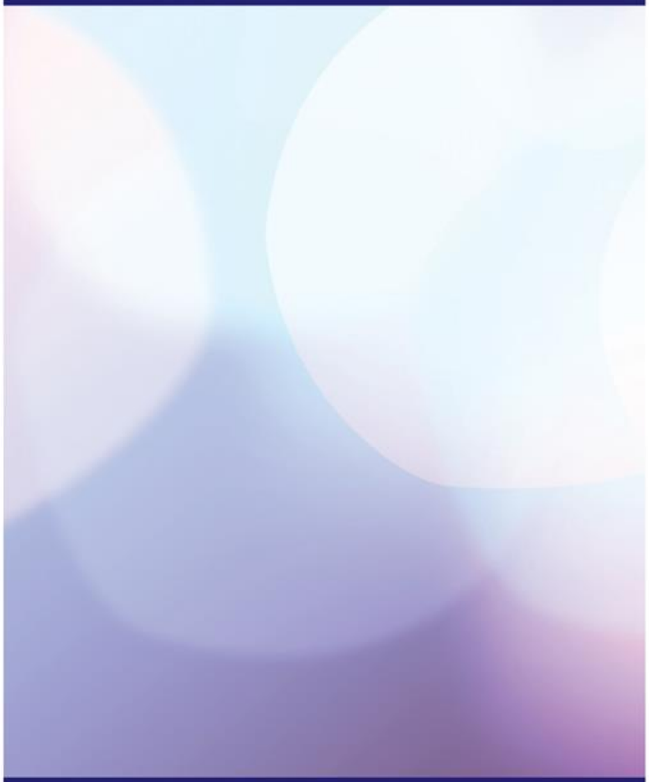

Report for Chorus

UCLL and UBA FPP draft determination submission – PUBLIC

20 February 2015

Ref: 2002396-81

www.analysysmason.com

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1 Introduction

On 2 December 2014, the Commerce Commission published the draft determination for its final pricing principles (FPP)[1] for the unbundled bitstream access (UBA) service and the unbundled copper local loop (UCLL) service.

Analysys Mason has been commissioned by Chorus to review and comment on the draft model and documentation underlying this draft determination. This report provides a summary of our investigations into several different aspects of the determination and is set out as follows:

- Section 1.1 summarises the documents that we have reviewed as part of our investigations
- Section 2 addresses to the modelled access networks
- Section 3 comments on the build parameters and costs assumed in the model
- Section 4 sets out our findings in relation to the UBA model
- Section 5 provides our thoughts on opex and non-network costs.
- Section 6 provides findings on the FWA modelling used as part of the FTTH model

Data that is confidential (i.e. can only be read by those who have signed the confidentiality undertakings) has been indicated by the scissor symbol '✂' and has been deleted in the PUBLIC version.

1.1 Reference documents

Figure 1.1 below summarises the list of the documents that we will refer to in this report. All of these documents are available on the Commerce Commission's website. We provide a short name for each document, which we will use to refer to it throughout the report for simplicity.

Figure 1.1: Documents referred to in this report [Source: Analysys Mason, 2015]

Title	Short name	URL
Model Specification (public version)	Model specification	http://www.comcom.govt.nz/dmsdocument/12785
Model Reference Paper (public version)	Reference paper	http://www.comcom.govt.nz/dmsdocument/12777
Model Documentation (public version)	Model documentation	http://www.comcom.govt.nz/dmsdocument/12784
Draft model presentation	Model presentation	http://www.comcom.govt.nz/dmsdocument/12794
Draft FPP briefing presentation	Commission briefing	http://www.comcom.govt.nz/dmsdocument/12787
Draft pricing review determination for Chorus'	UCLL draft determination	http://www.comcom.govt.nz/dmsdocument/12771

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[1] http://www.comcom.govt.nz/regulated-industries/telecommunications/regulated-services/standard-terms-determinations/unbundled-copper-local-loop-and-unbundled-bitstream-access-services-final-pricing-principle/

unbundled copper local loop service		
Draft pricing review determination for Chorus' unbundled bitsream access service	UBA draft determination	http://www.comcom.govt.nz/dmsdocument/12786
Beca FPP Corridor Analysis Full Report	Beca report	http://www.comcom.govt.nz/dmsdocument/12783

Figure 1.2 below summarises the list of modelling-related materials referred to in this report. We provided a short name for each of the Excel files as well, which we will use to refer to these files as well. We will be referring to the Excel files with the short names provided in the list below. Analysys Mason also has access to the confidential versions of these Excel files, but we refer to the public versions unless we state otherwise.

Figure 1.2: List of modelling materials referred to in this report [Source: Analysys Mason, 2015]

Title	Short name	URL
PUBLIC_Commission - Access network - v7.0.mdb	(Public) Access database	https://login.filecloud.co.nz/shares/folder/32248963d1ab3a/
PUBLIC_Commission - Access network cost model - v7.3.xlsb	(Public) Access model	As above
PUBLIC_Commission - Inputs for trenches - v5.0.xlsb	(Public) Trench inputs file	As above
PUBLIC_Commission - UBA model v5.1.xlsb	(Public) UBA model	As above
Public_TSO_Cluster_Polygons.zip	(Public) TSO polygons	As above
BECA Corridor Cost Analysis for Trenching Rates.xlsx	(Public) Beca trench cost analysis	http://www.comcom.govt.nz/dmsdocument/12806

All of the Excel files referred to in this report are used in the calculation of the costs of UBA and UCLL services. The flow of information between the files is illustrated below in Figure 1.3.

In particular, we also show the opex file which is only available as a confidential file.

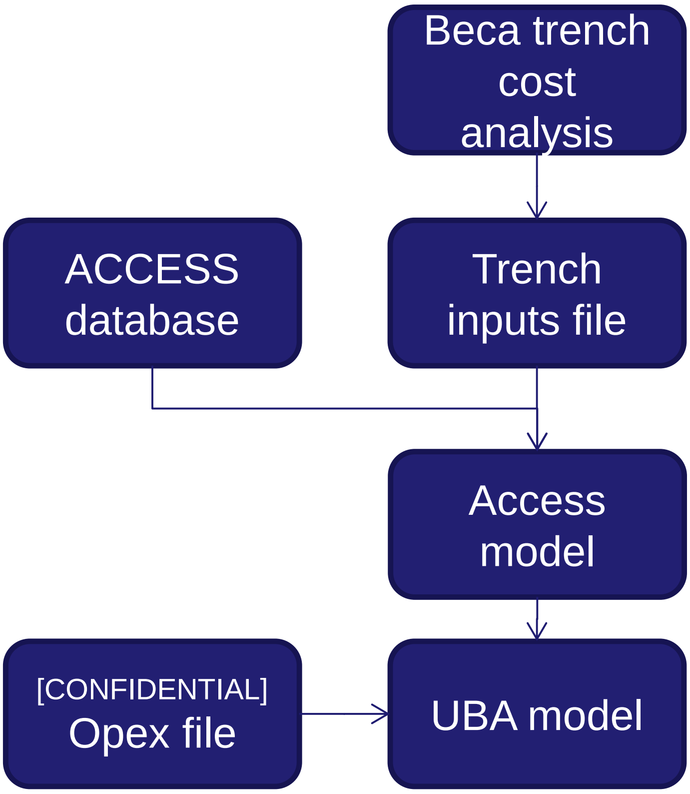

Figure 1.3: Flow of cost calculations in the draft model [Source: Analysys Mason, 2015]

The Beca trench cost analysis file provides the unit cost of trenching for each soil category used in the draft model. The outputs of the Beca trench cost analysis are used in the trench inputs file, which estimates the unit cost of trenching for each ESA. The Access database, which uses a combination of queries and Visual Basic for Applications (VBA) subroutines, calculates the asset counts of all the modelled access networks based on the geographic data (obtained from Chorus/CoreLogic and then pre-processed). The outputs of both the trench input file and Access database are used in the Access model, which calculates the investment and the annual cost of the modelled access networks. The outputs of the Access model feeds into the UBA model that calculates the final unit costs of UCLL and UBA services.

2 Investigations related to the modelled access networks

2.1 Treatment of the TSO area

The model does not include the costs of some of the road sections required to connect the buildings served within TSO polygons back to their parent exchange location. The approach used therefore does not connect the TSO locations together: they are left as a set of unconnected "islands". In other words, the modelled network would not provide UCLL because a connection at the MDF would not be able to reach the desired end customer in the TSO polygons.

The Access database should be modified so that all required road sections needed to connect buildings within the TSO polygons to the parent exchange location are included.

The Access database currently excludes the access network assets for any parts of the access network that are outside of the TSO-derived boundary[2]. Every road section is flagged whether or not it is in a TSO-derived boundary in the SOURCE_SECTIONS table in the Access database. We understand that these flags were derived using TSO boundaries (about which we comment in section 2.13) derived from data about the extent of Telecom New Zealand's network in December 2001[3]. Historic customer locations were grouped into clusters forming convex polygons and it was assumed that each road segment with at least 50% of its length falling within these convex polygons was defined as being within the TSO-derived boundary[4].

Analysis

Figure 2.1 below illustrates the specific case of the RNU exchange. In this ESA, the exchange location lies outside the TSO polygons, as are all of the road sections close to the exchange. In the Commissions draft model these road sections will be excluded from the access network asset counts as well.

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[2] Model documentation, Page 75

[3] Model reference paper, Page 78

[4] Reference Paper, Page 78

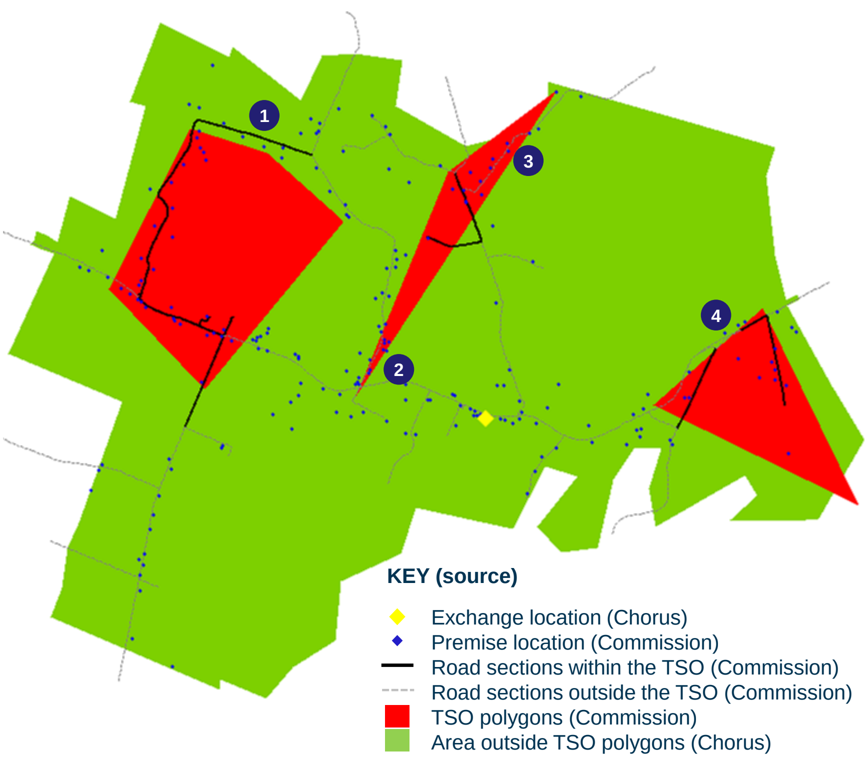

Figure 2.1: Illustration of the RNU exchange location lying outside the TSO-derived boundary [Source: Commission and Chorus data, 2015]

Figure 2.1 highlights several shortcomings in the approach taken. There are cases where:

- Buildings outside the TSO polygon are included since enough of the road section lies within the polygon (1 above)
- Buildings inside the TSO polygon are excluded since not enough of the road section lies within the polygon (2 and 3 above)
- Road sections within a cluster are disconnected (4 above).

In addition to these shortcomings a material issue is that the cable path for those premises within the TSO polygons must go through road sections outside of the TSO polygons to reach the exchange location. For the case of RNU shown above, this is true for all three TSO polygons. The approach does not connect the TSO locations together: they are left as a set of unconnected “islands”. The approach should instead be modified to include all those parts of the access network that are required to serve the premises lying within the TSO-derived boundaries.

In the example shown in Figure 2.1, 75% of the road sections in RNU are excluded in the draft model. However, very many of these road sections must have had network which existed in 2001 to serve the polygons as defined (see section 2.13 for a discussion of whether the polygons are accurate).

We therefore find that the Access model is not dimensioning a network capable of serving the points required.

Recommendation

As a minimum, the Access database should be refined so that any road section that is needed to connect a road section within the TSO polygons to the parent exchange location is also included.

Since the path for each road section back to its parent cabinet/MDF has been pre-calculated using the shortest path algorithm in the Access database[5], then the set of additional relevant road sections can be derived directly.

Based on our own analysis of the Access database, we believe that this amounts to more than 10,000 road sections with a total length in excess of 10 000 kilometres, a material omission. More than 90% of this length is to be found within ESAs flagged in the Access model as “Urban”.

2.2 Treatment of capital contributions as reducing the investment in specific assets means these contributions are modelled with the wrong lifetime

The Commission treats specific capital contributions as a deduction of the capital costs for specific assets (for example, the RBI DSLAMs). By doing this the Commission is ascribing the same lifetime to the capital contributions as the equipment they are assumed to buy. The issue is that, at the end of this equipment’s lifetime,

- either the Commission is assuming that there would be another capital contribution to replace the same assets (which we believe is unrealistic),
- or the Commission is assuming that the future wholesale price will increase (in this specific example, the replacement DSLAMs will need to be funded). A price for the wholesale service which was lowered and then raised in this way would be very likely to impose inefficient costs (it means that marginal customers will first sign up and then later churn away).

This effect is particularly problematic for assets with a short lifetime.

A superior approach (if there is to be a capital contribution modelled) is to treat it as an asset with a negative capital cost and its own lifetime (we suggest 20 years as a minimum).

2.3 Modelling of road width and lead-ins

An additional lead-in distance is required to reach from the edge of the metalled road surface to the edge of the property boundary. This would add to the current values of “vertical length” in the Access database.

This vertical length should also be increased to reflect the indirect routes taken by lead-ins, such as those constructed for the rights-of-way (RoW) properties that are prevalent in New Zealand.

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[5] See tables SOURCE_DETAILED_MDF_BUILD_PATHS (fibre), SOURCE_DETAILED_MDF_SC_PATHS (copper) and SOURCE_DETAILED_SC_BUILDINGS_PATHS (copper) in the Access database

Analysis

In the Access database, each building is assigned a value in the VERTICAL_LENGTH field in the table SOURCE BUILDINGS. This value is said to correspond to "the vertical part of the lead-in from the building to the road frontage boundary"[6]. We understand the road frontage was derived from the Land Information New Zealand (LINZ) Primary Road Parcels dataset[7]. We understand that the calculation of this vertical length was then undertaken in two steps:

- In 609,000 cases, where footprints for the building could be determined (from council datasets or council web services), the shortest distance between the building footprint and the road frontage was calculated.
- In the remaining cases, where the building footprint was not available, the location of the address point sourced from CoreLogic was used to define the building location. The straight-line length from the address point to the road frontage (X) was then calculated, In order to estimate the vertical length, the average distance (8.3 metres) from the address point to the edge of the building was calculated for those cases above where the building footprints were available. The vertical length for the building was then assumed to be X–8.3 metres.

This is summarised in the diagram provided by the Commission shown in Figure 2.2 below. In particular, the dotted grey lines represent "X" for each building, the 8.3 metre adjustment is represented by the brown arrow labelled "Average distance deducted" and the green arrows represent the final vertical length calculated.

---

[6] Response to Question ID 39 in the Commission's Excel file "FPP Draft TSLRIC Model Questions"

[7] https://data.linz.govt.nz/layer/796-nz-primary-road-parcels/

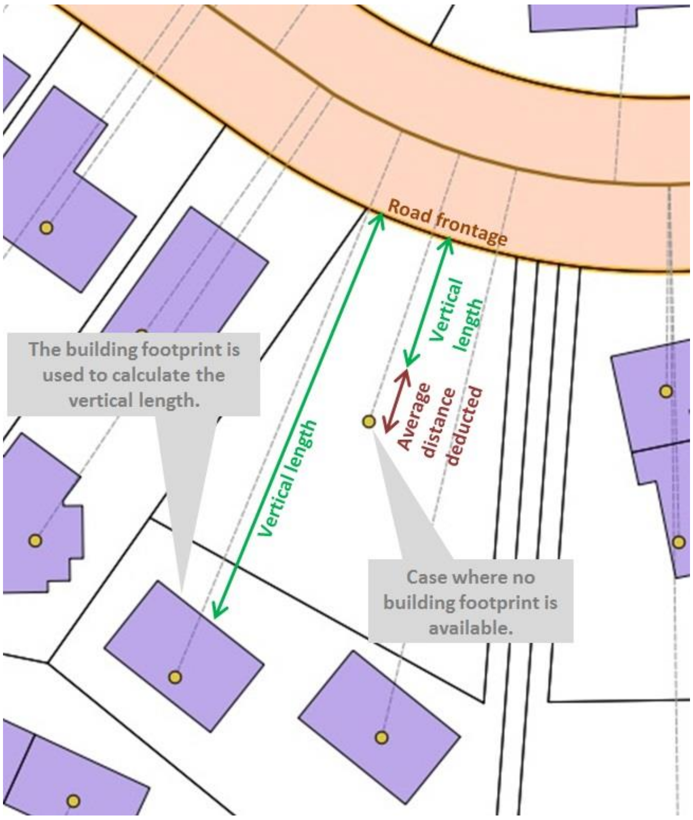


Figure 2.2: Illustration of calculation of road widths [Source: Commission, 2015]

We believe there are two significant shortcomings in this approach, which we believe are significantly understating this vertical length. These are the road width data used and the use of straight-line lead-in distances. We describe both shortcomings in turn below.

- *Road width assumptions*

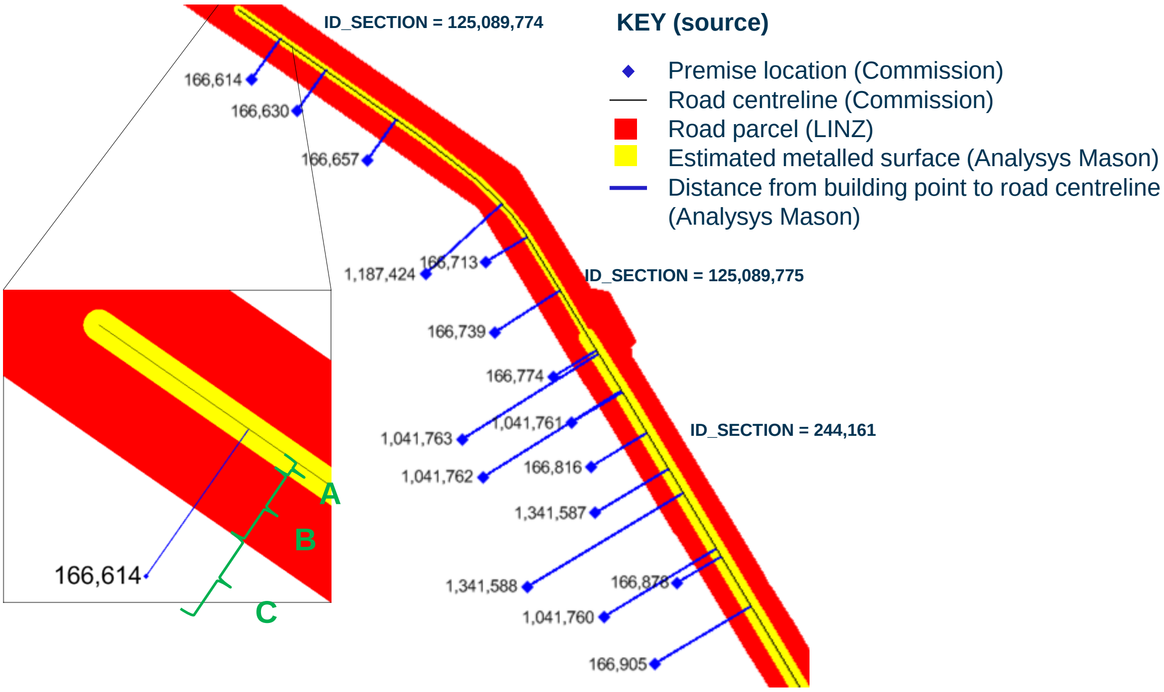
The Commission have further clarified that the "ROAD_WIDTH" value in the SOURCE SECTIONS table is the width of the metalled surface i.e. the estimated physical width of the road carriageway based on the number of lanes stated in the Corelogic datasets with an average width of 3.75 metres per lane[8].

The problem is that the draft model estimates the length of the lead-ins between the edge of the building and the edge of the property boundary, but the Access database assumes that trench runs alongside the edge of the metalled surface of the road, with road crossings periodically deployed across the metalled surface of the road. Therefore, the network between the edge of the metalled surface of the road and the edge of the property boundary is missing. In other words we expect this missing network will in many cases be the width of the road verge and footpath, where present. We have illustrated this for an example area in Waitara (for 16 buildings) below.

---

[8] Response to Question ID 59 in the Commission's Excel file "FPP Draft TSLRIC Model Questions"

Figure 2.3: Illustration of missing lead-in assets in the draft model (each building labelled with its ID_BUILDING) [Source: Analysys Mason, 2015]



For each of the buildings above, the distance from the building point to the road centreline is represented by the blue line, which can be split into three parts:

- The part shown as overlapping with the yellow areas (A) i.e. on the metalled road surface to the road centreline
- The part shown as overlapping with the red areas (B) i.e. between the metalled road surface and the edge of the road parcel
- The remainder (C) i.e. between the building (either the edge of the building footprint or the building location) and the edge of the road parcel.

The draft model uses a vertical length for each building calculated as the component C (with a reduction of 8.3 metres where the building footprint is unavailable). The road width in the draft model (for the purposes of dimensioning road crossings) is assumed to be 2×A.

However, this road width implies that the major and minor trenches lie along the edge of the yellow area, whereas their lead-in terminates on the edge of the red area. There is therefore no lead-in captured within the red area (component B), meaning that the lead-ins cannot reach the distribution network. This distance B therefore needs to be added for all lead-ins.

► *Use of straight-line distance*

The draft model assumes straight-line lead-ins, whereas in reality obstacles cause a longer lead-in to be required. It can be seen as necessary in the Commission’s own example diagram (shown in Figure 2.2 above), where two of the buildings at the bottom of the diagram are accessed by a narrow right of way along the edge of another property. Their lead-ins are very likely to follow this angled route rather than the illustrated straight line across the intervening property which may well intersect the building[9].

This real-life effect has been captured (directly or indirectly) in other cost models. In particular, the versions of the fibre access network cost model developed by the Danish regulator in 2011 (supported by Analysys Mason[10]) and 2014 (supported by TERA[11]) include such an uplift (15% and 20% respectively). Both versions of the model, although they used different methodologies, used building outlines, road centrelines and property boundaries as their raw data, just as the Commission's draft model employs.

Recommendation

Additional lead-in distance ("vertical length") is needed to reach from the edge of the metalled road surface to the edge of the property boundary. This can be quantified in the following way:

- Using the GIS, create a "buffer" (i.e. a locus) around each road section, with the radius of the buffer equal to half of the road width corresponding to that road section (this will generate a dataset of "new road parcels", which are equivalent to the metalled surface)
- To calculate the vertical length for the 609,000 buildings where the footprint is available, calculate the straight-line distance between the edge of the building footprint and its corresponding "new road parcel"
- To calculate the vertical length for the remaining buildings, calculate the straight-line distance between the CoreLogic building location and its corresponding "new road parcel" and subtract 8.3 metres
- To account for the non-straight nature of lead-ins, apply an uplift to all these vertical lengths (we would suggest 15% based on the models employed in Denmark)
- Update the VERTICAL_LENGTH column of SOURCE BUILDINGS with these uplifted values.

If, for each building, the distances between (i) the building and the road centreline and (ii) the building and the road parcel already exist, then the correction can be made to the vertical length stored in SOURCE BUILDINGS without any further geo-analysis. It can be done by adding the value (i) – (ii) – [0.5 × road width] to the original vertical length and then applying the assumed uplift.

---

[9] In the case of the Commission's illustration, we believe that there is a building on the front plot, as a point is shown, but no outline is shown for that building.

[10] http://erhvervsstyrelsen.dk/file/233745/lraic-horingsnotat_14042011_pdf.pdf, Page 37 of 73

[11] http://erhvervsstyrelsen.dk/file/497321/3-udkast-horingsnotat-2014.pdf, page 116 of 123

When we apply this correction to the 16 buildings in Figure 2.3 (assuming an uplift of 15%), the total lead-in length in this case increases by almost 70%. We therefore believe this is a highly material omission.

2.4 The horizontal lengths appear often to be measured to the wrong end of the road segment

> The Commission should revisit the calculation of the values of horizontal length used in the model to ensure that they are consistent with the pre-calculated paths in the modelled copper and fibre networks. We have found cases where the horizontal length for a building has been calculated as zero, even though the building is located at the far end of a road section in the modelled access network.

We have undertaken a review of the horizontal trench length calculation and find that it is underestimating the length of trench needed in a significant number of instances for the horizontal part of the network. An example is provided below for the Kaukapakapa (KPA) ESA below in Figure 2.4, which illustrates the path taken by the road section with ID 1 back to its parent street cabinet in the modelled copper network. This is based on the data in the table SOURCE_DETAILED_SC_BUILDINGS_PATHS in the Access Database and the geodata provided by the CC.

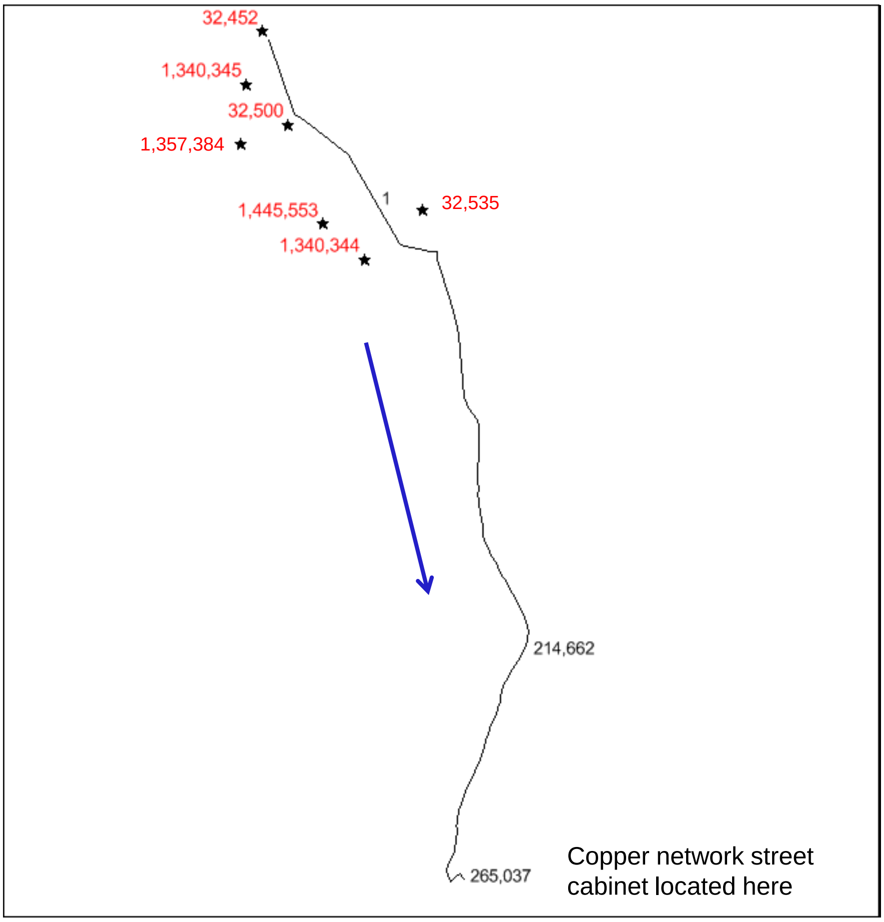


Figure 2.4: Illustration of erroneous horizontal trench length calculation in the KPA ESA; road section identifiers are in black text and building identifiers are in red text [Source: Analysys Mason, 2015]

In the table PROCESS SECTION MODELLING, the total length of the road section with ID 1 is 618 metres, but only 526 metres of trench is calculated as required in the copper network. As can be seen above, the building with ID 32,452 is situated at the far end of road section 1 from the direction to the street cabinet, and therefore the length of trench required is the full length of the road section (i.e. 618 metres).

Our understanding of the Access database implementation indicates that the horizontal length is assumed to be defined as the road distance between the building (when mapped onto the road section) and the end of the road section which links back to the street cabinet (for copper) or exchange location (for fibre).

In this case, the horizontal length has not been pre-calculated correctly, since the horizontal length for the building with ID 32,452 in SOURCE BUILDINGS is given as 0 metres, rather than 618 metres. This is not an isolated case.

The issue is that there is no clear recording of which end of the road section has actually been used to calculate these horizontal length values, and whether in a specific deployment case the values of trench etc required need to be measured from the other end. This needs to be corrected, and the horizontal lengths measured from the correct end of the road segment[12].

We do not think that it is safe to justify this inaccuracy on the grounds that it will lead to a mix of over- and under-estimates which will “cancel out on average”; this would depend on the choice of ends being truly random, which may well not be the case. Even if this were the case, this lack of precision is in any case unnecessary as the Commission have sufficient data to determine which direction is to the street cabinet (or MDF location) and to calculate the distances from that end.

2.5 Mapping of buildings to road segments is not accurate

Some of the buildings are not allocated to the closest road section. We provided an example below in Figure 2.5 which illustrates a road section in Kaukapakapa (KPA) ESA and all of the buildings allocated to this road section. As shown below, there are 11 buildings allocated to the road section with ID 214,451. Two of these buildings (with ID 33,814 and 1,490,996) are closer to the other road sections shown in grey. This is not an isolated case. As far as we know there is no justification of this allocation method.

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[12] Note that for some road segments the end to use might vary between the FTTN/copper and FTTH models as the network built uses different routes, which are via the SC segment in the FTTN/copper case

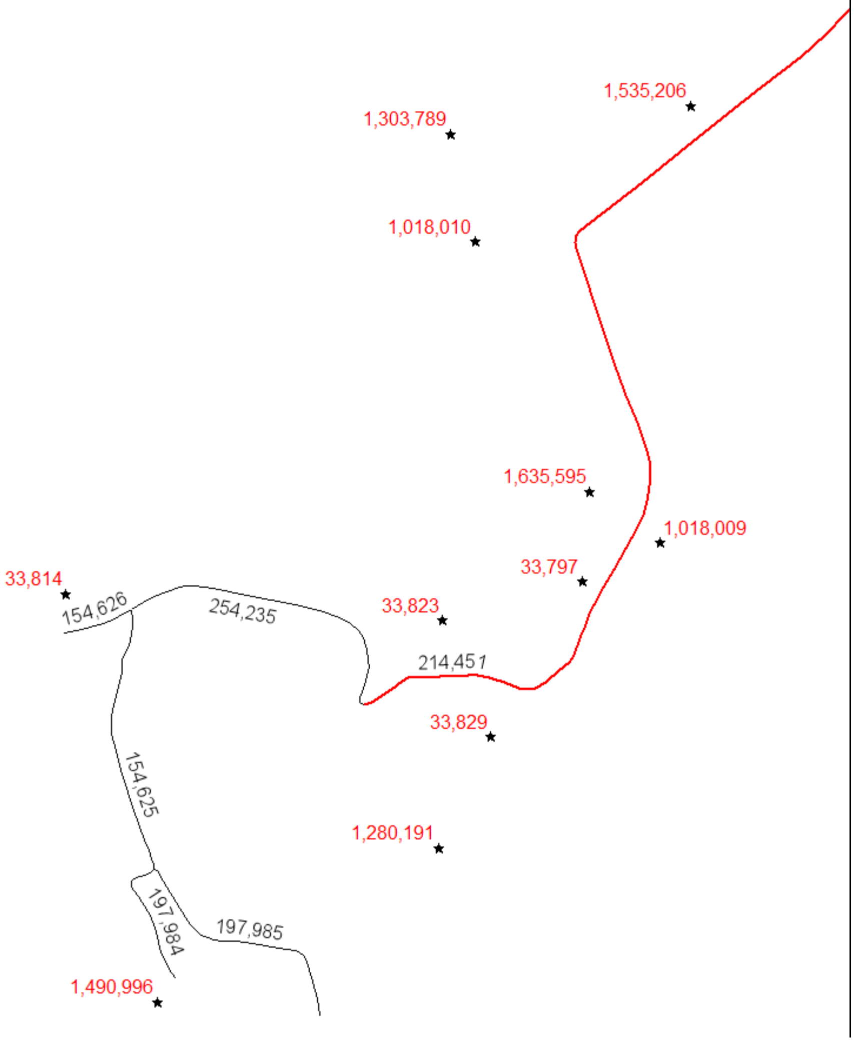

Figure 2.5: Illustration of odd allocations of buildings to road section in the KPA ESA; the road section in interest is in red line, road section identifiers are in black text and building identifiers are in red text [Source: Analysys Mason, 2015]

The required change to the model is to re-do the mapping of the buildings to the road sections[13]. Some related aspects of the geoanalysis will also need to be repeated (e.g. distance of each building from each end of the segment; number of buildings on the segment; and other calculations which follow from these).

2.6 Number of CCTs

There is an error in the Access database/model whereby when there are premises on the minor side, and single sided deployment is used (in particular the aerial case) the model builds too few CCT/FAT. This can be observed by looking at the number of CCT/FAT built in the aerial (OH) case (Access model: Inventory K75), which is insufficient to serve the number of lead-ins (Access model Inventory K109) given the maximum number of lead-ins per OH CCT/FAT (4).

---

[13] In MapInfo Professional, this can be achieved using the “Nearest.. from . .to.. into..” syntax.

In the Access database, the number of CCT on each segment is calculated[14] as the maximum needed (given the demand and distance) on either the major or minor sides. This is a material underestimate in a significant number of cases (the number needed can be as high as the sum of the number needed on each side). For example, this is the case in urban areas where the number of aerial CCT/FAT is driven by the maximum capacity (4) rather than set by the maximum size of clusters (300m) and where there are premises on both sides of the road. In the case of an urban road with 20 premises on each side, at 20m spacing, the result of the current algorithm would be 5 CCT/FAT (=MAX(20/4,20/4)) when the true number required is 10 CCT/FAT (=40/4). This error will result in an underestimate of the costs.

A very simple fix would be to use the sum of the number required on both sides, noting that this would result in a slight overestimate of the number of CCT/FAT required[15]. A superior approach would be to modify the algorithm for the single sided cases to calculate the number of CCT/FAT by combining the road segment length with served premises on either side (the superset of the served length of the road on major and minor sides) and the number of buildings on both sides of the road (the sum of the major side and minor side buildings). Having done this amalgamation, a similar approach to the existing algorithm could be re-used, though some caution may be needed[16].

2.7 Number of poles along the road segment

The way in which the TERA algorithms work means that there will be too few poles in the TERA model. The error is caused by the fact that the CCT/FAT poles that are present (serving the relevant maximum number of customers or a specified maximum distance) may not be in the right locations to provide the coverage of distance that is assumed when adding poles to get to the end of the section.

What the algorithm does is to calculate the number of additional poles required for the distance needed as the number required for distance (length of section to be built divided by maximum pole spacing) minus the number of poles already built for CCT/FAT demand (one per CCT/FAT). If this goes negative then no additional poles are built. In effect the resulting total number of poles is the maximum of the “poles needed for distance” and the “poles needed for CCT/FAT capacity”, which is only a lower bound for the number of poles needed. The actual total number required can be as high as the sum of the number needed for the distance plus the number needed for the CCT/FAT demand.

The impact of the error is hard to quantify as it depends on the actual distribution of the premises served along the road. An illustrative case where the existing model algorithm is certain to be wrong is a road segment which needs to be built with a dense cluster of demand at one end (e.g. 40 houses

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[14] This is calculated in the functions GetCCTOH and GetFATOH respectively.

[15] Using the sum of the two sides CCT needs would only overestimate in cases where the major side CCT were dimensioned based on the maximum distance (rather than maximum capacity) and there were so few premises on the minor side that they could reuse the “spare” capacity on the major side (or vice versa).

[16] For example, there could be some “difficult to handle” cases such as where the major side and minor side premises are at different ends of the road segment; it might be necessary to detect these cases and handle them separately.

spread over the first 400m on both sides of the road (20 on each side, each 20m apart)), followed by 800m of no houses[17]. Using the model parameters, these 40 houses need 10 CCT/FAT and therefore 10 poles, and the remaining 800m needs 8 poles. Accordingly the true requirement is 18 poles; but the current access model algorithm will result in just 12 poles in total (1200/100). In this case, 12 poles is not sufficient.

Because the algorithm is a lower bound, it will result in an underestimate of the costs.

A first order fix for this underestimate would be to use the maximum and minimum horizontal length for the street segment to estimate the part of the street segment for which the poles supporting CCT/FAT will provide some coverage of distance, and to add additional "distance" poles for the remainder of the street as required. In effect this would run the existing algorithm twice, once for the fraction of the segment containing the CCT/FAT and once for the fraction without CCT/FAT.

An example calculation would be:

- Street distance with CCT = max(horizontal length) – min(horizontal length)
- Street distance without CCT = total street distance required (either whole segment or distance from furthest required point to serving end) – street distance with CCT
- Additional poles required in CCT region = max(roundup(Street distance with CCT/pole spacing)-number of CCT, 0)
- Additional poles required in non-CCT region = roundup(Street distance without CCT/pole spacing)
- Total additional poles = Additional poles required in CCT region + Additional poles required in non-CCT region

2.8 Deployment of poles

The Access database should add poles on the minor side of aerial road sections where there are lead-ins on the minor side.

The assumed height of poles should be increased, with a corresponding increase in unit cost to reflect a higher-specification pole.

Analysis

The draft model only deploys poles on the major side of the road section (i.e. the side of the road with the most buildings)[18]. Poles are located according to the maximum distance between poles and the cable overhead equipment (i.e. copper cable terminals, CTs, and joints) that must be deployed

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[17] We are assuming that the network needs to reach the end of the segment in order to reach the exchange.

[18] Model Specification, Page 40

on poles. Also, it is stated that "*Poles are also deployed on the vertical part of the section, when the lead-in cable exceeds the maximum distance between poles*".

The number of poles and the allocations of poles between buildings/road sections are calculated by the VBA code in the Access database. The *Poles* module sets out the VBA functions used to calculate the number of poles. The number of lead-in poles (including the "horizontal" pole that bears the CCT/FAT) is calculated in the *Dimensioning at the building level* module and the number of distribution/feeder poles is calculated in the *Dimensioning at the section level* module.

Deploying lead-in poles on only the major side of the road is not realistic. This would require, in many cases, more than one aerial cable crossing the road from each pole on the major side of the road to premises on the minor side road. If there are lead-in poles only on the major side this may also result in the lead-in cable itself falling below minimum road clearance height (e.g. if the served premise is single storey).

Based on the input *Poleheight* in SOURCE_PARAMETERS_COMMON in the Access database, the assumed height of a pole is insufficient to reflect the statutory requirement of a minimum 5.5 metre clearance across all roads[19]. The unit cost of a pole should also be updated to reflect this larger pole.

We understand that Chorus's designs its network such that CTs typically serve only two premises and are placed at the boundary of these two properties[20]. We therefore believe that extra poles must be deployed on the minor side, the first of which will be on the minor side directly opposite from the CCT/FAT (which is on the major side), in cases where there are lead-in routes required on the minor side[21]. A demonstration of our suggested pole deployment is shown in Figure 2.6 (comparable to Figure 28 of the Reference Paper).

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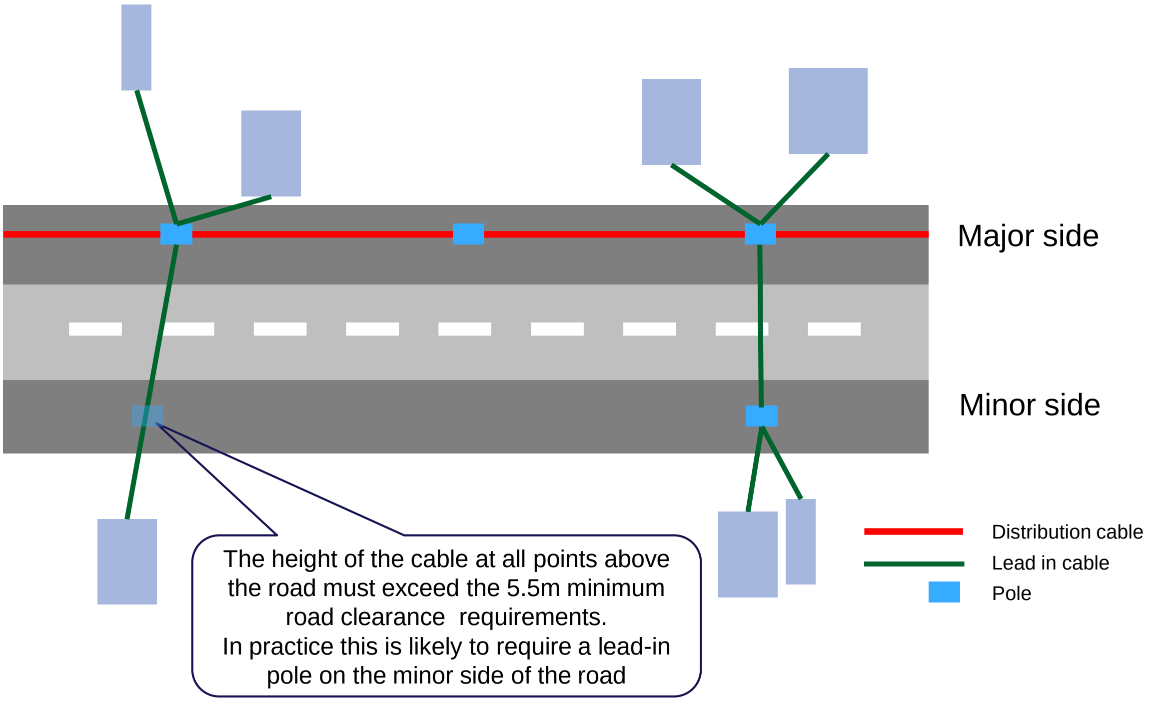
[19] As described in Chorus' Section 98 response to Q 6.14.1(e)(x) (Self_supporting_aerial_cable_SSA_7455_v1.1.pdf, Page 8)

[20] See Suburban_Rural_Copper_Cable_Network-Architecture_Design_Rules_5670_v3.1.pdf, Section 4.5

[21] As noted in the Incite RMA report, even placement of a pole on the minor side opposite the CCT/FAT may not be possible if there is no existing road crossing at that location.

Figure 2.6: Suggested lead-in pole deployment [Source: Analysys Mason, 2015]



The height of the cable at all points above the road must exceed the 5.5m minimum road clearance requirements.
In practice this is likely to require a lead-in pole on the minor side of the road

As stated in the figure above, a pole on the minor side might not be required for a single lead-in on the minor side, provided that the poles assumed are more than 5.5 metres high and the premise served is of similar height (so that the aerial cable crossing the road can exceed the minimum required clearance of roads, allowing for sag and the height at the served premises).

Recommendation

First, we believe that the assumed height of poles should be increased to a height of more than 5.5 metres permitting the required road clearance (allowing for sag) and of greater height if assuming electricity distribution sharing in the Access database, with a corresponding increase in unit cost in the Access model (the point regarding consistency of unit cost is described further in Section 2.10.

Secondly the functionality should also be added to the Access database to deploy poles on the minor side of road sections where there are lead-ins on the minor side.

Below are the subroutines we believe need to be modified:

- *GetCuLeadinPoles()* and *GetFbLeadinPoles()* in the *Poles* module calculate the number of poles dedicated to the lead in for the copper network and fibre network respectively. These functions are used in the dimensioning at the building level and estimate the dedicated lead in poles for each dwelling. These subroutines need to be modified to deply an additional pole on the minor side of the road; a proportion of the pole should be dedicated to the building depending on the number of dwellings sharing the pole.

- *GetLeadInOHOneTrenchCableDist()* in the *Copper Cables* module (and *GetLeadInOHOneTrenchFibreDist()*in the *Fibre Cables* module) calculate the length of overhead cable from CCT to the dwelling. Their output is used to estimate the additional poles needed when the length of the cable exceeds the aerial span of the pole and length of the cables used in the lead-in. If there is a pole deployed on the minor side of the road, then for minor side dwellings the function should return the length of the overhead cable from the pole on the minor side of the road to the dwelling, plus the road width. These subroutines should also continue to deploy additional poles for long lead-ins, but now calculating the lead-in length from the pole on the minor side of the road rather than that on the major side of the road

- *GetLeadinPolesbyLength()* function in the *Poles* module calculates the number of dedicated poles per building excluding the first pole (CT/FAT) using the overhead cable length calculated by *GetLeadInOHOneTrenchCableDist()*/*GetLeadInOHOneTrenchFibreDist()* function. Depending on how the *GetCuLeadinPoles()* and *GetFbLeadinPoles()* subroutines are modified, this function may need refining as well.

There are 626,000 lead-in poles in the modelled fully aerial copper network and 542,000 lead-in poles in the modelled fully aerial fibre network. Using the Access database, we have determined that there are almost 100,000 road sections with demand on both sides of the road (within the TSO polygons and not served by FWA), which could therefore need at least one more pole on the minor side. Assuming that the minor side of a road segment is that with the fewest buildings to serve, and further assume that an extra pole is required per 2 buildings on the minor side[22], then this amounts to at least 300,000 poles that are not currently captured by the model, which we consider to be a material omission.

2.9 There is no spare deployed in copper feeder cable or in fibre distribution

Page 57 of the model documentation indicates that the input "CuSparePairsFeeder" is 11%, but the value in SOURCE_PARAMETERS_COPPER in the Access database is 0%. It should be corrected in the database.

The fibre network design makes no account for spare fibres in the distribution network (except through the modularity of the cable size). This is unlike the copper network, which assumes 11% spare capacity in the distribution network.[23] This fibre network is therefore highly inflexible: any real operator would build more capacity than this to avoid the need to deploy new cables to serve new customers on day 2 (e.g. new in-fill build in existing areas or conversion of buildings to residential apartments).

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[22] We note that, according to Tables 39 and 40 of the model documentation, at most 4 buildings are served by an aerial CCT/FAT in the draft model. However, as has been argued elsewhere in the Chorus response, we believe a more appropriate value should be 2 buildings per CCT/FAT and this is the assumption used for this calculation.

[23] "CuSparePairsDistribution" in SOURCE_PARAMETERS_COPPER in the Access database

We recommend that a new input “FbSparePairsDistribution” should be added to SOURCE_PARAMETERS_FIBRE, set to the same value as “CuSparePairsDistribution” and applied in the same way.

We would also note that even this assumed spare capacity assumption for the distribution network of 11% is low compared to other public cost models that use a similar approach. For example:

- In the model developed by the ACCC in 2009, the copper distribution network was dimensioned assuming 25% spare capacity[24]

In the model developed by the Danish regulator in 2014, the copper/fibre distribution networks are dimensioned assuming at least 25% spare capacity and the copper/fibre feeder networks assume 30% spare capacity[25].

2.10 Pole costs need to be appropriate to the specification

The underlying costs per pole assumed should be made consistent with the assumed aerial deployment. Specifically, the Commission should demonstrate that the assumed costs per pole are consistent with the length of the pole required and the loading of cables assumed.

The unit costs provided by Chorus within the Section 98 response on pole costs reflect the actual mix of pole types deployed in their current network, which are designed to carry a lighter load than the Commission assumes and do not as a matter of course also carry electricity distribution cables.

2.11 Assuming a uniform deployment of aerial infrastructure does not reflect NZ conditions

Urban areas in particular have stringent restrictions on the use of aerial deployment. This is particularly important given the much higher cost of trenching in these areas. The Commission should lower the aerial proportion in these urban areas. We comment more on this point in section 3.3 on the cost of trenching.

2.12 The model deploys very large fibre cables aerially

It is unlikely that the largest fibre cable sizes would be feasible to deploy using aerial.

The model should be updated to use only a subset of the fibre cable sizes for aerial (as it does for copper). Using the cost model published by the Swedish regulator as a benchmark[26], only cables with 144 or fewer fibre pairs should be assumed to be feasible options for aerial. On this basis, the

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[24] See http://www.accc.gov.au/system/files/Model%20documentation.pdf, Figure E.1

[25] See https://erhvervsstyrelsen.dk/sites/default/files/media/endelig-modeldokumentation.pdf, Table 3

[26] http://www.pts.se/upload/Ovrigt/Tele/Bransch/Kalkylarbete%20fasta%20n%c3%a4tet/Hybridmodell%202013/Final-hy-model-10_1.zip

two largest fibre cable sizes in the Commission's draft Access model should not be available for aerial deployment.

2.13 Identification of the TSO area

> The TSO polygons should be enlarged to include all the geocoded locations produced by Chorus' recent calculations.

We used the public TSO polygons published by the Commission to estimate the proportion of exchange locations (excluding notional exchanges) within the TSO-derived boundaries. We have identified 46 exchange locations that appear to be outside the TSO polygons, whose codes we provide in Figure 2.7 below.

Figure 2.7: List of exchange locations outside of TSO-derived boundary [Source: Analysys Mason, 2015]

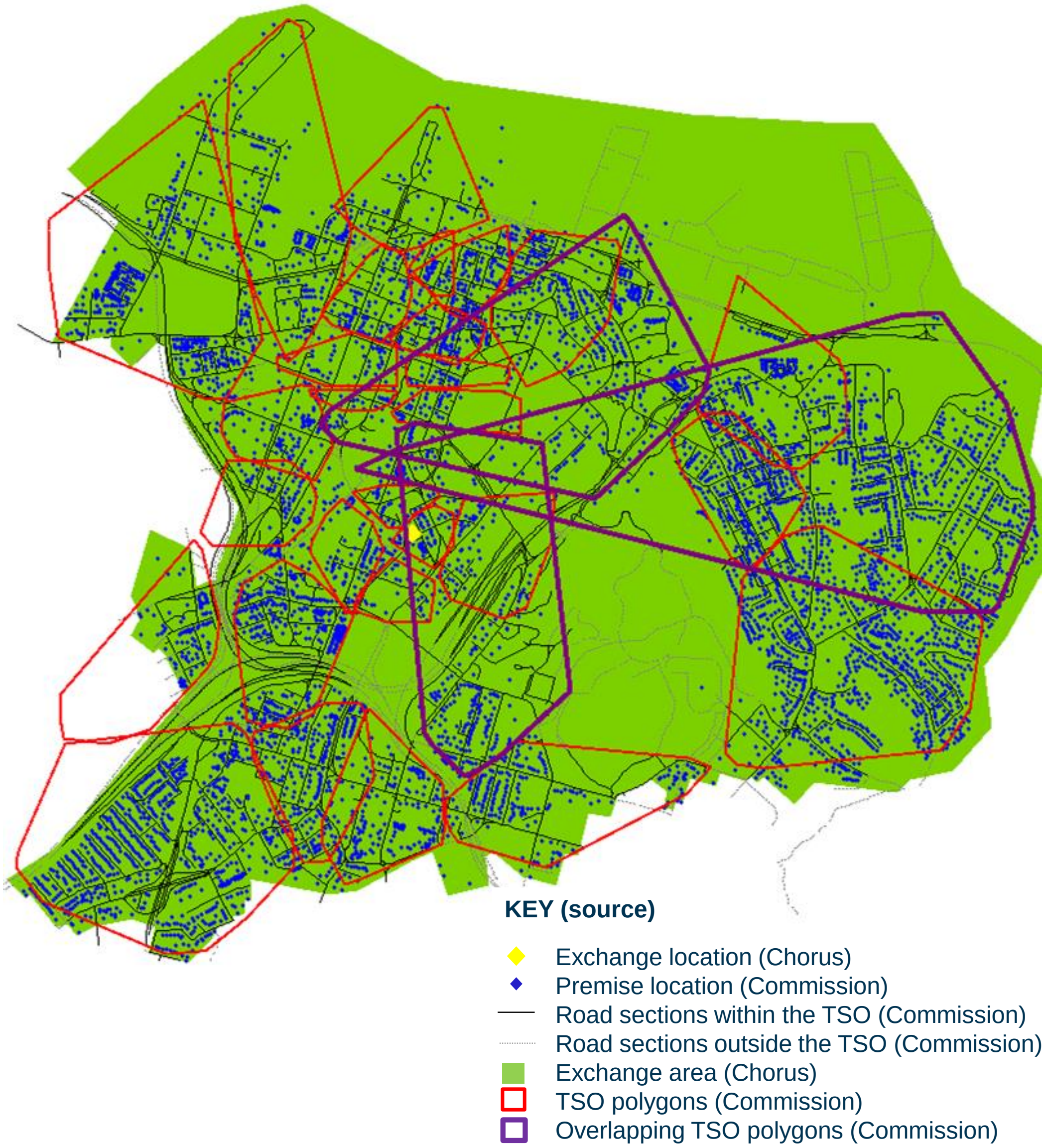
Exchange locations outside of TSO-derived boundaries					
ARD	GMY	KOU	OGU	RNU	WBA
BLI	GTN	LVN	OIA	RO	WEN
BTN	HAG	MAN	OPN	RS	WGH
CAM	HAS	MCK	OTI	THE	WKG
DOR	HYD	MIA	PNY	THN	WPI
FJG	INJ	MKN	PTE	THS	WTG
FP	KAU	MRI	RGT	TRV	
GLS	KIN	MRP	RGW	TUB	

We have also observed that there is no modelling of the assets required in the access network for Kawau Island (KAU) and Chatham Island (WTG). Their buildings have not been included in the Access model. The Commission should document and justify why these two cases have been omitted.

The counter-intuitive exclusion of the MDF locations suggests that the TSO polygons may not properly represent the extent of the premises served in 2001.

We have found other anomalies occurring in the AK ESA in Auckland, as shown below in Figure 2.8. In particular, we observe that several of the polygons heavily overlap (e.g. those outlined in purple below) which indicates there may be shortcomings in the definition of the polygons.

Figure 2.8: Illustration of the TSO polygons in the AK ESA [Source: Commission and Chorus data, 2015]



This is not the only issue. For example, as can be seen above, the Auckland War Memorial Museum in the Auckland Domain is also not within a TSO polygon, despite being a major public building.

Chorus have undertaken a new geocoding exercise using their own database of buildings served in 2001, with their attempt to determine co-ordinates for each of these buildings. Each building has been identified based on their SAM identifier (‘SAM ID’). Out of 1,819,940 SAM IDs in the database for which the geocoding was attempted, 1,579,302 were successfully associated with a co-ordinate based on the cross-referencing of appropriate databases. Using the TSO polygons provided by the Commission, there are 5.3% of these locations that lie outside a TSO polygon, which implies that the TSO polygons do not encompass enough locations.

We have also attempted to map each of these 1,579,302 co-ordinates to road segments by mapping them to the buildings in the draft model, by drawing a 10 metre buffer around each building from the draft model and identifying any co-ordinates from Chorus’ dataset that lie within these buffers.

1.256 million buildings from the draft model can be associated to buildings in the Chorus dataset in this way. When we determine the road sections associated with these buildings using the table SOURCE BUILDINGS, we have identified 13,247 road sections associated with these buildings that are currently set to TSO_ADJUSTED = FALSE in the draft model (i.e. they are excluded from the basecase calculation), with a total road length of 25,776 kilometres. This indicates that a material quantity of road network that is necessary to serve the buildings served in 2001 is missing from the draft model.

2.14 The modelled architecture does not ensure that critical infrastructure is well protected

Our understanding is that Chorus seeks to avoid more than 5,000 lines being served by one route. The modelled fibre architecture results in some routes carrying many more lines than this. Such large routes would be at greater risk of a serious fault affecting many customers.

If the TERA route finding algorithm cannot be modified to avoid such effects (and we suspect it cannot), it would be appropriate to ensure that these critical segments were buried.

Slides 25 and 26 of the model presentation (which we believe to be the Birkdale ESA (BKL), shown below in Figure 2.9 and Figure 2.10 respectively) highlight that the modelled fibre architecture appears to aggregate demand along road sections in a much more centralised way in the absence of a series of aggregation points (i.e. cabinets served by FTTN) between the fibre access terminals and the exchange location. This can be seen in Figure 2.10 below by the thick red line representing a central “trunk” route that is not deployed in the FTTN/copper distribution network shown in Figure 2.9.

Figure 2.9: Illustration of concentration of cables in the modelled copper distribution network [Source: Model presentation, 2015]

Figure 2.10: Illustration of concentration of cables in the modelled fibre distribution network [Source: Model presentation, 2015]

We have analysed this case further. In the case shown in Figure 2.10, we have estimated the number of 312 fibre cables in the distribution route shown by the red line[27], which is illustrated below.

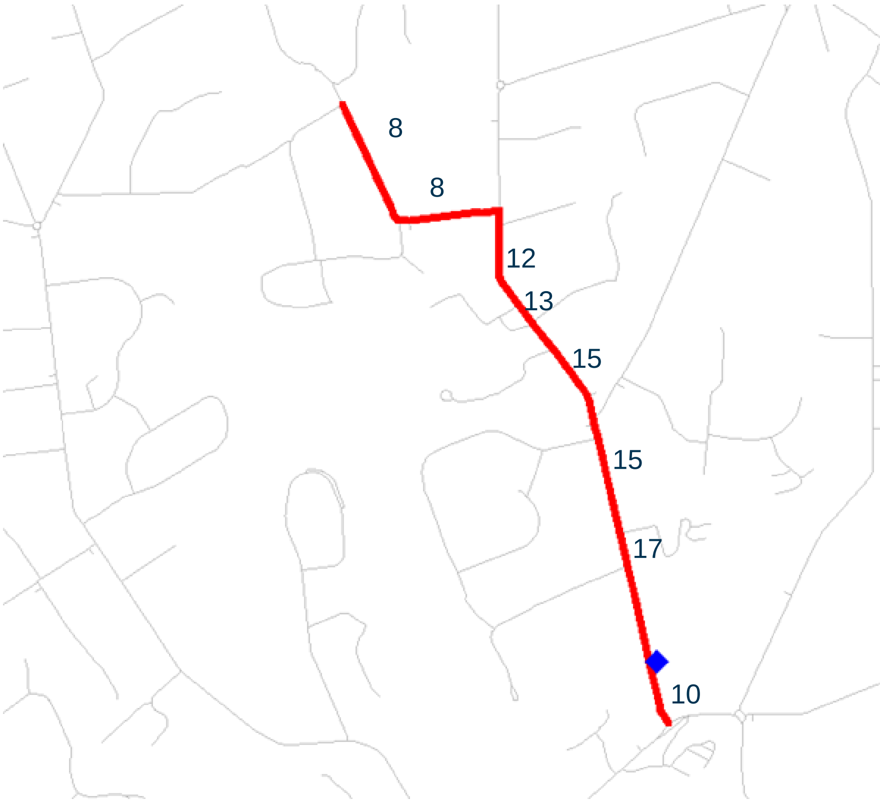


Figure 2.11: Estimated number of 312 fibre cables deployed in each road section [Source: Analysys Mason using Chorus and Commission data, 2015]

Our understanding is that Chorus seeks to avoid more than 5,000 lines being served by one route. The link with 17 312 fibre cables above does not satisfy this requirement.

In terms of addresses served, there are almost 90 ESAs larger than BKL. For example, in the AK ESA, using the information in the table PROCESS SECTION MODELLING in the Access database, we have estimated that 2.7 kilometres of road sections contain more than 16 312-fibre cables and therefore would not satisfy the above Chorus requirements.

Recommendation

The fibre architecture should be revised to minimise the opportunity for unacceptably serious single point of failure, for example by burial of all cables serving more than 312 lines.

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[27] This uses the ratio of the fields LENGTH_OH_DISTR_FB and LENGTH for the relevant road section

3 Investigations related to the build parameters

3.1 Copper and fibre cabling

> The Commission should include the additional costs of installation for cabling, which are a clear omission from the draft model.
>
> The Commission should also revisit the assumed unit costs of the fibre cables, based on the values provided by Chorus in its Section 98 response.

Analysis

The assumed cabling costs are based on Chorus' price lists submitted through the Section 98 response [**CI**:(✂✂)]. However, the costs assumed exclude overheads, handling fees or hauling fees and mark-ups for consigned materials.

The copper cable unit cost in the draft model is structured in the confidential inputs file [**CI**:(✂✂)] as made up of material and labour components. However, the installation labour costs provided by Chorus in the Section 98 response has in fact not been included and can be found in the file [**CI**:(✂✂)] submitted under the Section 98 response.

The fibre unit costs in the draft model convert the values given in Chorus's price lists and convert them into NZD currency. They take this to be the full cost of cabling, when in fact this does not include the cost of installation.

As the trenching costs developed by Beca are for a ducted network, the handling/hauling costs are a required expenditure and should be included. SerCo overheads are also applicable.

We would also note that the unit costs of some smaller fibre cable sizes in the confidential input files [**CI**:(✂✂)] are very low. The costs for the most comparable cable that were provided in Chorus' Section 98 submission may be more appropriate to use (e.g[**CI**:(✂✂)]).

Recommendation

The Commission should include these additional costs of installation for cabling, since they are a clear omission from the draft model and are understating the costs of cable deployment. The Commission should also revisit the assumed unit costs of the fibre cables, based on the values provided by Chorus in its Section 98 response.

3.2 Aerial routes and poles

The Commission should reduce the assumed percentage cost reduction for shared aerial infrastructure to be less than 100%, to reflect that there are some capex costs for shared poles (e.g. pole survey fees).

Moreover, if the Commission continues to assume that the modelled poles are all available for reciprocal sharing with electricity distribution then the average pole unit cost must reflect the specification of shareable pole of sufficient height and loading capability for supporting both electricity distribution and telecoms distribution.

The Commission should define new inputs in the Access model for pole spacing for those poles supporting CCT/FAT in the copper/fibre network, which should be set to a smaller value than the corresponding inputs for the distribution/feeder network.

Analysis

Pole costs are based on the file [**CI**:(✂✂)]. This raw data includes RMA consents (but not CAR) and traffic management. The design costs component has been excluded, but some network build staff costs are included in the non-network annual costs. SerCo and Chorus project management costs have also been included.

A network deployment compliance annual cost of NZD1 200 000 in 2014 nominal terms is also included (in the public model [**CI**:(✂✂)]). This value is not sourced in the cost inputs file and is not documented. It is fed into the annual capex calculation directly rather than inserted via the investment calculation first. A ‘regulatory consents’ capex of NZD[**CI**:(✂✂)]million is assumed: this is not sourced either (but is included in the pole investment).

The Access model includes a parameter called ‘Percentage of cost reduction due to shared OH infrastructure’ (cells 'MDF data'!H17 and 'MDF data'!H26) set to 100%. This implies that for aerial routes that are shared, no capex is incurred for the poles. This is assumed to occur for 50% of pole infrastructure (cells 'MDF data'!H15 and 'MDF data'!H24 in the Access model). As stated on page 44 of the model specification, this is justified by saying that “*As half of the poles used by Chorus are rented to other utilities, it is assumed the overall cost reduction stemming from pole sharing is 50%.*”

According to the Access database, the assumed maximum aerial span is 65 metres in urban areas and 100 metres in rural areas[28]) with a height of 4.5 metres (as can be seen in the public Access database). The unit capex assumed for these poles in the access model is NZD[**CI**:(✂✂)] per pole.

The draft model assumes a “gentleman’s agreement” between sharing parties whereby no lease payments are paid on each other’s shared pole assets.

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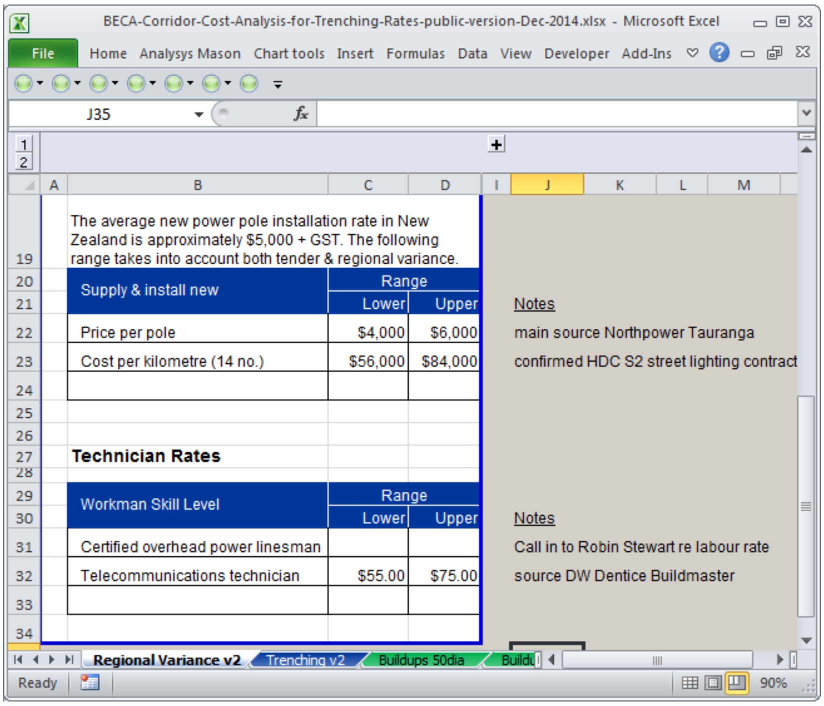
[28] Each individual road section is defined as urban or rural based on the CoreLogic dataset

We find this assumption of a 100% cost reduction on the 50% of poles that are shared to be incorrect as there are still some costs incurred with the shared infrastructure, such as the costs of pole surveys and upgrades (where required). Furthermore, if other parties (i.e. power companies) are going to be using the poles deployed by the hypothetical operator, then the poles must meet the specification of both parties. We note that a pole deployed by a power company is assumed in the Beca trench cost analysis file to cost NZD5000, as shown below in Figure 3.1. This is dramatically different to the cost of the poles assumed in the model, meaning that the draft model pole does not meet the specification required by a power company (and could not be shared meaning the assumed reciprocal agreement could never work).



The average new power pole installation rate in New Zealand is approximately $5,000 + GST. The following range takes into account both tender & regional variance.

Supply & install new	Range			Notes
	Lower	Upper		
Price per pole	$4,000	$6,000		main source Northpower Tauranga
Cost per kilometre (14 no.)	$56,000	$84,000		confirmed HDC S2 street lighting contract

Technician Rates

Workman Skill Level	Range			Notes
	Lower	Upper		
Certified overhead power linesman				Call in to Robin Stewart re labour rate
Telecommunications technician	$55.00	$75.00		source DW Dentice Buildmaster

Figure 3.1: Illustration of power company pole cost assumed by Beca [Source: Beca, 2015]

We think that the span for poles supporting CCT/FAT should be separately specified in the Access database and set as a shorter length (effectively placed by every other property on a road).

Recommendation

The Commission should change the cost assumptions for shared infrastructure (e.g. reduce the assumed percentage cost reduction for shared aerial infrastructure to be less than 100%) to reflect that there are still some capex costs even for leased poles (e.g. pole survey fees); if adopting the proposed very high levels of sharing with electricity distribution (in effect, 100% shared) then the average pole unit cost must reflect the specification of such a shareable pole of sufficient height and loading capability for both electricity distribution and telecoms distribution.

The Commission should define new inputs in the Access model for pole spacing for poles supporting CCT/FAT in the copper/fibre network, which should be set to a smaller value than the corresponding inputs for the distribution/feeder network. A typical maximum span for such a pole would be 40 metres, assuming the positioning of poles between consecutive pairs of residential plots[29].

3.3 Trenching

The unit trench cost for urban areas needs to be revisited, as the Beca report states that their analysis does not consider urban areas.

The trench inputs workbook should be updated so that it uses the current implementation of the blending calculation only if all routes (TSO and non-TSO) are included in the modelled network. If non-TSO routes are excluded, then an appropriate average cost for the mix of routes by soil type should be calculated for the TSO routes only. Otherwise, the Commission is effectively assuming rural trench costs for a heavily urbanised trench network, which is a clear and significant inconsistency.

The Commission should ensure that the assumed costs capture all relevant components, such as those used in Chorus' hybrid model, to include adequate allowances for traffic management, consents and planning/design. All key parameters that can influence the choice of trenching cost for a given soil type should be documented and sourced.

In Section 5.2.3.2 of the model documentation, the "weights used for the small, medium and extra large trenches" are said to be "the inverse of the number of ducts". However, this is not what is implemented in row 64 of the Soil-specific trenching costs worksheet in the trench inputs file: the Excel file should be corrected.

Analysis

The Access model uses the unit costs of trench calculated by Beca. Beca defined the soil categories to be used in the draft model and estimated the unit trench cost for each soil category, for different numbers of ducts. For each case, this estimation is undertaken in the Beca trench cost analysis workbook, which selects the cheapest trenching method (out of chain digger, open trench, directional drilling, thrust boring, rock saw). Beca gathered pricing data from nine contractors.

Beca was able to define soil categories in rural areas by applying Bell-Ducat soil/rock class system to the 'lithology' dataset, which was obtained from the Land Resource Information System (LRIS) GIS portal[30]. However, the NZLRI datasets did not include the lithologies underlying the urban areas[31], meaning Beca was not able to define soil categories for the urban areas. Beca identified five

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[29] See Q 6.14.1 (e) (iii) Span Aerial-UG-Local Access.pdf in Chorus' Section 98 submission, Page 2 of 2, under "Fibre Service Lead for Underground and Aerial use"

[30] https://lris.scinfo.org.nz

[31] Beca FPP Corridor Analysis Full Report – November 2014, Page 20

soil categories for the rural areas and flagged urban areas with a sixth category "Urban". It is clearly stated in the Beca report that further analysis is required to accurately cost urban areas.[32]

No account is made of different reasons to use different trenching methods other than unit costs (e.g. avoiding tree roots or other utilities). It is also unclear what allowance is made for trench width in the unit costs. For example, it questionable whether a (very deep) 600mm trench would really be used for a 10 duct route, rather than a wider trench (which would have a different unit cost).

We reviewed the approaches to estimate unit cost of trench and identified several weaknesses that we believe indicate that the values should be revisited. These are described below.

- *Comparison of blended cost of trench per metre used in the draft model versus the cost derived by Analysys Mason*

We have calculated a blended average trench unit cost by ESA from the draft model and compared it with the trench unit costs by ESA that were derived for use in Chorus' hybrid model. In particular, we have looked at 130 ESAs where using the UFB/RBI project information there was sufficient data to calculate a representative average cost per metre (those where there have been at least three recent projects undertaken in the ESA, all of which deployed at least 50 metres of trench).

We have also calculated the blended unit trench cost for each ESA using the draft model to compare with the average values derived using Chorus' project data, as shown in **[CI:** Figure 3.2 (ordered by highest cost to lowest cost according to the Chorus cost data). The arrowhead represents the cost derived by Beca, whilst the other end of the arrow represents the cost derived by Analysys Mason using the cost data provided by Chorus.

[CI: *Figure 3.2: Comparison in blended cost of trench per metre between the values derived by Analysys Mason and from the draft model [Source: Analysys Mason, 2015]*

(✂✂)]

As can be seen above, the outputs of the Beca report are considerably lower in the majority of ESAs. In particular, it can be seen that there is no significant range in the average cost of trench by ESA in the Beca report, whilst there is a considerable range in the unit costs by ESA that we have derived from actual build costs. We have highlighted particular ESAs that display unusual characteristics e.g. the AT ESA displays by far the largest difference, whilst the costs for the HV ESA are almost the same.

We have also reviewed Beca's report on their FPP corridor cost analysis in more detail and the post-processing of the average trenching costs and identified several weaknesses. These are described below:

- Unsourced inputs
- Urban trenching costs

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[32] Beca FPP Corridor Analysis Full Report – November 2014, Page 24

- Blending effects
- Missing costs
- Use of a representative sample.

► *Unsourced inputs*

We have observed that the differences between soil types in certain trenching costs are down to unsourced inputs that appear to be arbitrary. For example, the different costs for

- 400mm open trench in soil type 2
- 400mm open trench in soil type 3
- 600mm open trench in soil type 2
- 600mm open trench in soil type 3

are due to four hard-coded cells in the Beca trench cost analysis (cells C5, J5, C48 and J48 on the *Buildups 100dia* worksheet). Since these inputs directly determine the trenching cost selected for that soil type, these inputs should be clearly labelled and documented.

► *Urban trenching costs*

The LRIS dataset used by Beca was not sufficient to analyse the cost variations in the urban areas and it is clearly stated in their report that further analysis is required to accurately cost urban areas.[33]

In the trench inputs workbook, the cost of directional drilling is used as the trench unit cost in urban areas (being the cheapest method of trenching). It appears in the Beca trench cost analysis workbook[34] on the *Trenching v2* worksheet (Cells C59 and C64) that the directional drilling cost is derived by applying uplift to the directional drilling cost of Type 1 soil by 29% for 50mm dia meter duct and 25% for 100mm dia meter duct. Therefore, the trenching costs in urban areas have clearly not been analysed geographically in any way, but yet are being used in the draft model.

In addition to this point, the uplift of directional drilling cost for urban areas is calculated based on one data point on the *Dir.Drilling* worksheet in Beca trench cost analysis workbook (cell S40), which appears to be very limited evidence when compared to the significant database we have used of actual costs faced by Chorus UFB and RBI deployments.

► *Blending effects*

Regardless of the values calculated by Beca, we further find that the trenching costs assumed in the model are too low, due to two significant areas of bias introduced in the post-processing of the average trenching costs:

- The Access database for the draft model removes a significant proportion of rural trench routes, by excluding the non-TSO areas. Therefore, the routes in the draft model will be predominantly

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[33] Beca FPP Corridor Analysis Full Report – November 2014, Page 24

[34] http://www.comcom.govt.nz/dmsdocument/12806

urban. However, the blended average cost of trenching derived on the *MDF-specific trenching costs* worksheet in trench inputs workbook is derived using the mix of all road routes by soil type (this calculation is included on the *Geotype per MDF* worksheet). This is a very significant flaw in the implementation, since the mix of all road routes by soil type are being used to calculate the blended average costs for a network of routes that is now predominantly urban.

- A significant proportion of the routes that are modelled are aerial. It is quite likely that in reality the propensity for using aerial routes will be higher outside urban areas (since, for example, fewer pairs are required along rural routes, and planning restrictions related to aerial deployment are more likely in urban area). However, the model effectively deploys aerial equally across both urban and rural areas. In this way, the modelled underground network will therefore be more non-urban than would practically occur. Therefore, the calculation that uses road section lengths to blend the trenching costs will contain proportionately too much non-urban road length (and therefore non-urban soil types), leading to too low a blended cost.

► *Missing costs*

We do not believe that a number of costs applicable to trenching projects are covered within the costs derived by Beca. These are summarised below. Values were provided in the Chorus response to Q6.14.1.j of the Section 98 request and we do not believe they are represented in the planning/consenting cost per metre assumed by Beca.

Figure 3.3: Missing costs identified in trenching rates [Source: Draft models, Analysys Mason, 2015]

Missing components in Commission's model	Source
Project management	Design costs: NZD4.50 per metre Q 6.14.1 (j) trenching v3.pdf
RMA, CAR, arborist, design and planning costs	Other costs: NZD18.70 per metre Q 6.14.1 (j) trenching v3.pdf

► *Use of a representative sample*

Beca gathered pricing data from nine contractors, lacking a number of the larger firms. This is concerning since these larger firms would be more likely to provide costs that would be incurred by a nationwide deployment trenching project. Therefore, the applicability of the costs used is questionable in the context of the draft model.

Furthermore, Beca calculates a flat cost per trench metre for both consenting costs and traffic management costs, using the data gathered from projects in two districts (located side by side) out of 53 districts. We similarly do not think this is a representative sample.

Recommendation

The unit trench cost for urban areas should be changed. We recommend that the Commission consider the trenching unit cost rates in the hybrid model as a starting point, since they are based on analysis of Chorus' recent, actual costs of trenching incurred on a wide range of projects across more than a hundred ESAs including urban areas.

If the Commission persists in excluding non-TSO demand, then the trench inputs workbook should be updated so that it uses an appropriate average cost for the mix of routes by soil type for the routes included in the model. A national average is only appropriate if the network does not exclude certain routes.

All key parameters that can influence the choice of trenching cost for a given soil type should be documented and sourced, ensuring that all relevant cost components are captured in the trenching costs, including design costs and management overheads.

Also, in Section 5.2.3.2 of the model documentation, it is stated that "the weights used for the small, medium and extra large trenches are the inverse of the number of ducts". However, this is not what is implemented in row 64 of the *Soil-specific trenching costs* worksheet in the trench inputs file, which needs to therefore be corrected.

3.4 Other costs

> The Commission should include missing costs for the jointing assets, since they are necessary for the installation of joints in a network.
>
> The assumed cabinet costs should also be revised to include installation costs.
>
> The Commission should document to what extent design costs, installation costs, overheads and RMA/CAR costs are included in the assumed unit costs for these assets.
>
> In particular, we believe that SerCo overheads and Chorus design/planning costs have not been included in the assumed unit costs. These are costs incurred by actual operators and we believe they are therefore applicable to the modelled operator.

Analysis

In this section we consider the assumed unit costs of joints, cabinets, copper/fibre terminals and manholes in the modelled access network.

- *Joints*

The cost of joints is derived using the file [**CI**:(✂✂)], but the design component has not been included in the values derived.

- *Cabinets*

A unit capex of NZD4150 (public model) is assumed for the modelled cabinets, which on page 59 of the model specification is stated to be a benchmark (although the sources of the benchmarks are not specified).

The cabinet cost assumed in the Access model seems very low compared to the cost of the range range of cabinet types that Chorus provided in the Section 98 response, particularly since we believe that this value is intended to include the cabinet, groundworks installation and cabinet distribution frames (though this is not made clear anywhere in the documentation). The cost data provided by Chorus ranged from NZD[**CI**:(✂✂)] to NZD[**CI**:(✂✂)], noting that these values also included contributions from RMA, CAR and SerCo overhead[35].

- *Cable terminals (CCTs/FATs)*

The costs of cable terminals (CCTs) and fibre access terminals (FATs) are also based on (undocumented) benchmarks.

We would also observe that on page 59 of the model specification, it is implied that Chorus provided no unit costs for cabinets and distribution points (i.e. CCTs/FATs) which is not the case. See the file [**CI**:(✂✂)].

- *Manholes*

Manhole costs are based on [**CI**:(✂✂)] from Chorus' Section 98 response. We believe that design costs for manholes within this file have been excluded in the derivation of the unit costs and should be included.

Recommendation

The assumed cabinet costs should be revised to include the relevant installation costs.

The Commission should describe to what extent design costs, installation costs, overheads and RMA/CAR costs are included in the assumed unit costs for these assets.

Based on our review of the cost input derivations, SerCo overheads and Chorus design and planning costs have not been included in the unit costs assumed. However, on page 125 of the model documentation there is text suggesting that the inclusion of maintenance contractor overheads is '**<u>to be discussed</u>**'. These are costs incurred by Chorus and would be incurred by any HEO in obtaining the services of SerCo at the rates used by the Commission, and we believe they are therefore applicable.

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[35] RMA stands for Resource Management Act, CAR for Corridor Access Request and SerCo for Service company.

4 UBA model

4.1 The indirect capital costs of installing active equipment need to be included

The Commission’s model appears to have underestimated or completely excluded indirect capital costs. Examination of the UBA model alongside the model documentation[36] shows that the only indirect costs considered are associated with IT and miscellaneous network operating costs[37] and, the model therefore does not capture specific indirect capital costs.

Indirect capital costs include costs for:

- installation and commissioning,
- connection to the network and connection of power,
- design and testing,
- costs for fibre reservation in NetMap, and
- management overhead fee for the service company and Chorus.

Note that indirect costs are bundled with other assets in Chorus’ UBA model, namely:

- indirect costs for DSLAM chassis, which include indirect costs for DSLAM line cards and SFP links, and
- indirect costs for Ethernet aggregation switch, which include indirect costs for switch line cards.

Indirect costs for both sets of assets was provided in S98 data in Q 6.17.12 (d) Install costs.csv.

4.2 Including traffic throughput

The Commission’s model does not take into account the current or forecast levels of data traffic in the network. In doing so, they are deploying an under-provisioned network, which will be unable to cope with the levels of traffic throughput expected over the regulatory period.

An effective network needs to account for the current and expected data traffic requirements, as well as the number of lines to be served. The Chorus UBA model accounts for bandwidth as well as subscriber lines when dimensioning active equipment in the network. As such, it can serve as a worked example of how traffic calculations can be implemented in a network cost model.

Bandwidth requirements need to be considered when dimensioning the following active equipment in a UBA cost model (given in brackets is the reference to the calculation implemented by Analysys

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[36] See PUBLIC_ComCom - UBA model v5.1.xlsb sheet ‘Import from the OPEX model’ section 3 and dependant calculations, as well as TERA-Model-Documentation-public-version-Nov-2014 p36-37.

[37] IT costs include hardware and software costs related to customer services, network, billing platforms, network management platforms, VoIP/Voice platforms, Information system platforms, etc.. Miscellaneous indirect capex include costs related to office equipment, furniture, tools and plants, and motor vehicles.

Mason in their *Chorus UBA TSLRIC model 1 December 2014 ADDITIONAL PROTECTION* UBA model):

- Core-facing DSLAM Ethernet ports (see sheet ‘NwDes’ lines 3338-4421)
- Access-facing FDS Ethernet ports connecting to the DSLAMs (see sheet ‘NwDes’ lines 4422-4758)
- Access-facing FDS Ethernet ports connecting to RSPs and providing services from the switch, such as HSNS premium (see sheet ‘NwDes’ lines 4749-4959)
- Core-facing FDS Ethernet ports (see sheet ‘NwDes’ lines 4960-6189)

The impact of bandwidth on the dimensioning of the assets listed above has a direct effect on the dimensioning of the following assets:

- FDS line cards and chassis (see sheet ‘NwDes’ lines 6190-6927)
- OFDF ports, shelves, racks and associated cables (see sheet ‘NwDes’ lines 6928-11,581)
- SFP modules (see sheet ‘NwDes’ lines 11,646-11,675)

4.3 The costs of the different cabinet needed to support UBA should be within the additional costs of UBA

The incremental cost of larger cabinets to house UBA equipment should be included in the additional cost of UBA.

The Commission consider cabinets as part of their FTTN copper network scenario, used to determine the cost of SLUBH and hence SLU (noting that we have already commented that these costs are too low in section 3.4). However, they do not include the cost of additional facilities at the cabinet as part of the additional costs of UBA apart from power consumption capex for a single subrack (no cooling or space is provisioned)[38]. This is an error as without UBA, these cabinets would be very different.

The Chorus UBA model includes the incremental cost of having a larger cabinet to house active electronics in the cost of UBA. The incremental cabinet costs included:

- The direct cost for shell, battery, heat exchanger, and noise reduction
- The indirect cost for planning, installation and fibre leads

4.4 Calculation of SFPs

The Commission’s draft model deploys one SFP for each 1GE or 10GE port connected from DSLAMs in cabinets and exchanges. Therefore, the number of 1GE and 10GE SFPs is equal to the number of 1GE and 10GE ports from DSLAMs connected to the FDS, respectively.

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[38] See TERA-Model-Documentation-public-version-Nov-2014, pages 109-111.

The approach should be changed to dimensioning two SFPs for each DSLAM-FDS port (one at each end). Additionally, the network topology needs to be taken into account and SFPs of varying transmission lengths need to be deployed. These changes would double the number of SFPs currently deployed[39], and introduce new SFP assets of varying transmission lengths.

Last, SFP calculations need to account for traffic throughput[40]. This will directly impact the number of core-facing DSLAM Ethernet ports, which will affect the number of SFP modules required to support the traffic throughput in the network.

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[39] Doubling the number of SFPs results in the Commission's draft model deploying 9% more SFPs overall compared to Analysys Mason, based on TERA's public UBA model.

[40] Inclusion of traffic throughput in the network calculations is discussed in more detail in section 4.2.

5 Opex and non-network costs

5.1 Application of LFI adjustment to too many opex cost categories

The LFI adjustment should not be applied to the following categories:

- 'Alcatel Lucent maintenance' since this refers to the Network Operations Centre and licence fees which are related to Alcatel Lucent equipment such as DSLAMs and not to the fault rate in the Access network
- 'Engineering services' since this category refers to power equipment support services in exchanges. These are not affected by the fault rate in the Access network

5.2 An increased proportion of aerial access network will lead to higher opex

We believe maintenance opex should be increased to reflect the higher proportion of aerial deployment assumed by the Commission compared to actual NZ telecommunications networks (less than 5% for the legacy network and 20% target in UFB areas).

ARMIS analysis

In Annex B we present 2007 data from the FCC ARMIS database that allows us to calculate the annual maintenance expense per cable sheath km for aerial, UG and buried cable types (as well as pole and conduit expense) for the US ILECs. For the large ILEC holding companies AT&T, Qwest and Verizon (which make up a very large fraction of the US), in 2007, the result of this analysis is that aerial cable (including pole costs, but excluding "aerial wire" data) has a markedly higher annual expense per cable sheath km than the buried cable rates. Underground cable expenses (including conduit expenses) are slightly lower than the buried costs per cable sheath km.

The Irish regulator ComReg published an econometric analysis of ARMIS data by Europe Economics (ComReg0421a[41]) that also found statistically significant higher expenses for aerial cable than for ducted cable looking at data over time (using data up to 2002). This analysis suggested a 1.21% increase for the expenses per 1% increase in the amount of aerial cable.

The combination of these two analyses supports a material increase in the operating costs over the currently assumed operating costs (which are derived from the existing, largely underground network) if the Commission is to use a higher fraction of aerial deployment.

This is also consistent with the Commissions' own statements about aerial opex being higher. Therefore, the model opex should take into account the increased proportion of aerial network, which will raise the costs.

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[41] www.comreg.ie/_fileupload/publications/ComReg0421a.pdf

5.3 Fibre technology adjustment

We disagree with both the scale of the technology adjustment used by the Commission to convert from copper opex to fibre opex and the broad scope of its application on the grounds that:

- 50% is not applicable to the situation in New Zealand. The value should be smaller and should not be applied so broadly
- there is a risk of the 50% adjustment double counting when applied after the LFI adjustment

5.3.1 Size of adjustment

50% is based on only on a single estimate from a presentation on Next Generation Networks (NGN) from AGCOM, the Italian NRA, which estimates that a decrease in opex per line of 40-60% with respect to copper local loop may be expected[42]. Agcom's presentation does not provide clarity on the context in which the comparison was made. The comparison would have very different meaning if it was made between a legacy copper network and a modern, newly deployed fibre network, or between two modern networks one of which is copper and one of which is fibre.

We suggest that it is unsafe to rely on a single unclear source to make such a large adjustment and that therefore a wider range of appropriate sources should be taken into account.

For instance, a more recent (2013) study conducted by the FTTH Council Americas showed average opex savings of 20% rather than 50%. The report based on the survey of telecom managers at more than 350 telecommunications providers across North America indicated a wide range of estimated opex savings with a mean of 20%. The web page accompanying the report also identified that most cost savings were "largely because of a decrease in ongoing repair and maintenance" rather than from other opex expenses[43]. It is also likely that this 20% reduction is from the baseline set by an existing (copper) network (as this is the basis on which the operators can compare) rather than a new one.

In a presentation delivered in 2012, Portugal Telecom indicated that the number of technical calls per customer was 16% lower for its fibre network than for its copper network and that the number of truck rolls per customer was 40% lower.[44]

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[42] Model documentation, Page 133

[43] http://www.ftthcouncil.org/p/bl/et/blogid=3&blogaid=182

[44] Enabling convergence through IT, Portugal Telecom, Technology and Innovation conference, Lisbon, 29-30 October 2012, available at http://www.telecom.pt/NR/rdonlyres/36CA111C-EE89-45D3-8AEF-5400F63B2DB3/1462031/tek_201210290800Operations.pdf

Older studies dating from 2007[45] and 2008[46] do refer to higher possible savings but those are based on assumptions rather than on networks actually built and operated like the 2013 study; and they are relative to current (aged) copper networks. The Ovum report includes the explicit line *"Other Ovum studies have suggested that FTTH can provide opex savings as significant as 40-60% compared to the operations cost of running legacy access networks."*

The Commission has not sufficiently justified its choice of the 50% value when alternative, more realistic, levels of savings are quoted in publically available studies from parties reporting with first hand knowledge. The correct value is likely to be materially lower.

5.3.2 There is a risk of the 50% adjustment double counting if applied after the LFI adjustment

The Line Fault Index (LFI) adjustment is intended to adjust maintenance costs to reflect a modern equivalent copper network when using inputs from an older copper network.

The 50% technology adjustment has been applied to network opex after it has already had the LFI adjustment applied.

As noted above, the evidence for this large cut is very thin (a single data point) and there is no evidence offered by the Commission that that data point was relative to a new copper network rather than relative to an existing one. There is therefore a significant risk that applying both adjustments in succession is double counting efficiency savings. To avoid this risk, we suggest that the draft models should be amended so that:

- For the copper network scenario – an LFI adjustment is applied to maintenance related costs but no fibre adjustment (which is the approach currently used in the draft models) but
- For the fibre network scenario – only a fibre adjustment is applied (with no LFI adjustment)

5.4 Other

Allocation key used for non-network expenses

Ideally non-network opex should be allocated using an equi-proportional mark-up (EPMU) which allocates costs based on the proportions that have already been assigned (i.e. the network costs that have already been assigned). In the absence of the modelling of all services (both regulated and non-regulated), this is not implementable and revenue distribution is the easiest way to implement a proxy-EPMU.

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[45] Ovum Comparative Costs for Fibre to the Node and Fibre to the Home Rollouts in Australia Final Report to ACCC 10 August 2007 https://www.accc.gov.au/system/files/Ovum%20s%20Comparative%20Costing%20of%20FTTH%20and%20FTTN%20(Aug%202007).pdf

[46] Plum_June08_Evaluating_the_value_of_next_generation_broadband, page 110 http://www.plumconsulting.co.uk/pdfs/Plum_June08_Evaluating_the_value_of_next_generation_broadband.pdf

Therefore we agree with TERA’s use of revenue to allocate non-network expenditure between regulated and non-regulated services. However, TERA’s approach is inconsistent as it then allocates the share of non-network expenditure for regulated services based on network opex rather than revenue.

Firstly it is inconsistent to mix these two allocation methodologies. Secondly, the use of network opex as an allocation key between UCLL and UBA is unreliable as the individual components of non-network opex rely on different drivers to network opex and as different services incur expenditures with differing capex:opex ratios (e.g. UCLL is more capex intensive than UBA) leading to a misallocation of non-network expenditure.

To retain consistency we think that the Commission should allocate non-network opex between UCLL and UBA in the same way as it does between regulated and non-regulated services namely on the basis of revenue.

6 Fixed wireless access

6.1 The 250kbit/s throughput assumed is insufficient for 2019

We agree that the lack of capacity of FWA is an important issue limiting its suitability for this purpose.

The Commission is seeking to set a unit price over the period 2014-2019. It is therefore necessary for the Commission to model the costs in each of these years. The 250kbit/s service modelled may have been sufficient to meet typical NZ retail broadband demand in early 2014, but it is not sufficient on 1 December 2014 and will be grossly inadequate in 2019.

If using a more realistic estimate of the required level of busy hour average sustained throughput per premise in 2019, then the number of premises served by the proposed FWA solution will fall substantially.

Of course, it is highly likely that throughput will continue to grow beyond 2019, placing yet further constraints on the economics of FWA.

6.2 Many of the modelled premises will in fact not be servable

The Commission modelling does not seek to verify whether the selected premises can actually be served using wireless – it uses instead a coverage map which we believe to have been calculated by radio planning tool for a different technology, frequency band, and service specification. In addition, a fraction of the assumed sites will not have the required line of sight to the RBI sites due to either local terrain or vegetation. This means that the model needs to take the following effects into account:

- The propagation model used to generate the coverage maps will have assumed some specific level of availability (e.g. 90% probability of outdoor coverage); this means that even using the coverage maps as provided, a significant number of the notionally covered premises may not in fact be addressable.
- Beyond the finite availability implicit in the coverage map, localised vegetation can also be a significant issue in remote areas. There is considerable use of shelter belts (lines of trees) in New Zealand. Analysis using a GIS indicates that approximately 5.5% of very rural premises in New Zealand are within 50m of such a shelter belt or hedge line. It is very likely that these linear features are not taken into account in the coverage maps used by the Commission (which are likely to be based on terrain elevation and area clutter data).

Telecom offered a so-called Extend service in areas of rural New Zealand in the past, and this service had significant issues with service availability even within notionally covered areas. For the Extend service, approximately 17% of attempted installations within notionally covered areas failed, usually due to lack of signal. NBNCo in Australia has similar issues, and assumes that 7% of NBN FWA installs will fail for this reason.

The net effect of these restrictions will be to make some premises entirely infeasible to serve using wireless means, and to introduce the need for much more costly installation solutions for some other premises (e.g. adding a pole outside the shelter belt plus say 50m of buried cabling). There is no allowance in the Commission's draft model for either of these two effects.

Even a small number of premises that cannot be served will have a material impact on the unit cost as the Commission is assuming that FWA is only used to serve the very highest cost premises. It is not therefore a simple matter of arguing that a different set of 67 premises could be served, as these will by definition offer a lower cost saving.

The Commission should take this effect into account.

6.3 Not all relevant cost components have been included in the FWA modelling

RSPs seeking to use the modelled FWA service would not be able to use existing voice or data CPE. As we have previously argued, and as the Swedish regulator agrees, the costs of the wireless-specific equipment required at the end customer premises ought to be included within the modelled network costs. Not to do so is to shift costs from the UCLL service on to the RSPs; this would give the HEO incentives to move as much cost as possible onto RSPs whether or not it was efficient to do so in terms of minimising total costs.

The coverage map is likely to assume a fixed antenna in an elevated position, suggesting a professional installation is needed. Again, as we have already argued, it would be unreasonable to allow these costs to be pushed outside the cost boundary by the choices of the modelled HEO.

The Commission also models a service which does not include the necessary core infrastructure (such as switches, support nodes, remote node controllers) to allow an RSP to interface to the modelled components (base stations). As it stands, there is no service which could be offered.

These components should be included.

6.4 FWA spectrum cost is too low

According to paragraphs 605/606 of the UCLL Draft Determination, the 2×20MHz spectrum used for fixed wireless access (FWA) purposes has a fee derived from the 700MHz spectrum auction results. In the access model, the value assumed is NZD88 million (cell Assets!L119).

This assumed fee is too low. The average price paid per lot for those sold in the clock allocation round is not the final price paid[47]. The supplementary rounds sold the final lot at a much higher value

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[47] http://www.beehive.govt.nz/release/radio-spectrum-auction-details-announced

as Telecom New Zealand sought to buy that final lot (as its fourth lot) and then also purchase the lowest frequency lots available[48].

The Commission should increase the assumed spectrum cost, as a minimum based on the final outcome of the 700MHz auction, (4/9 of the final auction results is approximately NZD120 million).

Even this may be too low, as a hypothetical new entrant would have been another (fourth) participant in that auction, which would have increased the level of competition for spectrum. Therefore, we would expect a higher price paid for four lots of this spectrum in this circumstance. So the actual price paid may not even be high enough.

6.5 FWA opex is undocumented and too low

The source of the FWA opex is not documented.

Benchmarks from regulator's cost models in Europe indicate higher figures for site and base station equipment operating costs. The opex for 550 sites might be as much as NZD10-14M/annum based on public mobile models from EU regulators.

6.6 FWA backhaul assets are deployed even in the FTTN/copper model

FWA backhaul assets are deployed even in the FTTN/copper access model even though no FWA base stations are deployed in the FTTN/Copper case. This can be seen in the Inventory Sheet of the access model workbook, rows 310-406. This is an error.

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[48] http://www.rsm.govt.nz/projects-auctions/pdf-and-documents-library/recently-completed-projects/digital-switchover-and-the-digital-dividend/700-mhz-auction/700-mhz-auction-notice-of-results, Sectionfs 2 and 3

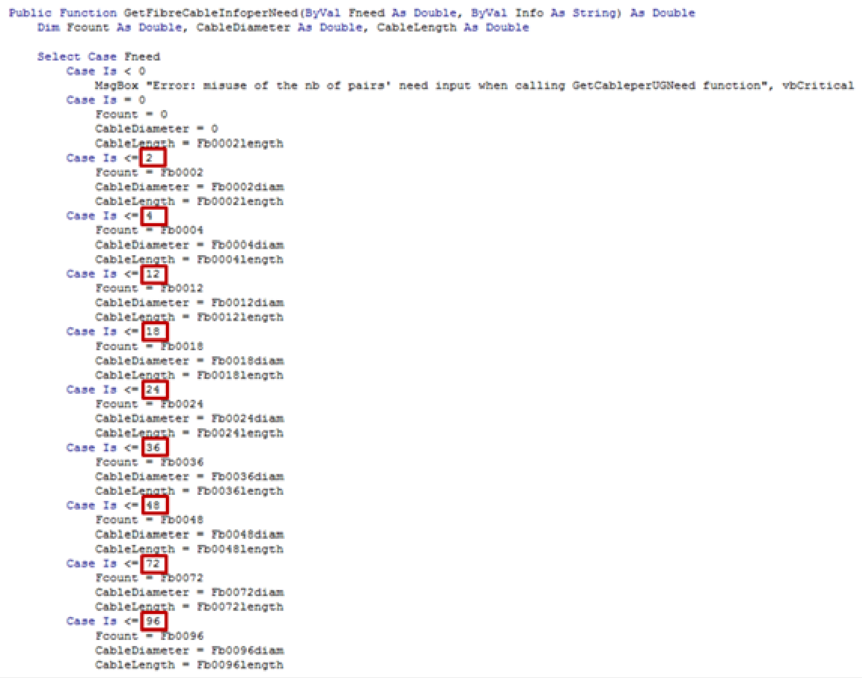
Annex A Flaw identified in the Access database

This annex provides more detail on the flaw identified in the Access database of the draft model in relation to the cable calculations, which had to be fixed to undertake our investigations in Section 2.6:

- Section A.1 describes the nature of the flaw

A.1 Flaw in the cable size inputs

Analysys Mason has attempted to modify the assumed cable sizes, but found that changing the values in the tables SOURCE_INVENTORY_COPPER and SOURCE_INVENTORY_FIBRE was insufficient. This is because the copper and fibre cable sizes used are also hardcoded in the VBA code[49] making it extremely non-transparent as to how users can modify these cable sizes. In order to make such a change, both the tables and the code must be modified. Figure A.1 below illustrates the parts of the code that must be revised for the fibre case (enclosed in red boxes): the copper case is handled similarly in its corresponding subroutine.



```
Public Function GetFibreCableInfoperNeed(ByVal Fneed As Double, ByVal Info As String) As Double
    Dim Fcount As Double, CableDiameter As Double, CableLength As Double

    Select Case Fneed
        Case Is < 0
            MsgBox "Error: misuse of the nb of pairs' need input when calling GetCableperUGNeed function", vbCritical
        Case Is = 0
            Fcount = 0
            CableDiameter = 0
            CableLength = Fb0002length
        Case Is <= 2
            Fcount = Fb0002
            CableDiameter = Fb0002diam
            CableLength = Fb0002length
        Case Is <= 4
            Fcount = Fb0004
            CableDiameter = Fb0004diam
            CableLength = Fb0004length
        Case Is <= 12
            Fcount = Fb0012
            CableDiameter = Fb0012diam
            CableLength = Fb0012length
        Case Is <= 18
            Fcount = Fb0018
            CableDiameter = Fb0018diam
            CableLength = Fb0018length
        Case Is <= 24
            Fcount = Fb0024
            CableDiameter = Fb0024diam
            CableLength = Fb0024length
        Case Is <= 36
            Fcount = Fb0036
            CableDiameter = Fb0036diam
            CableLength = Fb0036length
        Case Is <= 48
            Fcount = Fb0048
            CableDiameter = Fb0048diam
            CableLength = Fb0048length
        Case Is <= 72
            Fcount = Fb0072
            CableDiameter = Fb0072diam
            CableLength = Fb0072length
        Case Is <= 96
            Fcount = Fb0096
            CableDiameter = Fb0096diam
            CableLength = Fb0096length
```

Figure A.1: Hardcoded fibre cable inputs in the VBA that must be revised [Source: Access database, 2015]

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[49] See subroutines GetFibreCableInfoperNeed and GetCuCableInfoperOHNeed in the *Equipment Selection* module in the Access database.

Annex B ARMIS cost analysis

The US FCC gathers various data from the regulated Incumbent Local Exchange Carriers (ILECs). FCC Report 43-03, the ARMIS Joint Cost Report, Table I contains the following data:

Figure B.1: List of data in FCC ARMIS report 43-04 Table I [Source: FCC ARMIS report 43-03 Table I, 2007]

6411	Poles expense
6421	Aerial cable expense
6422	Underground cable expense
6423	Buried cable expense
6424	Submarine and deep sea cable expense
6426	Intrabuilding network cable expense
6431	Aerial wire expense
6441	Conduit systems expense
6410	Cable and wire facilities expenses

Data can be viewed by operating company or at an aggregated level. We have used data for the following major US ILECs::

- Qwest Corporation
- AT&T Inc.
- Verizon Communications

FCC Report 43-08, the ARMIS Operating Data Report Table I.A. Outside Plant Statistics - Cable and Wire Facilities contains the following columns for the years of choice. We have selected 2007 as after this date this report does not contain all the data needed:

- Company
- State or Territory
- Km of Aerial Wire
- Aerial Cable: Sheath Km of Metallic
- Aerial Cable: Sheath Km of Fiber
- Underground Cable: Sheath Km of Metallic
- Underground Cable: Sheath Km of Fiber
- Buried Cable: Sheath Km of Metallic
- Buried Cable: Sheath Km of Fiber
- Intrabldg Network Cable: Sheath Km of Metallic
- Intrabldg Network Cable: Sheath Km of Fiber
- Total Cable: Sheath Km of Metallic
- Total Cable: Sheath Km of Fiber
- Km of Fiber in Cable: Fiber Km Equipped

- Km of Fiber in Cable: Total Fiber Km Deployed
- Km of Metallic Wire in Cable
- Equipped Km of Tube in Coax Cable
- Equivalent Number of Poles
- Conduit System: Trench Km
- Conduit System: Duct Km

We have cross-referenced these two tables to generate a unit maintenance cost per km per annum for the different cable types:

Figure B.2: Cable sheath km for major ILECs [Source: FCC ARMIS 2007]

Total cable sheath km	Aerial copper cable and fibre cable	Underground copper and fibre cable	Buried copper and fibre cable
Qwest Corporation	87,458	117,768	584,256
AT&T Inc.	874,259	517,466	1,804,913
Verizon Communications	949,335	302,649	854,235
Total	**1,911,052**	**937,883**	**3,243,404**

We have added pole costs to aerial costs and conduit system costs to underground costs so as to include these cost components.

Figure B.3: Operating cost summary for major ILECs [Source: FCC ARMIS Joint cost report 2007]

Total costs (USD)	Aerial + pole costs	Underground + conduit costs	Buried costs
Qwest Corporation	130,726,000	53,414,000	549,320,000
AT&T Inc.	1,058,058,000	470,603,000	1,741,683,000
Verizon Communications	1,681,731,000	293,262,000	624,349,000
Total	**2,870,515,000**	**817,279,000**	**2,915,352,000**

We have then derived the unit annual operating cost per-cable sheath km.

Figure B.4: 2007 Annual unit costs per cable sheath km [Source: FCC ARMIS 2007, Analysys Mason]

Unit costs per cable sheath km per annum (USD/km/annum)	Aerial copper cable and fibre cable	Underground copper and fibre cable	Buried copper and fibre cable
Qwest Corporation	1494	453	940
AT&T Inc.	1210	909	965
Verizon Communications	1771	969	731
Average	**1502**	**871**	**899**

As can be seen, the resulting annual operating cost per km of cable sheath is significantly lower for buried and underground cables and significantly higher (well over 50% higher) for aerial cable. It is therefore necessary to allow for this effect if the Commission assumes a significantly larger use of aerial distribution in New Zealand.