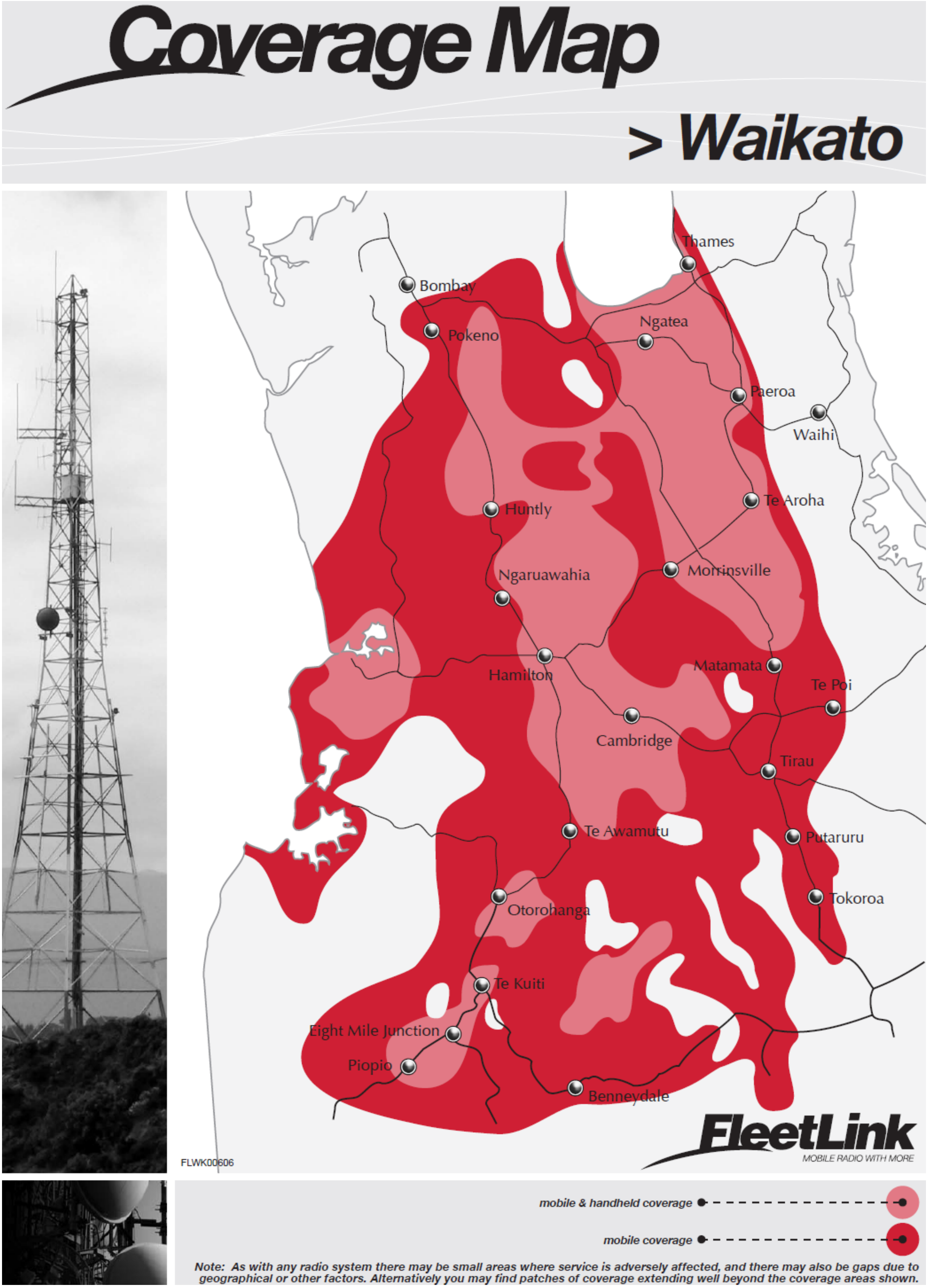
Run By: J Hills

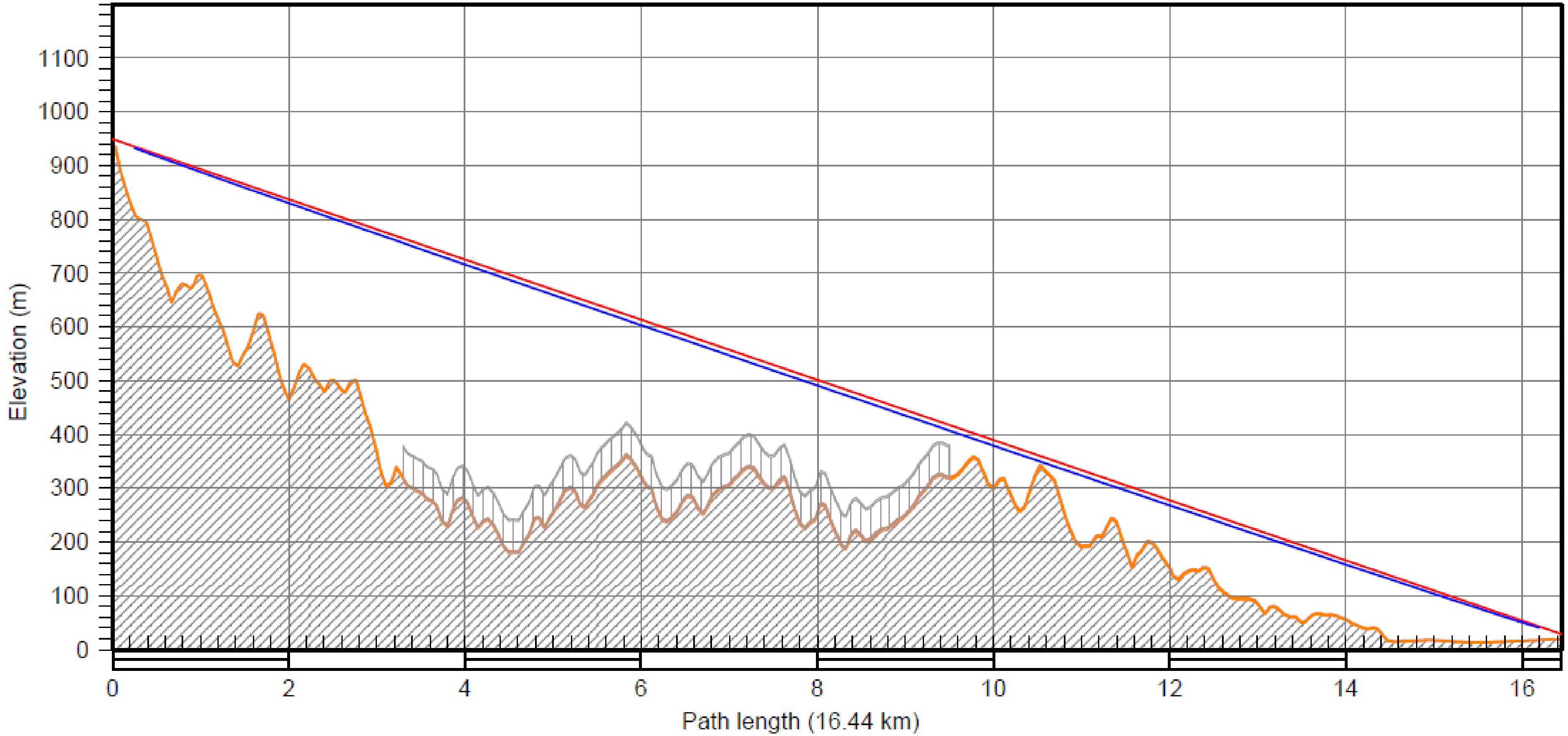
kordia

KorKor Coverage
Waikato

Appendix A – Teamtalk (Fleetlink) Mobile Radio Coverage



Appendix B – Radio Path Profiles: Mt Te Aroha to Silver Fern Farms Paeroa



Mt Te Aroha

Latitude	37 32 08.73 S
Longitude	175 44 29.77 E
Azimuth	343.08°
Elevation	939 m ASL
Antenna CL	10.0 m AGL

Frequency (MHz) = 11000.0
K = 1.33
%F1 = 100.00

Lambda Communications Ltd

Silver Fern Paeroa

Latitude	37 23 38.39 S
Longitude	175 41 15.24 E
Azimuth	163.12°
Elevation	19 m ASL
Antenna CL	10.0 m AGL

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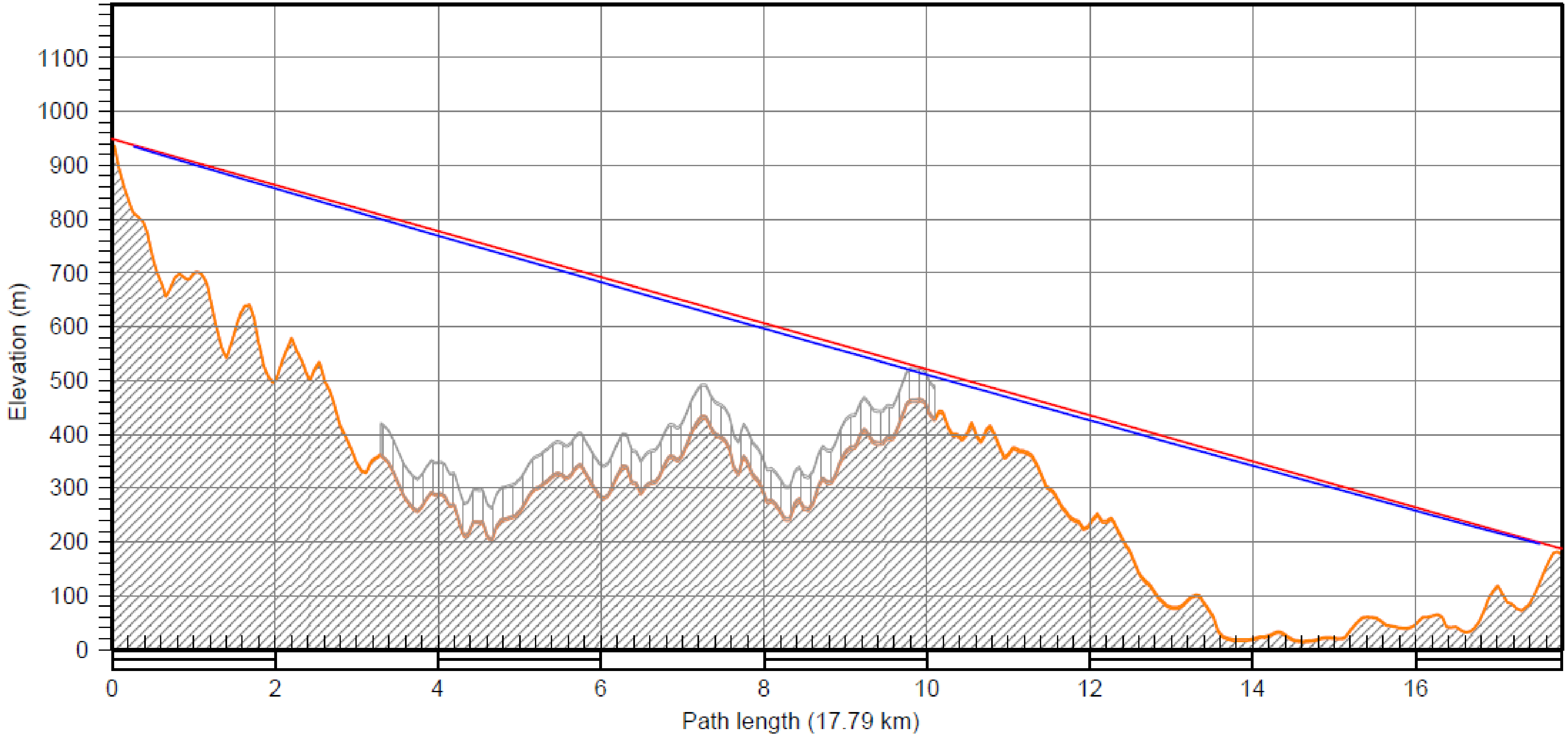
Appendix B – Radio Path Profiles: Mt Te Aroha to Aorangi Road Cell Site



Mt Te Aroha	
Latitude	37 32 08.73 S
Longitude	175 44 29.77 E
Azimuth	346.10°
Elevation	939 m ASL
Antenna CL	10.0 m AGL

Frequency (MHz) = 13000.0
K = 1.33
%F1 = 100.00

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Aorangi Rd Paeroa	
Latitude	37 22 48.55 S
Longitude	175 41 36.12 E
Azimuth	166.13°
Elevation	177 m ASL
Antenna CL	10.0 m AGL

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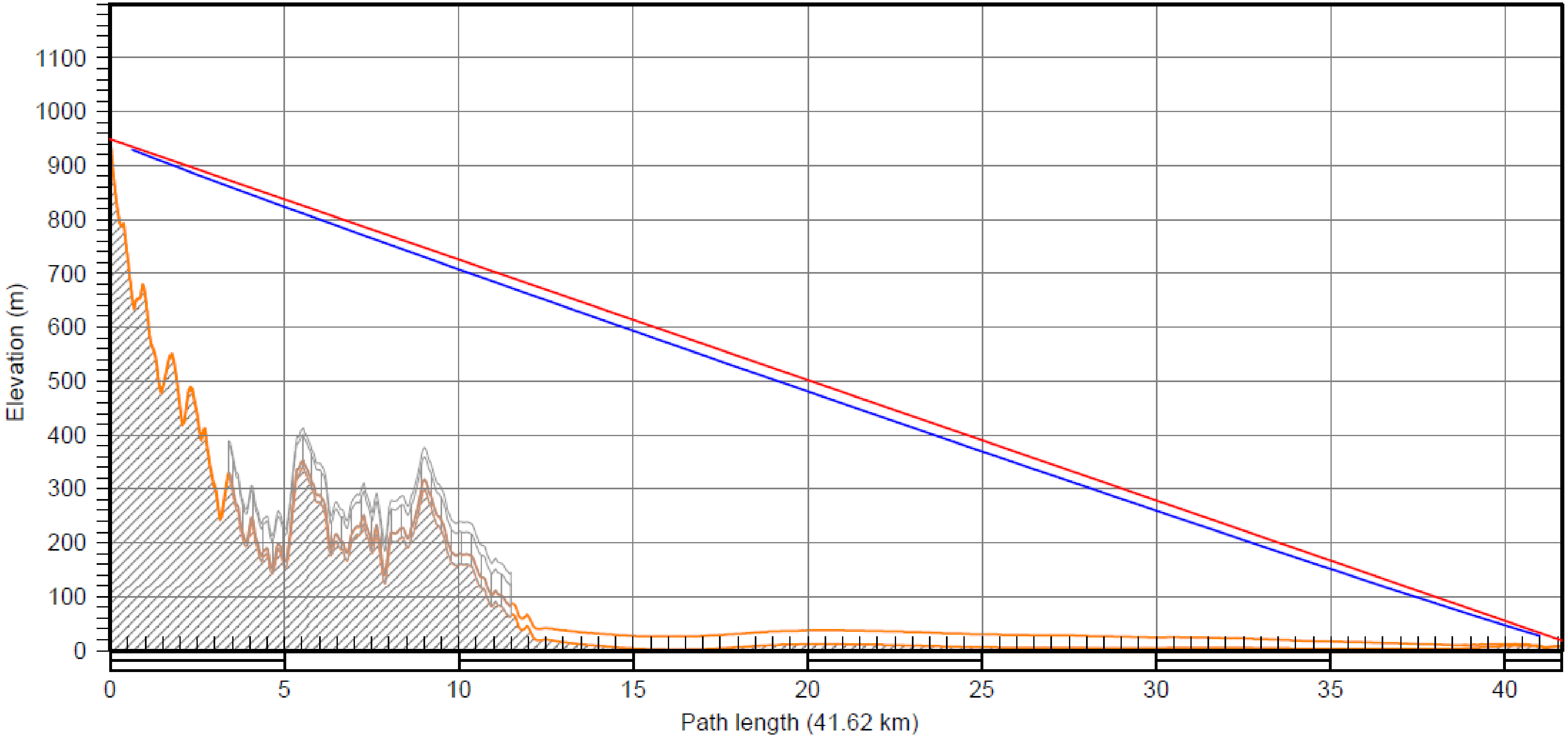
Appendix B – Radio Path Profiles: Mt Te Aroha to 56 Kopu Road, Kopu



Mt Te Aroha	
Latitude	37 32 08.73 S
Longitude	175 44 29.77 E
Azimuth	337.92°
Elevation	939 m ASL
Antenna CL	10.0 m AGL

Frequency (MHz) = 7000.0
K = 1.33
%F1 = 100.00

Lambda Communications Ltd

56 Kopu Road Kopu	
Latitude	37 11 17.40 S
Longitude	175 33 55.44 E
Azimuth	158.02°
Elevation	9 m ASL
Antenna CL	10.0 m AGL

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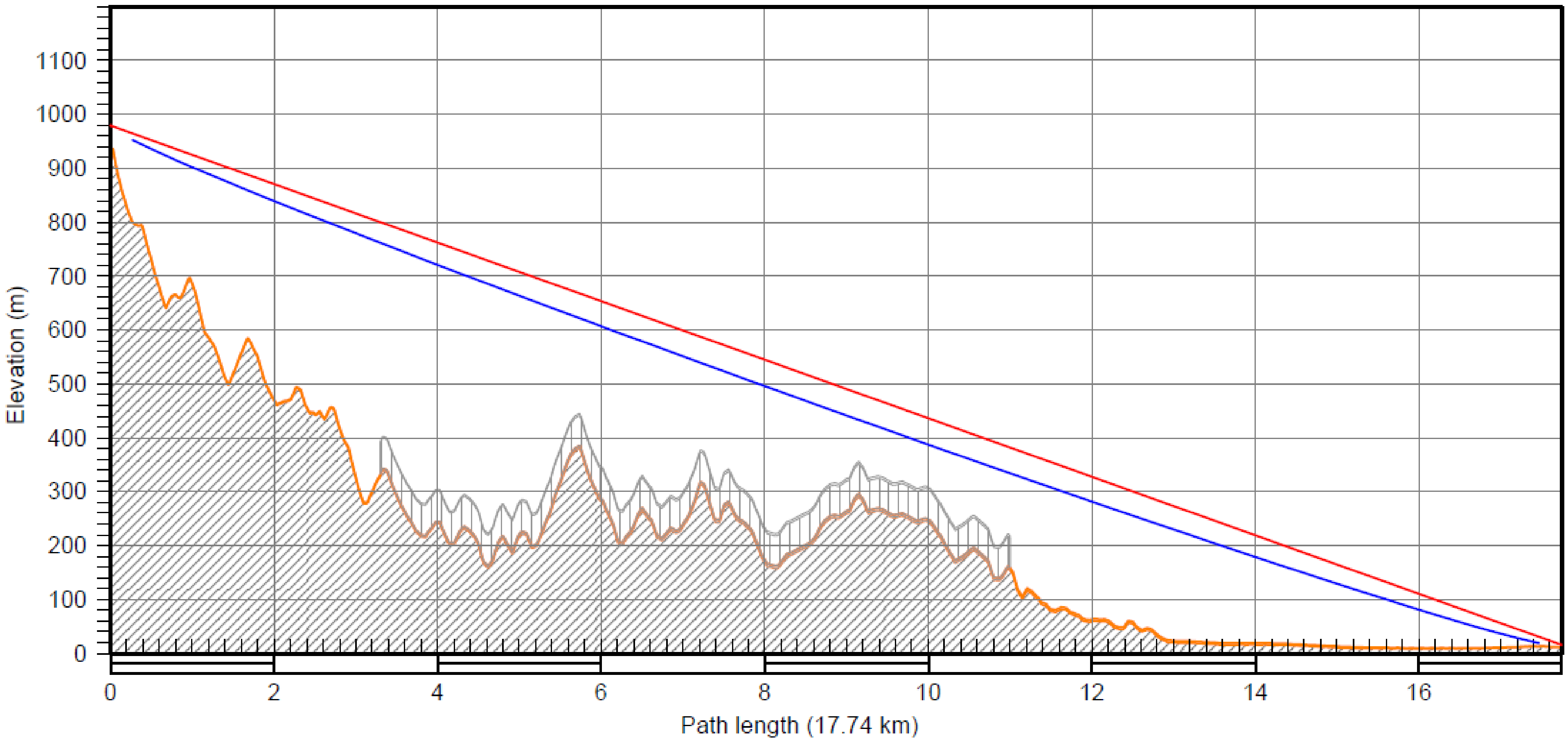
Appendix B - Television Broadcast Path Profile: Mt Te Aroha to Paeroa



Mt Te Aroha	
Latitude	37 32 08.73 S
Longitude	175 44 29.77 E
Azimuth	340.58°
Elevation	939 m ASL
Antenna CL	40.0 m AGL

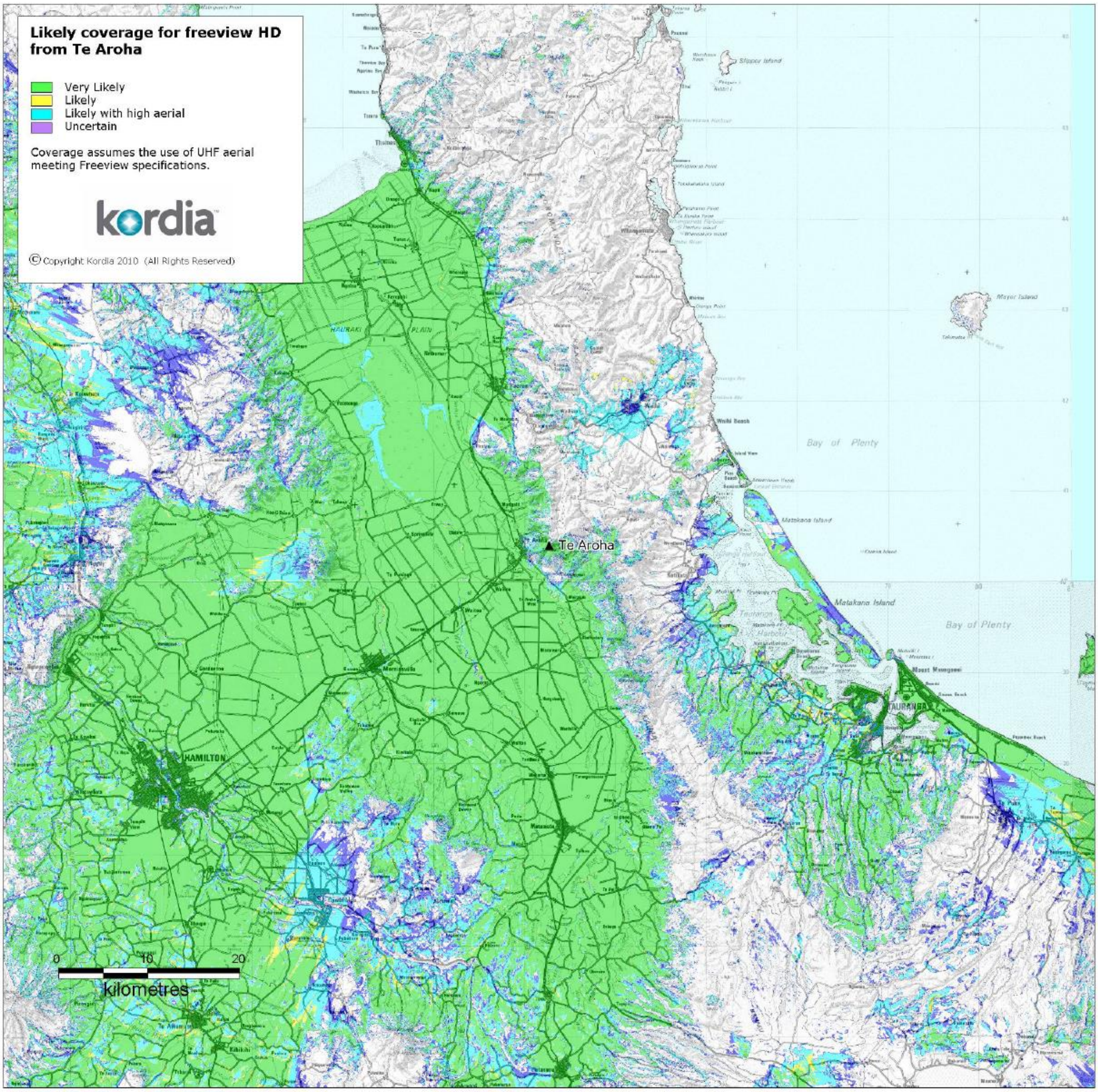
Frequency (MHz) = 550.0
K = 1.33
%F1 = 100.00

Lambda Communications Ltd

Paeroa	
Latitude	37 23 06.00 S
Longitude	175 40 30.00 E
Azimuth	160.62°
Elevation	11 m ASL
Antenna CL	5.0 m AGL

	Nov 30 16	

Appendix C – Freeview Television Coverage from Mt Te Aroha



Appendix C – Digital Television: Terrestrial Channel Allocation

Digital Television Channel Usage Table

Version: Janaury 2016

The information in this chart was taken based on licences as of 14 January 2016.
For up to date information, please refer to the Register of Radio Frequencies on the Radio Spectrum Website (www.rsm.govt.nz/smart).

	Channel		DTV25	DTV26	DTV27	DTV28	DTV29	DTV30	DTV31	DTV32	DTV33	DTV34	DTV35	DTV36	DTV37	DTV38	DTV39
	Frequency (MHz)		502-510	510-518	518-526	526-534	534-542	542-550	550-558	558-566	566-574	574-582	582-590	590-598	598-606	606-614	614-622
	Manager / Location & Pol			Crown Spectrum Management Right												Te Pūtahi Paoho	
Whangarei	Parahaki	V				WTV		Sky		MWTV		TVNZ		JDA		MTS	
Auckland	Waiatarua	H			Kordia		TVNZ		Sky		MWTV		WTV		Kordia		MTS
	Skytower	V				TVNZ		Sky		MWTV		WTV		Kordia		MTS	
	Waiheke	V				TVNZ		Sky		MWTV		WTV		Kordia		MTS	
	Remuera	V		Kordia		TVNZ		Sky		MWTV		WTV		Kordia		MTS	
	Pinehill	H		N.Jang	Kordia	TVNZ		Sky		MWTV		WTV		Kordia		MTS	
Waikato	Te Aroha	H				WTV		Sky		MWTV		TVNZ		Kordia		MTS	
	Hamilton	V					WTV		Sky		MWTV		TVNZ		Kordia		MTS
Tauranga	Kopukairua	V					WTV		Sky		MWTV		TVNZ		Kordia		MTS
Rotorua	Pukepoto	V			JDA		WTV		Sky		MWTV		TVNZ		JDA		MTS
Taupo	Whakaroa	V					WTV		Sky		MWTV		TVNZ		JDA		MTS
Gisborne	Parikanapa	H				WTV		Sky		MWTV		TVNZ		JDA		MTS	
	Wheatstone Rd	H					WTV		Sky		MWTV		TVNZ		JDA		MTS
New Plymouth	Mt Taranaki	H				WTV		Sky		MWTV		TVNZ		Kordia		MTS	
Wanganui	Mt Jowett	H					WTV		Sky		MWTV		TVNZ		JDA		MTS
Hawkes Bay	Mt Erin	V			Sh'view		WTV		Sky		MWTV		TVNZ		Kordia		MTS
	Napier Airport	V				WTV		Sky		MWTV		TVNZ		Kordia		MTS	
Palmerston Nth	Wharite	V				WTV		Sky		MWTV		TVNZ		Kordia		MTS	
Kapiti	Ngarara	V					WTV		Sky		MWTV		TVNZ		Kordia		MTS
Masterton	Popoiti	H					WTV		Sky		MWTV		TVNZ		JDA		MTS
Wellington	Kaukau	H				WTV		Sky		MWTV		TVNZ		Kordia		MTS	
	Fitzherbert	V					WTV		Sky		MWTV		TVNZ		Kordia		MTS
	Haywards	V					WTV		Sky		MWTV		TVNZ		Kordia		MTS
	Baxters Knob	H					WTV		Sky		MWTV		TVNZ		Kordia		MTS
Nelson	Botanical Ridge	H		NMB		WTV		Sky		MWTV		TVNZ		JDA		MTS	
	Mt Campbell	V			NMB		WTV		Sky		MWTV		TVNZ		JDA		MTS
Christchurch	Sugarloaf	H				WTV		Sky		MWTV		TVNZ		Kordia		MTS	
Timaru	Cave Hill	V					WTV		Sky		MWTV		TVNZ		JDA		MTS
Oamaru	Cape Wanbrow	V										45 South					
Dunedin	Mt Cargill	H				WTV		Sky		MWTV		TVNZ		Kordia		MTS	
Invercargill	Forest Hill	V				WTV		Sky		MWTV		TVNZ		JDA		MTS	
	Channel		DTV25	DTV26	DTV27	DTV28	DTV29	DTV30	DTV31	DTV32	DTV33	DTV34	DTV35	DTV36	DTV37	DTV38	DTV39

KEY TO COLOUR CODING

Blue	In use digital licence for Freeview NZ (Unencrypted, DVB signal).
Purple	In use digital licence for Sky TV (Encrypted, DVB-T2 signal).
Green	Digital licence likely to be utilised in 2016.
Orange	Local area DTT licence at an alternative site.
Yellow	Local area DTT licence
Green dotted	New TPP/MTS channels. Potential licences are indicative only
Grey dotted	Guard band, not in Management Right.

DTV channels 40-48 (622 - 694 MHz) are allocated for DTV in NZ but assignment is subject to future Cabinet decisions and they are not currently available for licencing.