Report

FPP Corridor Cost Analysis – Report 3, New Rates and General Recommendations

Prepared for Commerce Commission (Client)

By Beca Ltd (Beca)

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Revision History

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A	Barry Calvert	Draft issues	13-18 May 2015
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Document Acceptance

Action	Name	Signed	Date
Prepared by	Barry Calvert		05/06/2015
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1 Report Scope

Subsequent to the release of our draft report entitled FPP Corridor Cost Analysis Response to Submissions April 2015, we were asked to attend a meeting with the Commerce Commission ("the Commission") and two employees of TERA Consultants ("TERA"). The agenda for discussion was for TERA to explain how they had used the trench pricing information supplied by us (Beca) in the UBA and UCLL modelling.

The outcome of the meeting is that Beca have been asked to provide further advice to the Commission regarding the following items:

a) Trenching methodology - when a particular trenching technology is most appropriate and the limitations of each option

b) National trends for contractor discounting for large packages of work

c) Long term pricing trends for civil works in New Zealand

d) Rates for reinstatement

e) Rates for trench reinforcement of 3-4 ducts 110mm dia containing 5,000+ lines

f) Revised rates for high-density Polyethylene (HDPE) duct in all locations

The following report addresses each of these in detail and provides the information requested and, in most cases, a recommendation for best or most appropriate use.

2 Introduction to Trenching Methodologies

Beca, in its report to the Commission in November 2014 entitled FPP Corridor Analysis of Trenching and Ducting Rates in NZ – Final Issue Nov14 published on the Commissions website ("the Beca Report")[1], made general assumptions regarding the common types of trenching technologies (methods) that could or typically would be used in differing soil types and in urban environments throughout New Zealand.

In Table 2 (page 5) of our draft report we outlined appropriate trenching types as follows:

Soil/Rock Category	Appropriate Trenching Types
Soft Soil (Rural only)	Mole Plough (cable only) Chain Digger Open Trenching Directional Drilling
Medium Soil (Rural only)	Mole Plough (cable only) Chain Digger Open Trenching Directional Drilling

[1] Beca-FPP-Corridor-Cost-Analysis-Full-Report-Nov-2014

Soil/Rock Category	Appropriate Trenching Types
Hard Soil (Rural only)	Open Trenching Directional Drilling
Soft Rock (Rural only)	Open Trenching only
Hard Rock (Rural only)	Rock saw only
Urban	Open Trenching Directional Drilling Thrust boring

The purpose of categorising trenching methods in this way was to steer TERA to the appropriate technology for each specifically defined soil type (see Appendix 1 of the Beca Report) and to alert them to the limitations of each method.

Table 2 (copy above) notes in brackets below soil types 1 to 5 that the technology is limited to rural areas only. This was meant to distinguish rural locations from urban locations. It should be noted that the Urban areas identified in our geotechnical report also include what is commonly known as suburban development. However there will be many cases of built up (developed) areas in New Zealand that are not specifically identified as "urban" in our report. These will include housing areas in smaller towns which are serviced by sealed streets, paved footpaths and concrete driveways passing over grassy berms. Suitable trenching methods for these areas should be selected from the Urban options.

3 Open Cut Trenching

Open Cut Trenching is the traditional and most popular method for laying sewer and stormwater pipe as well as for cable ductwork in many situations. It provides "open", unrestricted access to the trench and guarantees visibility when there is the likelihood of encountering other services, tree roots or other obstacles. In fact it is the required method for dealing with underground congestion, tight changes in duct direction or or multi-directional junctions.

The open cut trench method involves excavating down to the required reduced level, either by hand (in limited circumstances) or with the use of mechanical hoes ("diggers" or "bucket excavators"), installation of the ductwork and then backfilling. If the open cut trench excavation is located in a non-pavement area the excavation can be backfilled with soil and surface vegetation restored by seed or sod. When the open cut trench excavation is located under pavement the existing pavement must be saw cut and removed, the excavation filled with granular backfill (compacted stone or sand to prevent settlement), and the pavement replaced (made good to match adjacent surfaces).

3.1 Benefits

- Can be less expensive than trenchless methods in non-pavement areas.
- Usually necessary for replacement of damaged ducting or cabling
- Can be undertaken by smaller contractor as it does not require specialist machinery
- Provides the best trench access for dealing with underground congestion
- Becomes more cost effective in paved areas where multiple ducts are required in one trench

3.2 Limitations

- More excavation is required than compared to other methods.
- May require removal of street and sidewalk pavement which increases expense
- Traffic issues including obstruction, accidents, extra cost in diversions such as maintenance
- Environmental issues - dust and air pollution by vehicles and machines, noise pollution to public, pollution of ground and surface water etc.
- Trenches over 1.5m deep and in sandy or ovular soil types require trench shields (or shoring boxes – see photo on right) to protect from collapse
- Road repair and rehabilitation costs, compensation for damage to vehicles from flying chips

- Safety considerations mean that open trenches cannot be left unattended without covers, barriers to prevent public access are required along with safety and directional signage.

3.3 Design Considerations

When considering the path of the proposed open trench thought needs to be given to safety issues associated with its proximity to roadways and public walkways, keeping essential roads and private driveways accessible, availability of space for truck parking or the lay down of backfill, sufficient room for excavator arm & bucket movement, the height of overhead wires, and establishing the location of existing services.

The reinstatement of roadway surfaces including all structural backfill must comply with local authority regulations and guidelines. Any such repairs to state highways must comply with TNZ HM12 “Digouts” specification.

3.4 Recommended Use

This method can be used in all situations with the exception of soil type 5 “Hard Rock”. It is ideal for urban areas where underground services are congested, and for soft, rippable rock. It can also be cost effective in sandy and ovular soils or where the water table is high.

It should be noted that trenchless methods may often require the use of open trenching for the excavation of entry and exit pits.

4 Chain Diggers

Often called chain trenchers, these machines are mounted on either the back of a tractor unit or on the end of a bucket excavator arm. They cut through the soil with a digging chain or belt that is driven around a rounded metal frame, or boom. It resembles a giant chainsaw. This type of trencher can create narrow and deep trenches, and the angle of the boom can be adjusted to control the

depth of the cut. To cut a trench, the boom is held at a fixed angle while the machine creeps slowly forward.

In New Zealand the chain trencher is used mostly for digging narrow trenches in rural areas electrical cables, water mains, gas pipe, smaller diameter drainage and ducting (suitable for 110mm PE).

The excavated material is normally deposited to one side of the machine and is easily reinstated. However when centrally mounted behind a tractor this trenching method requires a clear corridor of between 3.0m and 4.0m wide to accommodate machine wheels/tracks and excavated material.

Utilising a conveyor belt system and rubber tyre tractor the excavated material can be deposited into trucks alongside (either side) the operating chain, which is ideal for jobs where minimal ground surface repair is required, such as playing fields and golf courses.

4.1 Benefits

- One of the fastest methods of simple, narrow trench excavation
- Lower cost option in rural, non-paved areas
- Provides good trench access

4.2 Limitations

- Not suitable in urban environments, rocky soil (types 4 & 5) and un-consolidated soils
- Cannot be used cost effectively where existing underground services are present
- Requires 3.0m to 4.0m wide corridor
- Unable to trench through paved surfaces
- Trenches are relatively narrow and duct numbers are therefore dependant on trench depth

4.3 Recommended Use

This method is ideally suited to rural locations where soft and medium soil types (1 & 2) are present to a reasonable depth, and where there are no existing underground services. It distinguishes itself above mole ploughing where multiple ducts of 110mm diameter are required

5 Mole Ploughing

Mole ploughing is a trenchless method to bury cables or pipes. The machinery is a form of a traditional plough with a single blade. It is used to lay buried services of virtually any description, for drainage, water, electricity, telecommunications, gas supply etc.. A coil of the service pipe/cable is mounted on the tractor and is led down a guide behind the blade, and is left buried behind the plough, without the need to dig a deep trench and re-fill it.

This process is normally used in rural areas where previously buried services will not be encountered and there are no hardened surfaces, e.g. asphalt or concrete pavement.

The plough blade is often attached to the back of a large tracked machine (D8 bulldozer or similar) but can also be attached to a bucket excavator arm. This method is a fast way of laying long lengths of small diameter cable or ductwork – up to 63mm diameter, with some rigs set up to lay multiple lengths at the same time. Depths of around 1.0m are achievable with very little ground disturbance. Offset blades allow for ploughing close to fences or the like.

A few contractors have a vibratory plough to cut the ground as opposed to forcing open. This means that it does not require the weight or traction of the conventional tracked rigs and can be mounted on rubber tyre tractors which cause less damage to the ground surface.. It also enables deeper embedment (1500mm) and slightly larger diameter ducting (up to 125mm).

This method is ideal for laying continuous runs of pre-ducted telecommunication cabling, power cables, water pipe and gas pipe.

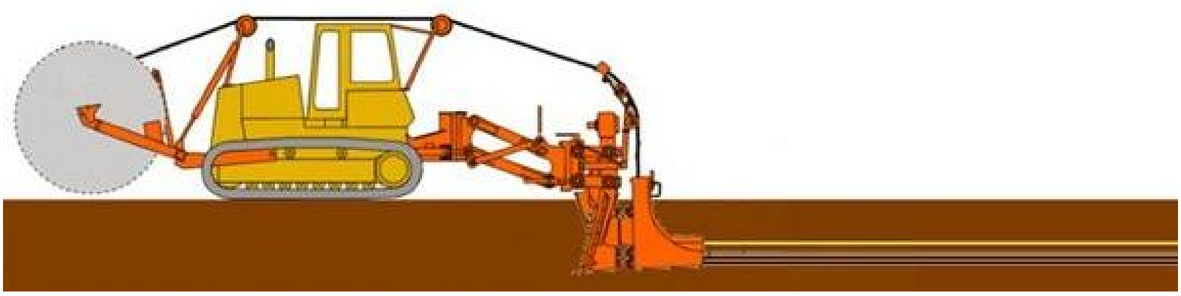
5.1.1 Benefits

The benefits of mole ploughing are:

- The fastest method of laying continuous pipe or cable
- Lowest cost option in rural, non-paved areas
- No significant ground reinstatement necessary
- Best option for un-consolidated soils
- Not restricted to straight line installations

5.2 Limitations

- Not suitable in urban environments or for harder soil types
- Cannot be used cost effectively where existing underground services are present
- Requires 3.0m to 4.0m wide corridor to accommodate machine tracks
- Unable to trench through paved surfaces
- Limited number of ducts in one trench
- Tracked vehicles leave impressions



5.3 Recommended Use

This method is ideally suited to rural locations where soft and medium soil types (1 & 2) are present to the required depths, and where there are no existing underground services.

Its only advantage over chain trenchers is speed and cost when it comes to installing a single 110mm PE duct.

6 Trench Surface Reinstatement

Techniques for excavating open trenches have developed over many years however the need to reinstate the original surface has often been a costly issue. Applied surface treatments such as roading, pavements, footpaths, driveways, and complex planting are expensive so the removal of these items should be avoided if possible, especially for relatively inexpensive reticulation work. Costs associated with trench reinstatement in urban and suburban areas are provided later in this report.

Other obstacles to open trenching (less relevant to our study) are immovable items such as non-habitable structures, railway lines, rivers and streams. In many of these cases the most cost effective option would be to tunnel underneath.

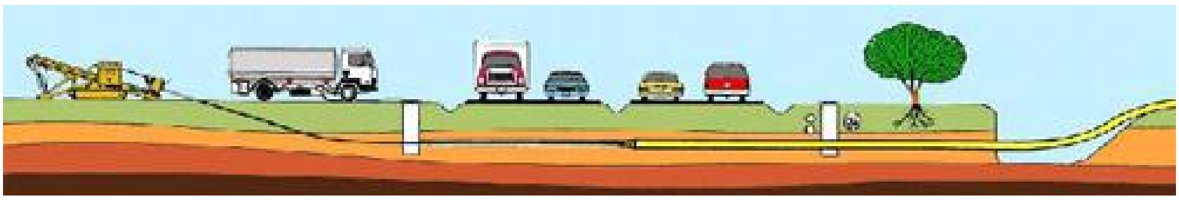
Newer “trenchless” technologies have been developed which leave the surface of the ground un-disturbed. Two technologies in particular are now commonly used in New Zealand for the reticulation of, power cables, telecommunication lines, gas mains, water lines, drainage pipework and product supply lines. These are Horizontal Directional Drilling (HDD) and Thrust Boring.

7 Horizontal Directional Drilling (HDD)

Sometime called directional boring, HDD is an extremely versatile trenchless technology that is used for the installation of everything from service connections to residences and buildings, through to pipes and cables under roadways and rivers. HDD is best suited for installing pressure pipes and conduits where precise grades are not required.

The main components of HDD are a directional drill rig sized for the job at hand, drill rods linked together for advancing the drill bit and for pulling back reamers and products, a transmitter/receiver for tracking purposes and drilling fluid.

A large, modern drilling rig can bore a hole 150mm in diameter 2km in length, and as large as 500mm over shorter distances.



7.1 Benefits

The advocates of HDD advertise the benefits as being:

- Less traffic disruption
- Deep and long installations are possible

- No access pit required
- Relatively short completion times
- Directional capabilities
- By boring underground the working area is confined to points of entry and exit only

7.2 Limitations

Directional boring can be used in a wide variety of conditions but is not the optimal method in all conditions. The most difficult ground formation for any method is un-consolidated soils (cobble). In some cases the un-consolidated soils can be grouted and then bored. Directional boring can be used for sanitary sewers but only when ground conditions permit a straight path.

7.3 Design Considerations

When designing a project for directional boring it is important to have accurate geo-technical data, sufficient space for the bore rig and support equipment and enough space for laying out the pipe on the other side. It is best to allow extended work-hours for boring operations and is essential for pull-back. Additional considerations may be required for specific projects. Pipe which can be used for directional boring installations includes HDPE, mechanical joint PVC and steel.

7.4 Comments Regarding Cost

Directional boring has evolved steadily over the last 20 years and is now the preferred method on many installations due to its low cost and low impact on surroundings. It is generally less expensive than other methods such as micro-tunneling, jack & bore and open trenching in urban areas. In urban areas it can not only save a considerable amount on installation cost it can provide a tremendous amount of public goodwill.

7.5 Recommended Use

This method can be used in both urban and rural locations with the machines operating well in soft, medium or hard soil types (1-3). HDD is ideal for suburban street berms where the duct runs can easily pass below concrete paths and driveways. It can also be effective in urban situations where open trenching is either not possible or too disruptive.

8 Thrust Boring

There are two main types of thrust boring. Most commonly used in urban areas for cable reticulation are impact (hammerhead) moles, sometimes known as pneumatic piercing tools. These are only suitable for smaller diameter bores (up to 75mm) but are very easy to use with minimal setup and low equipment cost.

More widely used for very large diameter boring is hydraulic thrusting or pipe ramming. This technology is however more expensive due to the cost of machinery, the scope of work required at the thrusting pit end and the slower installation speeds.

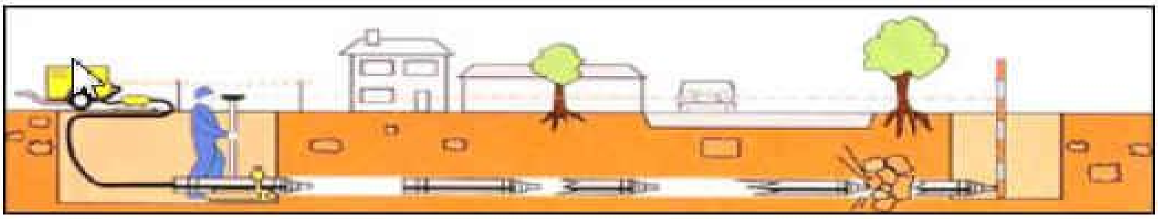
8.1 Piercing Tools

Besides gas and water service lines, these tools are used for cabling, cable ducts, garden irrigation, water treatment systems, outside water supplies, landscape lighting, drain replacements, lead piping replacement, etc. Impact moles can also be used for other applications, for example in pipeline rehabilitation for pulling a liner into the pipe or in non-utility applications for the installation of environmental wells.

8.1.1 How This Technology Works

This technique involves two excavations (launch and receive), where the torpedo shaped mole is lined up on the target in the first pit, the mole is pneumatically powered and hammers its way through the ground. On entering the receive pit the mole is removed from the air line which is then attached to the pipe / cable to be pulled back through the hole that has been bored.

Soil displacement hammers have been an economic and ecological alternative to open trenching for more than 20 years. Operated by compressed air, the mole thrust borer makes its way accurately through the ground creating a bore hole in all compressible soils.



8.1.2 Benefits

The advocates of Thrusting advertise the benefits as being:

- Open excavation only necessary at entry/connection points or changes of direction
- Minimal disruption to ground surfaces and property
- Suitable for almost all types of soil conditions.
- By tunneling underground the working area is confined to points of entry and exit only

8.1.3 Limitations

Impact moling can be used for installation of pipes up to 250mm in diameter, but typically is used for pipes in the diameter range between 12mm and 100mm. Installed pipes are usually made of PVC, HDPE or steel. Depending on tool size and soil conditions, the maximum boring distance for non-steerable moling is around 30m, but the typical installation length is usually up to 10m in one run and is usually limited by the length of the hose that supplies the tool with air.

The most commonly used tools are not steerable so once the hole head has exited the bore pit the operator no longer has control over it. The tool can be deflected by rocks and soil density to a path the operator had not intended. If this deflection is in the direction of the surface the tool can cause damage to the obstacle being bored under if it is downward the tool can dive to unrecoverable depth. If it is deflected side to side the tool could also run into other utilities.

The type of ground the tool is working in can also lead to problems if the soil is too loose the tool cannot compact the soil stalling it out or leaving no bore hole. If the soil is rocky the tool may be deflected or fail to pound forward due to its inability break the rock. Because the method uses a compaction principle to create the bore, this technique is most appropriate for compressible soil types such as clays, silt, peat and generally soft cohesive material. Sands and gravel are considered less appropriate, especially if they are densely packed, but can be penetrated successfully. Solid rock however is entirely unsuitable for this technique.

Also penetration rates of moles are marginally slower in comparison to other techniques such as directional drilling and should be taken into account when longer bores are being considered.

8.1.4 Design Considerations

When designing the borehole layout, consideration needs to be given to project requirements, equipment capabilities, and ground conditions. Although most ground conditions can be moled, they are not equally suitable for moling: the best soil type is moderately compacted soil with moderate moisture content that stays unchanging along the desired borehole route. Difficulty arises with loose soil, wet sand and solid rock, and changing ground conditions: changes in strata both natural and artificial[3] should be identified.

All underground objects on the job site must be located and known, i.e., depth and exact position of sewer and water mains and other utility lines, and any other facility to be crossed. Consideration should also be given to the possible existence of tree roots, as they normally obstruct moling operations. In the design phase, the existing ground conditions may affect selection of borehole route, mole type and mole head design.

Most bores done with impact moles are planned as straight bores. The working depth should be at least 10 times the tool diameter or approx. 1.2m, whichever is larger, to avoid surface damage from soil displacements. This minimum ground cover provides sufficient overburden to ensure directional stability of the hole. If the hole is too shallow, the mole can have the tendency to rise toward the surface. Thus, other types of installation methods should be considered when shallower product installation is desired.

8.1.5 Comments Regarding Cost

The equipment set up costs for impact moles are lower than those of directional drilling, however due to the necessity of excavating entry and exit pits, slower boring speeds and typically shorter runs, the rate for installing longer lengths of 110mm diameter PE ductwork (for example) using this method is higher than directional drilling.

Where this method comes into its own (and is most cost effective) is single, short runs of smaller diameter conduit for the likes of telecommunications cables to individual residential dwellings.

8.1.6 Recommended Use

Useful in both urban and rural locations, this trenchless technology works well in most soil types. Impact moles are ideal for short runs of small diameter duct and can be cost effective for single bores in suburban street berms or under local roads.

8.2 Pipe Ramming

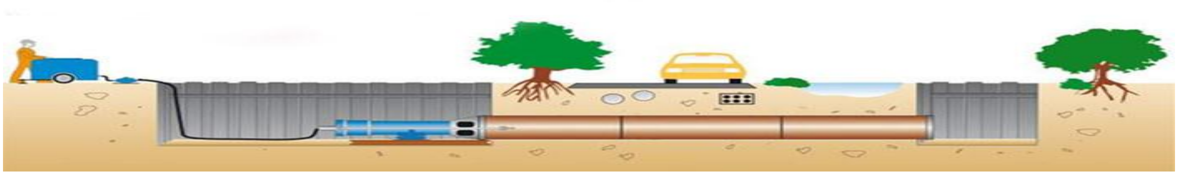
The pipe ramming method is for the installation of steel pipes and casings only. Distances of 30 m or more and over 1,500mm in diameter are common, although the method can be used for much longer and larger installations. The method is useful for pipe and casing installations under railway lines and roads, rivers, airports, buildings, contaminated landfill sites and Sites of Special Scientific Interest (SSSI) where other trenchless methods could cause surface settling or heaving.

The majority of installations are horizontal, catering for water, oil, gas, electricity, sewerage, chemicals, communication ducts and outfalls. The method can however be used for vertical installations.

8.2.1 How This Technology Works

The method uses pneumatic percussive blows to drive the pipe through the ground. The leading edge of the pipe is almost always open, and is typically closed only when smaller pipes are being installed. Its shape allows a small overcut (to reduce friction between the pipe and soil and improve load conditions on the pipe) and to direct the soil into the pipe interior instead of compacting it outside the pipe. These objectives are usually achieved by attaching a soil-cutting shoe or special bands to the pipe.

Further reduction of friction is typically achieved with lubrication, and different types of bentonite and/or polymers can be used (as in horizontal directional boring) for this purpose. Spoil removal from the pipe can be done after the entire pipe is in place (shorter installations). If the pipe containing the spoil becomes too heavy before the installation is complete, the ramming can be interrupted and the pipe cleaned (longer installations). Spoil can be removed by auger, compressed air or water jetting.



8.2.2 Benefits

The benefits of pipe ramming are:

- Dry method of installation - does not generate slurry
- Trenchless installations over distances up to 130 metres are possible
- Ideal for working on embankments or in changeable ground conditions
- No disruption to surface, buildings, road, river, rail or traffic
- The required method for any pipework or ducting under New Zealand Railway

8.2.3 Limitations

Pipe ramming is typically used for pipe installation over relatively short distances, usually up to 45m feet, but longer installations have been successfully accomplished. The method is mostly used on large diameter pipes between 500mm and 1200mm in diameter, although much larger pipes can be successfully rammed in the right ground conditions.

Although pipe ramming can be applied in a wide variety of soils, some soils are better suited for this method than the others. The most suitable soil conditions for pipe ramming are soft to very soft clays, silts and organic deposits, all sands (very loose to dense) above the water table, and soils with cobbles, boulders and other obstacles of significant size but smaller than pipe diameter. Most other soil types can be rammed through but the only soil conditions that pipe ramming is completely unsuitable for is solid rock.

Limitations generally come from the economical, environmental or safety aspects of the process. Drawbacks include high noise levels, which are typical for pipe ramming (if no noise protection barriers are used), and sometimes a significant soil disturbance that can happen if a blockage is created at the end of the installed pipe.

8.2.4 Recommended Use

Beca has not recommended the use of this trenchless technology. It is too slow and is limited to installations of 130m or less. This makes it too expensive per lineal metre over long distances.

9 Trenching Methods – Summary of Recommendations

The following table summarises the recommended trenching options addressed in the previous sections. These are general recommendations only and may not be the best option in some cases:

TRENCHING METHOD FOR 110MM DIAMETER POLYETHYLENE DUCT	RECOMMENDED USE - WHERE THIS METHOD CAN BE USED MOST BENEFICIALLY
Open Cut Trenching	Soil type is soft rippable rock; relocation of existing underground services; navigating through underground congestion; entry & exit pits (where required); wherever duct reinforcement is required; rural outlying areas where larger trenches are needed and no directional drilling rigs are available.
Chain Diggers	In rural areas only with minimum 4.0m corridor where more than one duct is required in soft or medium consolidated soils and no existing underground services are present.
Mole Plough	In rural areas only with minimum 4.0m corridor where only one duct is required in soft, medium or un-consolidated

	soils and no existing underground services are present.
Directional Drilling	In urban or suburban areas where multiple ducts are required in soft, medium or hard consolidated soils and surface reinstatement would be costly.
Piercing Tool	In urban and suburban areas where one duct is required in soft, medium or hard consolidated soils and surface reinstatement would be costly.

10 Contractor Discounting

The Commission has requested that Beca investigate price discounting trends by civil contractors when competitively tendering for large packages of work in New Zealand.

10.1 Method of Investigation

Our approach was to utilise the best of Beca's internal resources from around the country. We interviewed professionally qualified quantity surveyors and civil estimators in our four largest New Zealand offices, researched our recent cost data including tenders received both locally and regionally and gauged opinion from around the business on regional pricing trends. We also compared all of this information to the results of our previous rate build-up exercise.

10.2 Findings

In Auckland, Tauranga, Wellington and Christchurch the findings were consistent. Our research indicates that there are regional variances in contractor rates, but these appear to relate more closely to population size (size of the market) and the number of contractors competing within that market, and to a lesser extent the size of work packages being tendered. This has been confirmed recently as part of Beca's involvement in one significant joint public/private sector project that required us to evaluate tender submissions for similar sized packages of work throughout the country. The trend in this particular case was for tender bid rates in the larger cities to be consistently lower than the rates submitted in the smaller cities.

In Beca's experience, when contractors consider the level of discount they will apply to a specific tender, there are a significant number of determining factors. These include:

1. Market size and the number of contractors servicing that market
2. The buoyancy (or otherwise) of that market, i.e. supply vs demand
3. Their current and guaranteed future workload
4. The scope of work – how large is it and what are the risks
5. Is this an iconic or high profile job that the firm would benefit from being associated with
6. Companies capacity to grow and take on more work, i.e. can they find more resources?
7. The job (project) locality - greater distance = higher travel and supervision costs
8. Job difficulty and/or likelihood of low productivity
9. Will there be any material supply issues – stock availability, lead times, delivery costs
10. Local competitive advantage - good reputation, more modern machinery etc.

11. Relationship with client – mutual trust, good payment terms etc
12. Conditions of Contract – retention clauses, variation clauses, risk allocation
13. And a willingness to reduce profit margin, which is generally linked to all of the above

If market conditions are favourable to contractors, i.e. where demand exceeds supply and business is good, then contractor's tender pricing is higher and there is less competitive pressure on them to discount their work. Conversely, where supply exceeds demand and winning work becomes harder, then there is significant pressure for all tenderers in the market to negotiate discounts with their suppliers, take greater risks and reduce their profit margin.

Very large projects carry greater levels of risk and often result in lower profit margins. It is becoming commonplace for principals to use the conditions of contract to pass on more and more risk to the contractor. For this reason anecdotal evidence suggests that small to mid-size contractors and specialist subcontractors who do not have substantial financial backing will avoid large, risk filled contracts whenever possible.

Many Tier 1 (very large) building or civil contractors for example do not necessarily compete for very large projects with the hope of a healthy margin, but more for reasons of work continuity and "keeping their people busy". This is where the term "buying the job" comes from.

10.3 Conclusions

Our research on discounting has been inconclusive. We have not been able to verify that when tendering in a localised market, larger packages of civil work will necessarily result in greater discounts than small to mid-size packages. We were also not able to prove that discounting is applied consistently by contractors within a given area.

While monthly turnover was a contributor, other factors needed to be taken into account when assessing a contractor's willingness to reduce their margin. These include a firm's current and future workload, the job locality (travel distance), degree of difficulty, client reputation, conditions of contract, local competitive advantage and the state of the tender market.

One comparison we were able to make is that contractor pricing will be cheaper in more populated areas. This was borne out in our November 2014 report where the regional variations clearly showed Auckland rates were the lowest in the country.

In summary, we believe the national average rates we have provided are competitive and would not likely be any lower (on average across the country) when offered to the tender market in large packages of work.

As requested by the Commission we have re-priced some of our rates to allow for High Density Polyethylene (HDPE) ducting in all cases, however beyond these changes we do not recommend that the rates be lowered any further.

11 Long Term Price Trends

In our initial November 2014 report[2] we forecasted the annual inflation rate for civil works in New Zealand at 3.0%. The Commission has requested that Beca re-visit this exercise and expand the

[2] Beca-FPP-Corridor-Cost-Analysis-Full-Report-Nov-2014, section on Inflation (page 8)

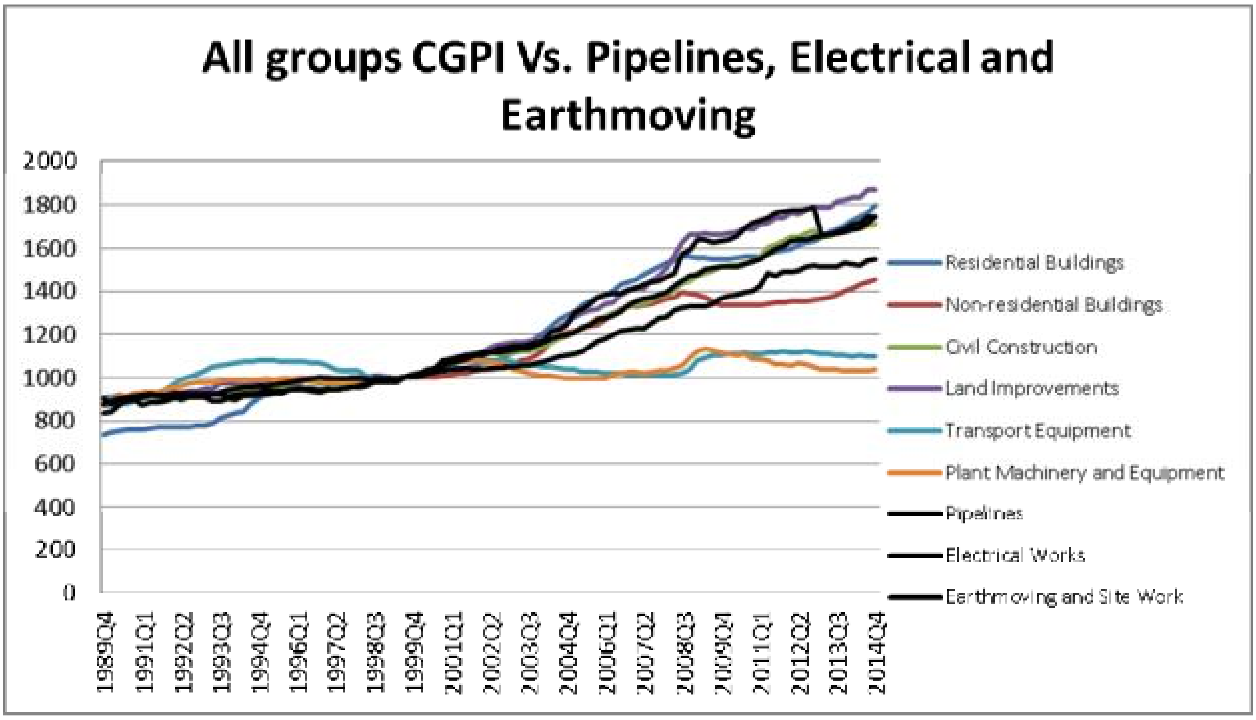
research to include past pricing trends over the last 20-25 years, and forecast a long term rates out to 2035.

Our investigation has found that the compound annual growth rate (CAGR) for the period Q4 1989 – Q4 2014 (25 yrs) for pipelines, electrical works and earthmoving and site work have each been weighted to provide annualized inflation rate of **2.635%.**

Pipelines, electrical works and earthmoving and site work have been used due to their definitions in the industrial construction classifications from StatsNZ website.

Beca has chosen not to use All groups CGPI, which CEG recommended as it includes residential buildings, non-residential buildings, civil construction, land improvements, transport equipment and plant machinery and equipment. We feel that these other sub groups distort the annual growth rate, which can be seen in Graph 1 below.

Graph 1



The black lines are pipelines, electrical works and earthmoving and site work which are three price indices that we feel are the most relevant, when you look at Transport equipment and plant machinery and equipment, they are significantly lower than the three key indices, which provides an explanation as to why the all groups CAGR over 25 years is 1.76%.

The three indices used can be seen in Graph 2 on the following page, and are tracking reasonably close to each other over the last 25 years.

Because there are three relevant indices we have chosen to use a weighted average. The largest cost to trenching and ducting is earthmoving and site works, therefore we have given a 50% weight to this and 25% each to pipelines and electrical works. These calculations can be seen in Table 1 on the following page.

Graph 2

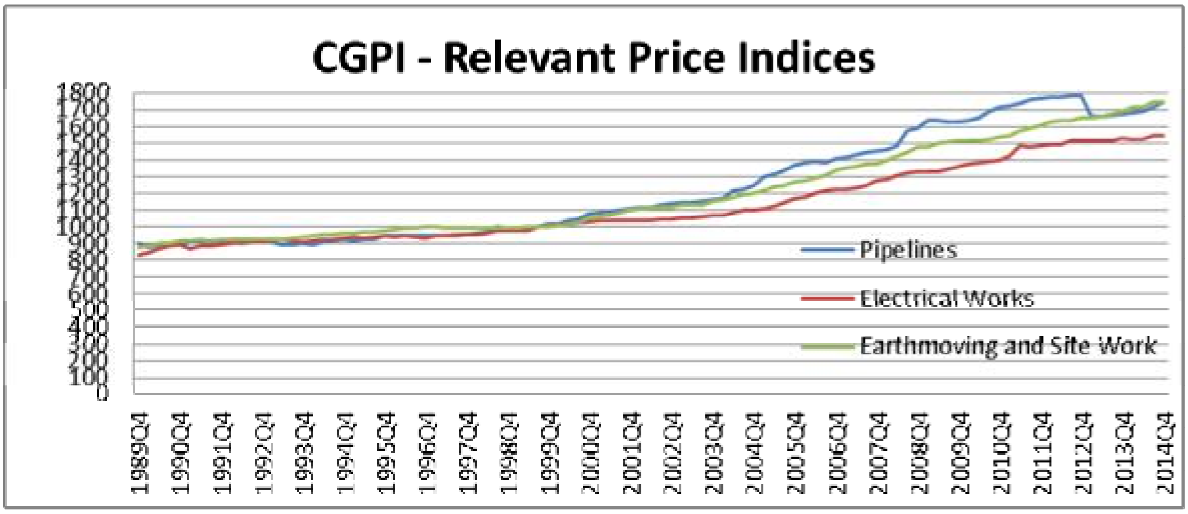


Table 1

Pipelines		Electrical Works		Earthmoving and site work	
Q4 1989 - Q4 2014	25 years	Q4 1989 - Q4 2014	25 years	Q4 1989 - Q4 2014	25 years
2.57138%		2.46414%		2.75294%	

Pipelines	0.642846%	25%
Electical	0.616035%	25%
Earthmoving	1.376469%	50%
yearly increase	2.635350%	

Civil construction was a group that could also have been used; We chose to breakdown the components of civil construction as roads were also included. The CAGR for construction was 2.69% while the weighted average of the three measures was 2.63%.

With reference to the trenching and ducting costs provided in our November 2014 report, we have calculated 20 year inflation table and plotted this in a graph, using the costs for 6 ducts. Calculations have been provided for each of the soil types as well as 40-50mm and 110mm for open trenching 400 wide in most cases.

This data can be seen in Graph 3 – refer to Appendix 1 at the end of this report. We have also included data labels for urban soil type 2/3 as an example to show how the values increase with inflation at year 1, year 10 and year 20. (Note: the Beca starting figure is year 1 so the inflation is actually for 19 years)

12 Rates for Reinstatement

As most of the rates supplied to the Commission in November 2014 were for rural areas only, we have been asked to provide generally applicable, national average estimators rates for trench reinstatement where concrete or asphalt surfaces have been disturbed.

The following table provides a range of rates, with a recommended overall "average" rate of NZD $40.00 per metre

Reinstatement Rates per Metre of Trench 400mm Wide	NZD
30 thick AC14 asphalt on compacted basecourse	34.00
70 thick concrete pathway on compacted basecourse	26.00
100 thick concrete pathway on compacted basecourse	36.00

Reinstatement Rates per Metre of Trench 600mm Wide	NZD
30 thick AC14 asphalt on compacted basecourse	52.00
70 thick concrete pathway on compacted basecourse	40.00
100 thick concrete pathway on compacted basecourse	54.00

Average over the six rates = NZD $40.33

13 Rates for Trench Reinforcement

Rates for trench reinforcement were requested for situations were essential data services need to be protected from heavy vehicular traffic, such as where copper or fibre cabling enters a nationally or regionally strategic building (exchanges or data centres).

The following overview provides three specific solutions; heavy-duty precast underground ducts of two different sizes, and reinforced concrete trench infill. Each one is large enough to protect a minimum 5,000+ lines.

Type 1 – Small Precast Duct

Description: four (4) x 110mm diameter PE ducts installed into 520 wide x 460 high heavy duty (trafficable) precast concrete duct with 130 thick reinforced precast concrete lid in 700 wide x 600 deep trench including 50 thick site concrete base, 140mm of GAP40 compacted backfill above and
30 thick AC14 surface reinstatement.

Rate: $650 per metre

Type 2 – Large Precast Duct

Description: four (4) x 110mm diameter PE ducts installed into 760 wide x 650 high heavy duty (trafficable) precast concrete duct with 150 thick reinforced precast concrete lid in 900 wide x 800 deep trench including 50 thick site concrete base, 150mm of GAP40 compacted backfill above and
30 thick AC14 surface reinstatement.

Rate: $850 per metre

Type 3 – Solid Concrete

Description: four (4) x 110mm diameter PE ducts installed into 400 wide x 750 deep trench with a typical reinforcing steel cage (45kg/m3), solid concrete infill 450 high, 300mm of GAP40 compacted backfill above and 30 thick AC14 surface reinstatement.

Rate: $240 per metre

14 Rates for HDPE

During discussions with the Commission and TERA Consultants (France), it was determined that Beca should recalculate the trenching and ducting rates previously supplied[3] to allow for HDPE ducting in all trenched and trenchless solutions including open excavation and chain trenching.

Beca was also made aware that in the TERA modelling exercise there was never a need for more than eight ducts in a single trench (or run). For this reason our revised rating calculations have been limited to 12 ducts in one trench, down significantly from 36 in the original report.

The revised Rate Tables produced can be found in Appendix 2 at the end of this report.

15 Traffic Management

Throughout the month of May 2015 we have been asked to respond to a number of queries from TERA regarding the value and apportionment of traffic management (TM) and consenting allowances. In some cases these questions have highlighted slight inconsistencies in our TM calculations. During the process of updating the rates tables for PE we have taken the opportunity

[3] BECA-Corridor-Cost-Analysis-for-Trenching-Rates-public-version-Dec-2014

to make the appropriate adjustments with the aim of applying TM costs more realistically across all methodologies. Relevant portions of our email responses[4] to the Commission are included below for transparency.

25/05/2015 - With reference to the Traffic Management & Consenting (TM&C) allowances, in our previous worksheets for open trenching we added a percentage to the duct base rate for TM&C – 10% for rural and 20% for urban. This has now been recalculated at $5 per metre of trench in every situation. The logic for the change was that adding a percentage to the duct price had a compounding effect. So for example in the case of 100 dia ducts in an urban trench, the TM&C allowance for one duct was $7.00 per metre, but for eight ducts it became $56 per metre of trench. The revised method of calculating TM&C makes the open trenching allowance consistent with directional drilling, and effectively reduces the overall cost per metre for each additional duct in a single trench.

25/05/2015 - Regarding PE rates, we confirm discounted supply rates for PE as $10/m for 50dia and $15/m for 110dia. Installation rates are $12/m for 50dia and $15/m for 110dia. This will now apply to all trenching methodologies mentioned in our report. The reason why directional drilling and chain trenching rates did not change is that flexible PE duct must be used for HDD, mole ploughing and thrusting, and was also allowed for in the chain trenching rates.

25/05/2015 - A note on trench reinforcement. In the recent rates table emailed to you 23 April, we provided rates for simple trench reinstatement only, i.e. no allowance for other roading items or transitions. The allowances of $40 and $60 included in the Trenching and Ducting tables do allow for the occasional reinstatement of other miscellaneous roading items such as manhole lids, short lengths of kerb & channel, crossings and road markings.

27/05/2015 - As a general rule using directional drilling requires more labour resource per metre than open trenching, so traffic management is usually required for a relatively longer period.

27/05/2015 - Regarding chain trenching our scope of work was to provide national "average" rates so we do need to consider all of the possible situations and locations in which this methodology may be used. If it was being used for example along-side a rural road or state highway then traffic management would definitely be required and $5.26 may not be enough. However if TERA could guarantee that their model will never utilise chain trenching in a "road-side" situation, then we would consider removing the TM component altogether.

04/06/2015 - We are concerned at TERA's comment regarding the use of chain trenching along roads where there are buildings. Beca has been pretty specific in our recommendations about NOT using chain trenchers anywhere close to incoming services.

[4] From Barry Calvert, Beca Associate and Senior Cost Manager

04/06/2015 - Beca has created another series of rates for chain trenching excluding traffic management. We have also amended the traffic management allowance for this methodology (downwards) to account for the reduced worker protection along rural roads. At this point we would caution TERA against using the lower rate (excl TM) where ductwork is being installed alongside any public road. NZ and local authority regulations should be consulted before removing any Traffic Management allowance.

04/06/20145 - Regarding their final questions, TERA will note that the new workbooks now show traffic management split out with the rate per metre of trench clearly identified. In my experience private roads (i.e. roads only used by owner/occupiers and NOT by the public) do not require any traffic management for the reason that any work being done on or alongside them will be known to the owners and users, effectively almost eliminating the risk of traffic accidents. I imagine TERA will be thinking of private roads as long, unsealed country roads either providing private access to a group of rural properties, or farm roads inside the farm gate. Any sealed roads (public or private) with two or more incoming underground services should be classified as urban.

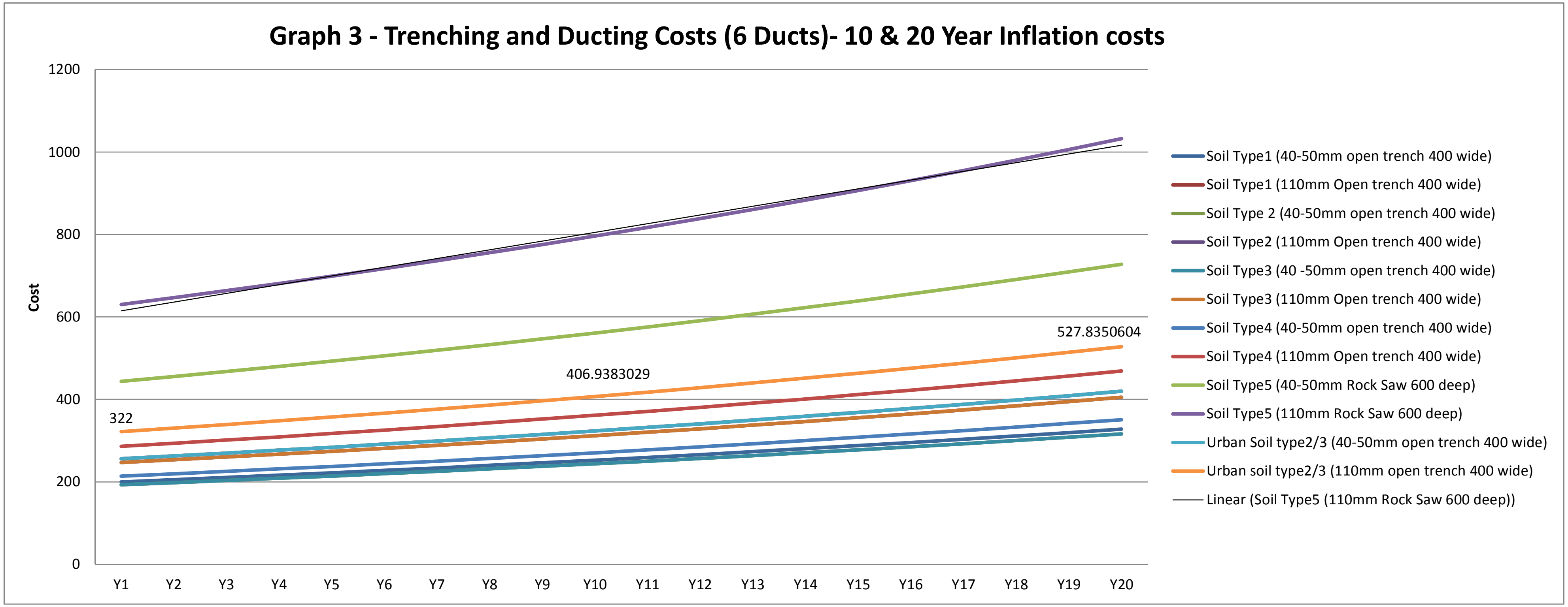
In our opinion the email responses above, although concise, do accurately summerise our view and do not require further comment.

16 Final Comments

This report is a compilation of all the recommendations, rates and other pricing information forwarded to TERA via the Commission over the period of 6 weeks from 23/04/2015 to 04/06/2015. This advice was in response to queries by TERA Consultants at a face to face meeting held in April at the Commerce Commission offices, and to further questions received from them in subsequent emails.

Beca has completed this report using all of the best information available to us at the time of writing, and we are confident that this provides robust budget costings and sound advice on the issues being addressed. However we have no control over the manner in which this information is used by TERA in their modelling and therefore take no responsibility for the accuracy of the final price outcomes.

Appendix 1: Graph 3 – Trench & Duct Forecasts


Graph 3 - Trenching and Ducting Costs (6 Ducts)- 10 & 20 Year Inflation costs
Cost
1200
1000
800
600
400
200
0
Y1
Y2
Y3
Y4
Y5
Y6
Y7
Y8
Y9
Y10
Y11
Y12
Y13
Y14
Y15
Y16
Y17
Y18
Y19
Y20
322
406.9383029
527.8350604
Soil Type1 (40-50mm open trench 400 wide)
Soil Type1 (110mm Open trench 400 wide)
Soil Type 2 (40-50mm open trench 400 wide)
Soil Type2 (110mm Open trench 400 wide)
Soil Type3 (40 -50mm open trench 400 wide)
Soil Type3 (110mm Open trench 400 wide)
Soil Type4 (40-50mm open trench 400 wide)
Soil Type4 (110mm Open trench 400 wide)
Soil Type5 (40-50mm Rock Saw 600 deep)
Soil Type5 (110mm Rock Saw 600 deep)
Urban Soil type2/3 (40-50mm open trench 400 wide)
Urban soil type2/3 (110mm open trench 400 wide)
Linear (Soil Type5 (110mm Rock Saw 600 deep))

Appendix 2: HDPE Rates Tables

CORRIDOR COST ANALYSIS OF TRENCHING AND DUCTING RATES IN NEW ZEALAND

National averge rates per metre for installed telecommunication duct in New Zealand — Rev.4 for PE Ductimg only, 28 May 2015

Rural Trenching

In Depths 0.6m to 1.0m

		1 duct	2 ducts	3 ducts	4 ducts	5 ducts	6 ducts	7 ducts	8 ducts	9 ducts	10 ducts	11 ducts	12 ducts
Per metre costs in Soil Type 1		NZD excluding GST											
	40 - 50mm dia duct												
1.1.1	Mole Ploughing	19	29	39	49	65	75	85	95	111	121	131	141
1.1.2	Chain Digger incl TM	35	57	79	101	123	145	167	189	211	233	255	277
1.1.3	Chain Digger excl TM	32	54	76	98	120	142	164	186	208	230	251	273
1.1.4	Open trench 400 wide	49	71	92	114	136	158	180	204	226	248	270	292
1.1.5	Directional Drilling	51	74	97	120	143	179	202	226	255	278	301	324
	110mm dia duct												
1.2.1	Mole Ploughing	27	50	73	96	119	142	165	188	211	234	256	279
1.2.2	Chain Digger incl TM	44	74	104	134	176	206	236	265	308	338	367	397
1.2.3	Chain Digger excl TM	41	70	100	130	169	199	229	258	297	327	357	387
1.2.4	Open trench 400 wide	56	86	116	146	176	209	239	269	299	329	362	392
1.2.5	Directional Drilling	59	104	141	183	235	267	312	367	412	449	491	543
Per metre costs in Soil Type 2		NZD excluding GST											
	40 - 50mm dia duct												
2.1.1	Mole Ploughing	19	29	39	49	65	75	85	95	111	121	131	141
2.1.2	Chain Digger incl TM	35	57	79	101	123	145	167	189	211	233	255	277
2.1.3	Chain Digger excl TM	32	54	76	98	120	142	164	186	208	230	251	273
2.1.4	Open trench 400 wide	41	63	85	107	129	151	173	196	218	240	262	284
2.1.5	Directional Drilling	52	76	99	123	147	183	207	231	261	284	308	332
	110mm dia duct												
2.2.1	Mole Ploughing	27	50	73	96	119	142	165	188	211	234	256	279
2.2.2	Chain Digger incl TM	44	74	104	134	176	206	236	265	308	338	367	397
2.2.3	Chain Digger excl TM	41	70	100	130	169	199	229	258	297	327	357	387
2.2.4	Open trench 400 wide	49	79	109	141	171	201	233	263	293	325	355	385
2.2.5	Directional Drilling	61	106	145	188	241	273	320	376	422	460	503	556
Per metre costs in Soil Type 3		NZD excluding GST											
	40 - 50mm dia duct												
3.1.1	Open trench 400 wide	41	63	85	107	129	151	173	196	218	240	262	284
3.1.2	Directional Drilling	74	107	141	174	208	260	294	327	370	404	437	471
	110mm dia duct												
3.2.1	Open trench 400 wide	49	79	109	141	171	201	233	263	293	325	355	385
3.2.2	Directional Drilling	80	140	191	247	318	360	421	495	555	606	663	733
Per metre costs in Soil Type 4		NZD excluding GST											
	40 - 50mm dia duct												
4.1.1	Open trench 400 wide	63	85	107	129	151	173	194	219	241	263	285	307
	110mm dia duct												
4.2.1	Open trench 400 wide	83	112	142	180	209	239	277	306	336	374	404	433
Per metre costs in Soil Type 5		NZD excluding GST											
	40 - 50mm dia duct												
5.1.1	Rock Saw 600 deep	155	177	199	221	376	398	420	442	597	619	641	663
	110mm dia duct												
5.2.1	Rock Saw 600 deep	163	193	356	386	549	579	742	772	935	965	1,128	1,158

Urban Trenching

In Depths 0.7m to 1.1m

		1 duct	2 ducts	3 ducts	4 ducts	5 ducts	6 ducts	7 ducts	8 ducts	9 ducts	10 ducts	11 ducts	12 ducts
Per metre costs in Soil Type 2/3 or Fill		NZD excluding GST											
	40 - 50mm dia duct												
6.1.1	Open trench 400 wide	91	113	135	157	178	200	222	246	268	290	312	334
6.1.3	Directional Drilling	67	97	127	157	188	235	265	295	334	364	394	424
6.1.4	Thrust Boring - Impact Mole	70	140	210	280	350	420	490	560	630	700	770	840
	110mm dia duct												
6.2.1	Open trench 400 wide	103	132	162	195	225	254	288	317	347	380	410	439
6.2.3	Directional Drilling	76	132	181	234	301	341	399	469	526	574	627	694
6.2.4	Thrust Boring - Impact Mole	100	200	300	400	500	600	700	800	900	1,000	1,100	1,200

Clarifications and Assumptions

All rates are the national average and allow for excavation, duct supply & install, backfill, surface reinstatement, consenting and traffic management.
Rates for rural open trenches deeper than 0.9m allow for trench shields in soil type 1 only.
Rates for rural open trenches and chain digging allow for reinstatement of grass only, with no imported and compacted backfill.
Rates for urban open trench allow for 'highest cost' reinstatement i.e. compacted, imported backfill with 30mm thick AC14 asphalt.
Minimum depth of compacted hard fill under trafficable areas is 600mm.
Urban trenching in berms and under carriageways to comply with TNZ HM12.
We are not aware of any NZ standards or codes of practice that govern or restrict the number of telecommunication ducts placed in a trench. Rates for ducts in open trenching therefore allow for one (1) trench only with variable depths as required to suit duct numbers.
No allowance made for de-watering in any locations.
Directional drilling is not suitable in non-cohesive soils.
Chain digging rates are for 110-120mm wide, 1.0mm deep in all cases. This trenching method is suitable in non-cohesive soils.
Mole ploughing rates are for 1.0mm deep in all cases.
Rock sawing rates are for 120mm wide, 600mm deep in all cases. Multiple trenches necessary for more than 4x 50dia or 2x 110dia ducts.