



Department of Infrastructure

Northern Central City Corridor Study

Strategy Elements Cost Estimate Validation

November 2002

Department of Infrastructure

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1. Introduction

To ensure that construction estimates developed as part of the Northern Central City Corridor Study (NCCCS) are robust and can be defended in any forum, a review of those estimates likely to come under critical scrutiny has been undertaken.

The particular estimates validated in this report are:

- £ Road tunnel from the Eastern Freeway near Hoddle Street to City Link near Racecourse Road/Flemington Road. The review of the above estimate can automatically flow on to the road tunnel estimate for a connection to the CBD.
- £ Heavy rail connection from near Victoria Park Station to the Doncaster Hill shopping complex.

As part of the validation process, a number of source documents have been utilised as well as construction costs for recent road tunnel projects in Melbourne. The source documents and projects referred to are:

- £ Draft report “Northern City Corridor Study, Route Concepts-Long List (1999)” prepared by VicRoads and the Department of Infrastructure that considered various connections (tunnel and surface roads) from the eastern end of the Eastern Freeway to City Link and the CBD.
- £ Report prepared by Professor E W Russell for the Victorian Minister of Transport in 1991 that considered the Eastern Corridor Transport Options, titled “On the Right Track, Freeways or Better Public Transport for Melbourne’s East?”
- £ Construction costs for City Link tunnels (construction assumed to be in 1999 on average).
- £ Tender prices for the tunnels on the Eastern Freeway Extension (2002).

2. Road Tunnel Estimates

2.1 VicRoads Estimate

VicRoads prepared an estimate for various tunnel connections in 1999 that formed the basis of the draft report “Northern City Corridor Study, Route Concepts-Long List”. All estimates were prepared on a tunnel cost estimate of \$45M per kilometre of single tube, 2-lane tunnel (refer to spreadsheet attached as **Appendix A**).

Option A is the closest representation of the scheme tested in the NCCCS. The total estimated cost was \$904M made up from the following components:

Tunnelling	\$450M
Eastern Freeway Connection	\$ 50M
City Link Connection	\$100M
Traffic Management	\$ 5M
Design and Supervision (15%)	\$ 91M
Contingency (30%)	<u>\$208M</u>
TOTAL	\$904M

The two cost items related to connections at Eastern Freeway and City Link were based on significant reworking of the interchanges at these locations. For the scheme tested as part of the NCCCS, no major works are required at either location.

At the Eastern Freeway end, access/egress to/from the tunnel will only be from the freeway median with no other changes to the existing road network. At Racecourse/Flemington Road, the existing road network and ramps are proposed for access to City Link.

Thus, for the NCCCS cost estimate, neither of these costs need to be included.

The VicRoads estimate was produced in 1999. Escalation in cost based on the CPI between 1999 and 2001 is 11%. The equivalent tunnel cost in 2001 is therefore \$50M per single 2-lane tube. That is, \$100M per kilometre for the twin tube, 4-lane connection.

2.2 City Link Experience

City Link tunnels were all 3-lane tunnels. The typical cost (varied for different tunnel sections) for deep driven tunnel was \$85M per kilometre of single tube, 3-lane tunnel. The break down of the unit tunnel cost is \$55M for excavation/civil work and \$30m for mechanical/electrical work.

The pro-rata rate for a 2-lane tunnel has been determined by:

Excavation/civil cost (55% roughly based on excavation area)	\$30M
Mechanical/electrical (80% based on smaller components)	<u>\$25M</u>
TOTAL	\$55M

The estimated cost for twin 2-lane tubes is therefore \$110M per kilometre. Assuming that most tunnel construction occurred in 1999, the equivalent 2001 cost is \$120M per kilometre of 4-lane tunnel.

Note that this cost includes project management and supervision costs. Assuming the 15% adopted by VicRoads and subtracting 4% for design indicates the above cost can be discounted by 11% to give a direct comparison with the tunnelling cost adopted by VicRoads. For comparison, the cost is \$107M per kilometre of 4-lane tunnel.

2.3 Eastern Freeway Tenders

The range of recently submitted tender costs for the proposed Eastern Freeway tunnel was \$175M-215M per kilometre for twin 3-lane tunnels. Using the same factor as used for the City Link tunnels to derive a twin 2-lane tunnel cost (65% overall), the equivalent cost is in the range \$115M-\$140M per kilometre.

Adopting the approximate mid-range suggests \$130M per kilometre for twin 2-lane tunnels. Similar to City Link, this cost includes design, project management and supervision. For direct comparison, the rate can be discounted by 15%, the comparative cost being \$110M per kilometre of 4-lane tunnel.

2.4 NCCCS Estimate

The tunnel cost adopted in the estimates to date has been \$70M per kilometre of 4-lane tunnel. In addition to this, the following cost items have been included:

- £ 8% for Project Management (Principals cost).
- £ 4% for design and investigation.
- £ Nominal amount (\$5M) for possible land acquisition (Racecourse Road?).
- £ 10% for site establishment and site supervision (Contractor cost).
- £ Costs associated with additional work in vicinity of interchanges (Nicholson St and Royal Pde).
- £ 25% contingency allowance.

2.5 Summary Discussion

The following table summarises the estimated tunnels costs as determined from the various methods described in previous sections. Note that the contingency cost is applied to the base cost plus design and supervision costs.

Source of Cost	VicRoads	City Link	Eastern Fwy	NCCCS
Base Cost (\$M/km)	100	107	110	70
PM Cost (Principal)	Included?	Assume 8%	Assume 8%	8%
Design Cost	4%	Included	Included	4%
Site Costs	11%	Included	Included	10%
Contingency	30%	Included	Included	25%
All inclusive cost (\$M/km, 4-lane)	150	115	120	107

From the above comparison, it would appear that the current all-inclusive cost for tunnel construction is in the range \$115-\$120M per kilometre of 4-lane tunnel. Adopting a base tunnel cost of \$80M per kilometre for NCCCS would give an all-inclusive cost of \$122M per kilometre.

If \$80M per kilometre was used for tunnel construction, the overall cost for the various tunnel schemes tested in the study would vary from those already reported as follows (refer **Appendix B**).

Scheme Description	Current Estimate⁽¹⁾	Varied Estimate⁽²⁾
Eastern to City Link, with I/Cs (G1 & G1a)	\$723M	\$810M
Eastern to City Link, no I/Cs (G4 & G4a)	\$592M	\$665M
Eastern to Victoria Parade (G3 & G3a)	\$370M	\$408M

Notes

- (1) Estimate based on tunnel cost of \$70M per kilometre
- (2) Estimate based on tunnel cost of \$80M per kilometre

3. Heavy Rail Estimate

3.1 E W Russell Estimate

Professor Russell prepared a report for the Minister of Transport in 1991 that considered various public transport options to connect the existing system to the Doncaster Hill shopping complex. Included in the report were estimated costs of the options, including provision of heavy rail from near Victoria Park Station to Doncaster Hill. The option costed surface rail via Eastern Freeway to Bulleen Road then underground to Doncaster Hill and referred to as Option D (attached in **Appendix C**).

The unit rates used in this report are provided in the table below, including an equivalent 2001 cost based on a CPI increase of 26% from 1991 to 2001.

Cost Item	E W Russell (1991)	2001 Equivalent
Underground Station	\$40M	\$50M
Double Track (\$/m)	1500	1900
Overhead (\$/m)	600	760
Signalling (\$/m)	600	760
Rail Tunnel (\$M/km)	15	19
Sub-Stations (each)	\$1.5M	\$1.9

The total Option cost was estimated to be \$336M in 1991, which equates to \$423M in 2001.

3.2 NCCCS Estimate

The unit rates adopted for the heavy rail scheme test in the NCCCS are tabulated below.

Cost Item	NCCCS Estimate
Underground Station	\$50M
Double Track (\$/m)	1900
Overhead (\$/m)	800
Signalling (\$/m)	800
Rail Tunnel (\$M/km)	20
Sub-Stations (each)	\$1.5M

The total estimated cost is \$430M (refer **Appendix D**).

3.3 Discussion

The NCCCS estimate as provided in the initial cost estimate report closely correlates to the earlier estimate by Professor Russell in 1991 when the latter is updated to current prices. The scope of work costed is also identical.

Professor Russell's report also makes reference to cost estimates prepared by the Public Transport Users' Association (PTUA) that were significantly lower than those prepared by the PTC. The PTUA estimate for the rail link to East Doncaster (no figure quoted for rail link to Doncaster Hill) was \$240M in 1991 compared to the PTC estimate of \$567M for the same link. Because of this wide variance in cost estimates, Professor Russell convened a joint conference to explore the reasons behind the difference. The main reasons for the difference were found to be:

- £ \$6M per kilometre difference in tunnelling cost.
- £ Significant cost difference for each underground station (PTC - \$40M each, PTUA - \$10M each)
- £ No contingency or design and administration costs included in the PTUA estimate.

Addressing each of these differences in turn, it is considered that the PTC estimate is more realistic for the reasons detailed below:

- £ The tunnelling cost of \$15M/km (\$19M/km in 2001) adopted in the Russell report aligns closely with known tunnelling costs for road projects in Melbourne recently, when factored down for the smaller tunnel tubes required for rail.
- £ The underground station cost of \$40M each adopted in the Russell report is based on the actual construction cost for Flagstaff Station.
- £ It is common practice and wise to include a contingency amount when developing estimates based on a preliminary scope and little or no design information. Similarly design and administration costs are real and need to be included.

4. Recommendations

Further investigation of unit rates adopted for cost estimating during the NCCCS indicates that:

- £ The cost of road tunnel construction should be increased by approximately 14% to reflect recent industry costs.
- £ The estimate for provision of heavy rail to Doncaster Hill is almost identical to an earlier estimate produced by Professor Russell and no change is recommended.
- £ Heavy rail costs produced by the PTUA in 1991 be considered as artificially low based on knowledge of recent tunnelling costs and the fact that no allowance was made for contingencies, design or administration costs.

Appendix A VicRoads Tunnel Estimates

NORTHERN CITY CORRIDOR STUDY

Route Concepts – Long List

The following route concepts were developed during a brainstorming session with the Reference Group on Thursday 23 September 1999.

Note that these are concepts only, and should not be seen as specific proposals. Locations for interchanges between the tunnel and City Link have been selected as general indicators only, based upon their possible attractiveness for that concept. Separate work is being undertaken on possible interchange arrangements at City Link, Hoddle Street and intermediate locations.

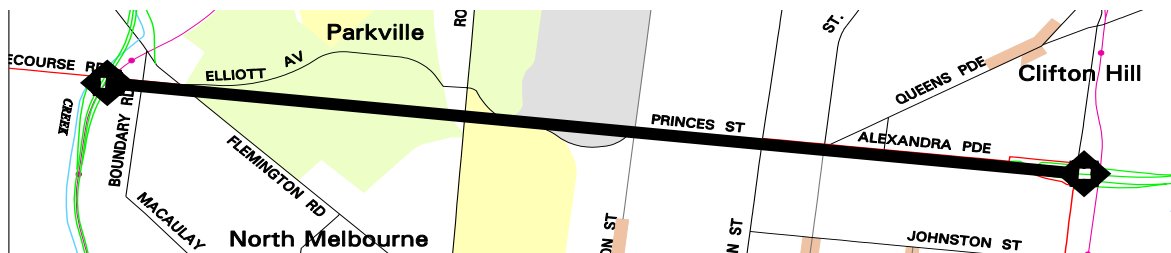
No lane configurations are implied in any of these concepts.

In the following diagrams depicting each of the concepts:

- § a solid thick line represents a tunnel fully constructed below surface level with limited disruption during construction,
- § a dashed thick line represents a tunnel immediately below surface level which could involve significant disruption during construction,
- § a solid diamond indicates a full freeway to freeway interchange,
- § a light coloured circle indicates a tunnel portal accessing the road system, and
- § a doughnut symbol indicates a partial interchange between the tunnel and the surface road system.

A. Direct Link to Racecourse Road

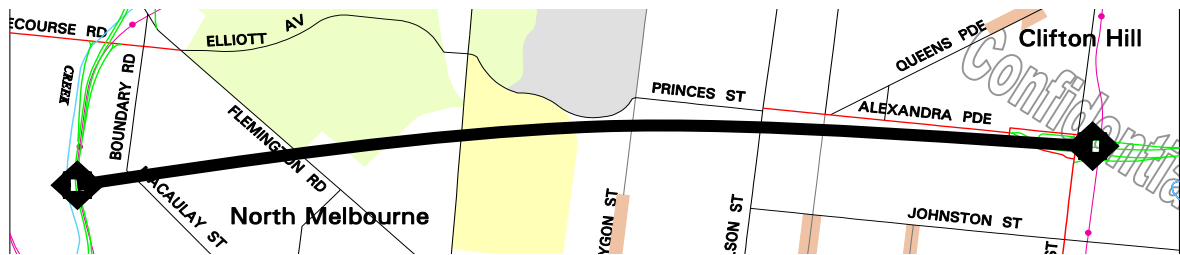
Direct tunnel link from Eastern Freeway at Hoddle Street to City Link at Racecourse Road.



Advantages	Disadvantages
Provides high level access between Eastern Freeway and City Link	Freeway/freeway connection at City Link may be difficult to achieve
Shortest length of tunnel	Existing surface level road system still required to perform its current distributor/access role
Full route options retained at Hoddle Street	No specific provision for improved access to CBD

B. Direct Link to Macaulay Road

Direct tunnel link from Eastern Freeway at Hoddle Street to City Link near Macaulay Road

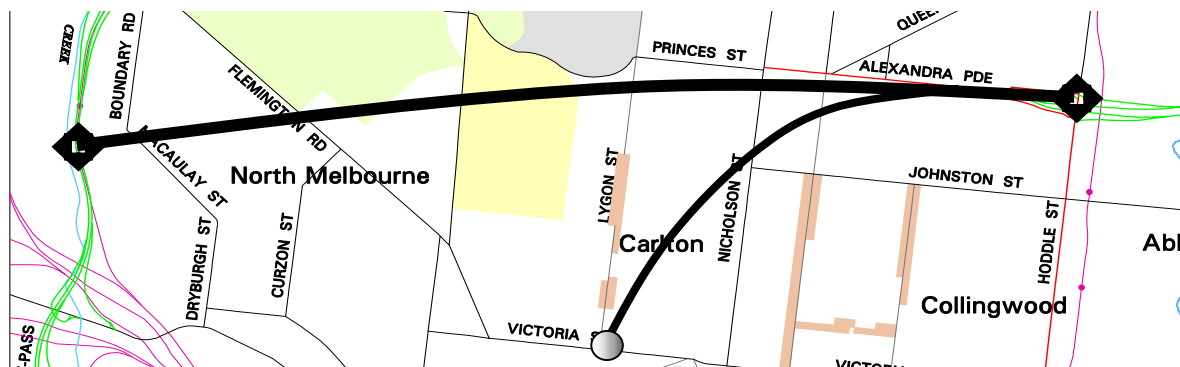


Advantages	Disadvantages
Provides high level access between Eastern Freeway and City Link	Longer length of tunnel required
Full route options retained at Hoddle Street	Interchange required at City Link between the existing ramps at Dynan Road and Racecourse Road
	Existing surface level road system still required to perform its current distributor/access role
	No specific provision for improved access to CBD

C. Direct Link to Macaulay Road + CBD Access Tunnel

This concept aims to also attract to the facility traffic that is bound for the CBD. It provides for a half diamond (easterly) interchange at Hoddle Street, with no direct connection to Alexandra Parade. The interchange at City Link could be at other locations.

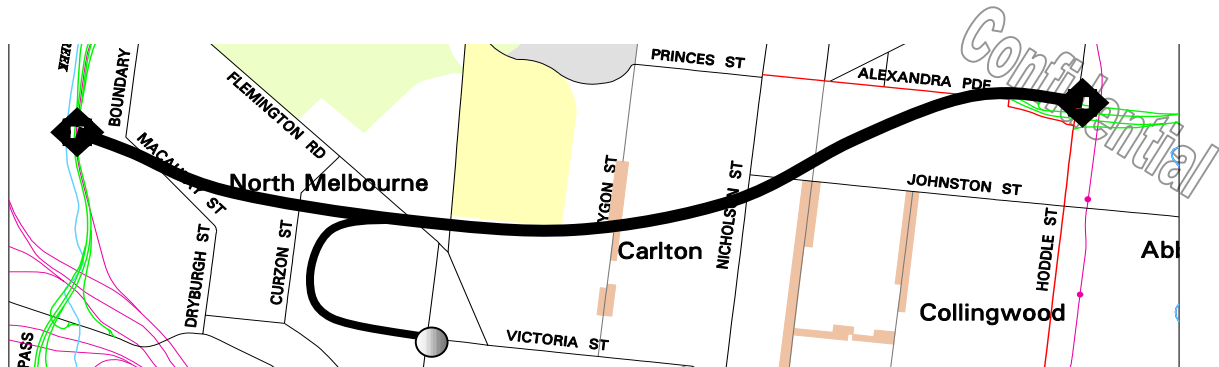
The key feature of this concept is that the tunnel splits to provide direct connection between the Eastern Freeway and the CBD.



Advantages	Disadvantages
Provides high level access between Eastern Freeway and City Link	Length of tunnel significantly increased
Provides high level access between Eastern Freeway and the CBD	Interchange required at City Link between existing ramps at Dynan Road and at Racecourse Road
Reduces the existing surface level road system's distributor/access role	No direct access from Eastern Freeway to Alexandra Parade

D. Direct Link to Macaulay Road + CBD Access “Hook” Tunnel

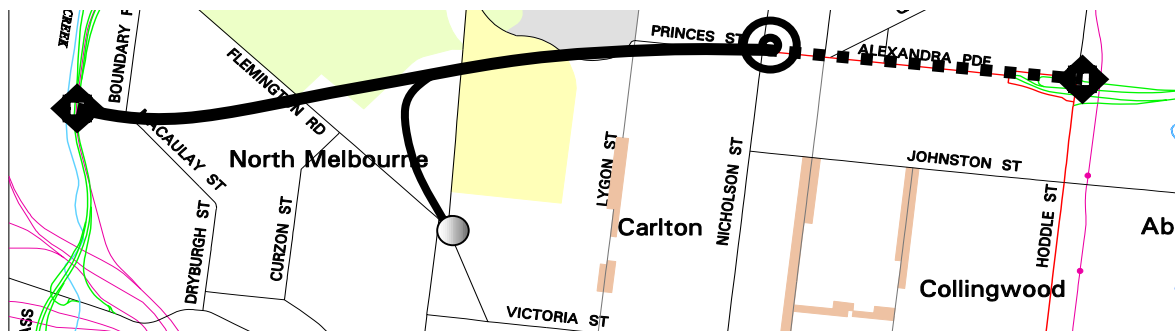
Direct tunnel link from Eastern Freeway at Hoddle Street to City Link near Macaulay Road, and with additional tunnels providing direct access to CBD by “reverse hook” to Victoria Street. The interchange at City Link could be at other locations.



Advantages	Disadvantages
Provides high level access between Eastern Freeway and City Link	Length and complexity of tunnel increased
Provides high level access between Eastern Freeway and the CBD	Interchange required at City Link between the existing ramps at Dynan Road and Racecourse Road
Access to City improved due to “counter peak” approach	Access to CBD is towards western side of CBD, already serviced by City Link
Reduces the existing surface level road system’s distributor/access role	

E. Tunnel Link to Macaulay Road with easterly half diamond interchange at Nicholson Street + CBD Access Tunnel

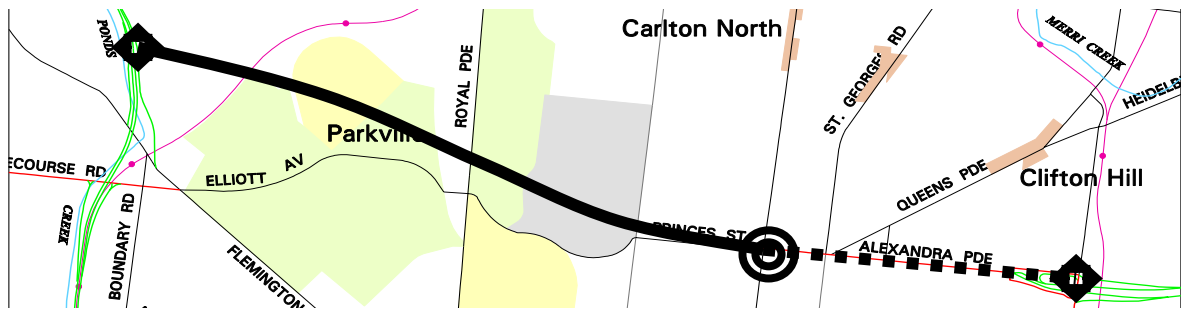
Cut and cover tunnel (shallow) from Eastern Freeway at Hoddle Street to Nicholson Street, then tunnel through to City Link near Macaulay Road, with a tunnel providing direct access to CBD at Elizabeth Street near Flemington Road. Easterly oriented ramps at Tunnel/Nicholson Street. Alexandra Parade still operates as a surface road. The interchange at City Link could be at other locations.



Advantages	Disadvantages
Provides high level access between Eastern Freeway and City Link	Interchange required at City Link between the existing ramps at Dynan Road and Racecourse Road
Provides improved access between Eastern Freeway and the CBD	Puts more pressure on already congested Nicholson Street
Reduces Alexandra Parade's traffic role	CBD access tunnel does not provide direct access to CBD

F. Tunnel Link to north of Racecourse Road with easterly half diamond interchange at Nicholson Street

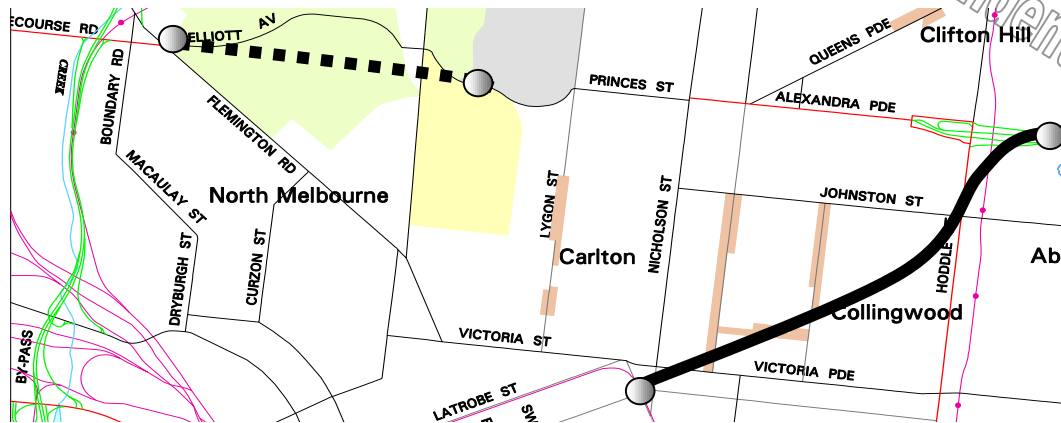
Cut and cover tunnel (shallow) from Eastern Freeway at Hoddle Street to Nicholson Street, with a tunnel from there to Tullamarine Freeway between Flemington Road and Brunswick Road. Easterly oriented ramps at Tunnel/Nicholson Street. Alexandra Parade still operates as a surface road.



Advantages	Disadvantages
Provides high level access between Eastern Freeway and City Link	Existing surface level road system generally required to perform its current distributor/access role
Reduces Alexandra Parade's traffic role	Access to CBD not improved

G. Direct Tunnel Link from Eastern Freeway to CBD, with tunnel through Royal Park

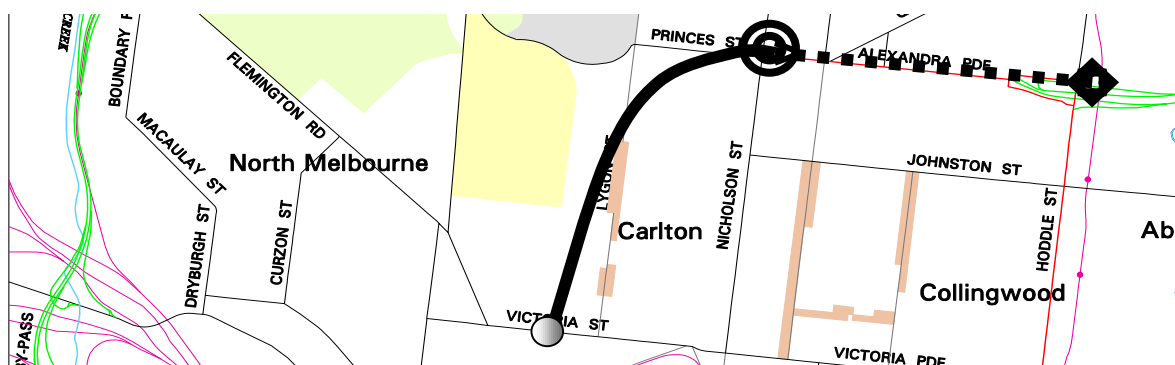
Direct tunnel link from Eastern Freeway east of Hoddle Street to Lonsdale Street near Spring Street. Additional tunnel under Royal Park from Elliott Avenue east of Racecourse Road to Cemetery Road at Swanston Street.



Advantages	Disadvantages
<ul style="list-style-type: none"> High level access from Eastern Freeway to CBD Traffic relief through Royal Park 	<ul style="list-style-type: none"> Existing surface level road system still required to perform its current distributor/access role Does not provide high level access between Eastern Freeway and City Link

H. Tunnel Link from Eastern Freeway to CBD, with easterly half diamond interchange at Nicholson Street

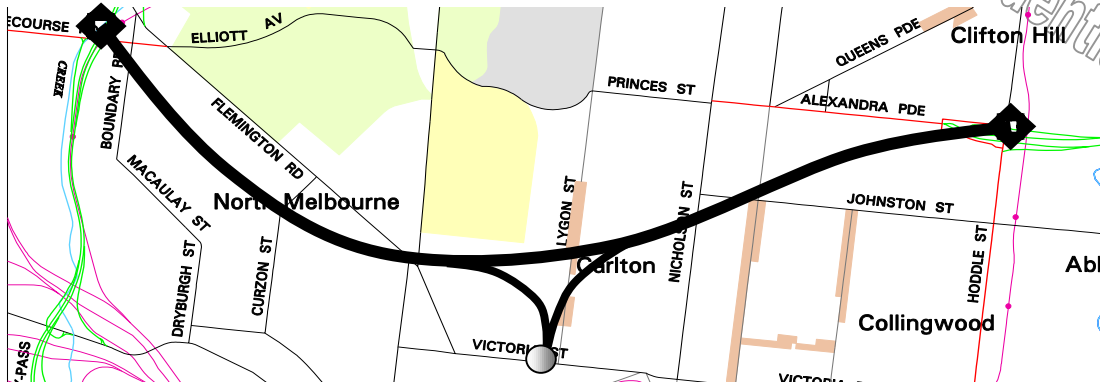
Cut and cover tunnel (shallow) from Eastern Freeway at Hoddle Street to Nicholson Street, with a deep tunnel from there providing direct access to CBD (at CUB site near Swanston/Victoria).



Advantages	Disadvantages
<ul style="list-style-type: none"> High level access from Eastern Freeway to CBD Reduces Alexandra Parade's traffic role Access to CBD tunnel from other parts of the road network 	<ul style="list-style-type: none"> Does not provide high level access between Eastern Freeway and City Link Existing surface level road system generally required to perform its current distributor/access role

I. Direct Link to Racecourse Road + access tunnel to CBD for both directions

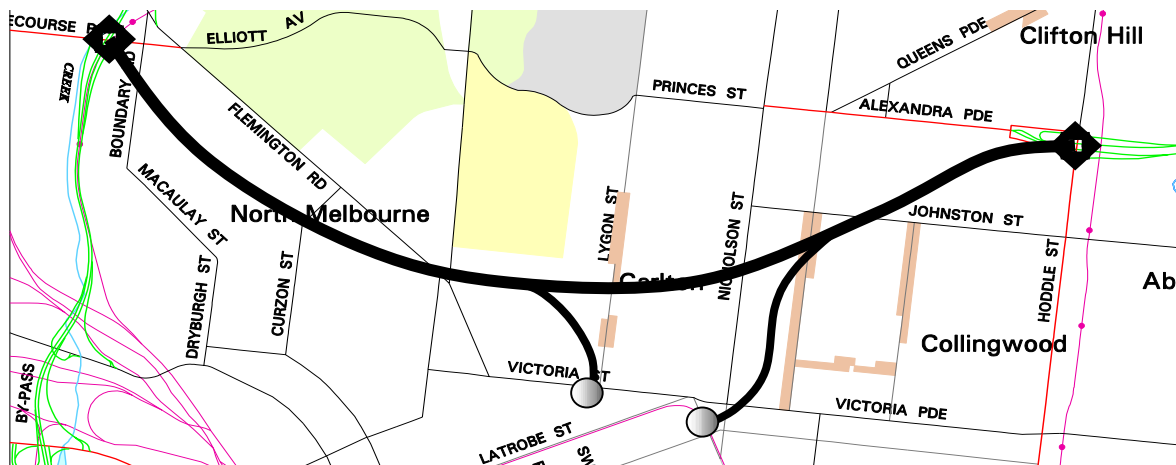
Direct tunnel link from Eastern Freeway at Hoddle Street to City Link at Racecourse Road, and with additional tunnels providing direct access to CBD (at CUB site near Swanston/Victoria) from both easterly and westerly arms of tunnel. The interchange at City Link could be at other locations



Advantages	Disadvantages
Provides high level access between Eastern Freeway and City Link	Length and complexity of tunnel increased
Provides high level access from Eastern Freeway and from City Link to CBD	Freeway/freeway connection at City Link may be difficult to achieve
Reduces the existing surface level road system's distributor/access role	Potential congestion point at CBD access

J. Direct Link to Racecourse Road + access tunnels to CBD from each direction

Direct tunnel link from Eastern Freeway at Hoddle Street to City Link at Racecourse Road, and with additional tunnels providing direct access to CBD at different locations for each tunnel approach (at CUB site near Swanston/Victoria for traffic from City Link side and at Lonsdale Street near Spring Street for traffic from Eastern Freeway side). The interchange at City Link could be at other locations

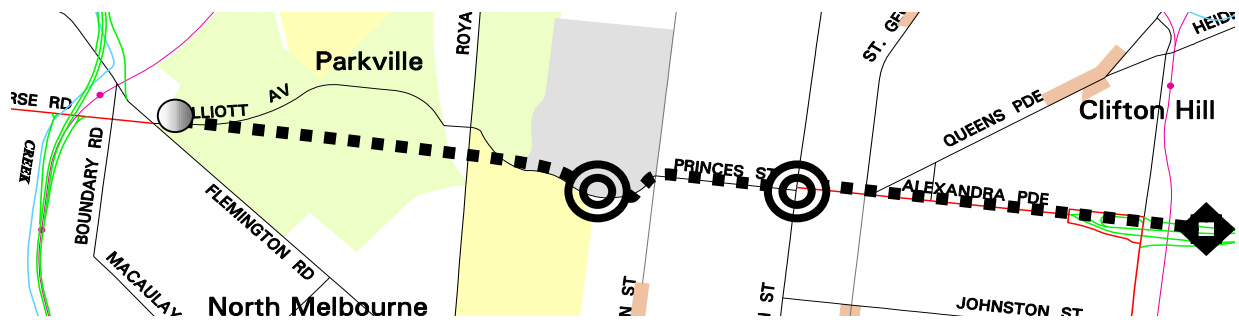


Advantages	Disadvantages
Provides high level access between Eastern Freeway and City Link High level access from Eastern Freeway and from City Link to CBD Reduces the existing surface level road system's distributor /access role	Length and complexity of tunnel increased Freeway/freeway connection at City Link may be difficult to achieve

Confidential

K. Shallow Tunnel to near Racecourse Road

Shallow “cut and cover” tunnel generally along existing surface level route between Eastern Freeway and City Link. Tunnel portals in Elliott Avenue near Flemington Road provide access to City Link. Interchanges at Swanston Street/Cemetery Road and Nicholson Street.



Advantages	Disadvantages
Provides high level access between Eastern Freeway and City Link Reduces traffic volumes on existing surface level road system	Freeway/freeway interchange at City Link not provided Access to CBD not improved

Long List
22/09/99

Appendix B NCCCS Tunnel Estimates

NORTHERN CENTRAL CITY CORRIDOR STUDY

Strategy G1 - Driven Tunnel, Hoddle St to Elliott Ave (2 x 2 lane, I/Cs @ Nicholson St & Royal Pde)

ITEM	DESCRIPTION OF WORK	QUANTITY	UNIT	RATE	AMOUNT	SUMMARY
A	Project Management					\$ 42,466,714
	Project Management	Item		8%	42,466,714	
B	Design and Investigation					\$ 20,416,689
	Detailed Design & Investigation	Item		4%	20,416,689	
C	Land Acquisition					\$ 5,000,000
	Acquire land	Item			\$ 5,000,000	guess
D	Construction					\$ 510,417,230
1.0	GENERAL ITEMS					\$ 46,337,930
1.1	Site Establishment	Item		5%	\$ 23,168,965	
1.2	Site Management & Supervision (including QA)	Item		5%	\$ 23,168,965	
2.0	STRUCTURES					\$ 460,000,000
2.1	Bridge Construction		m ²			
2.2	Tunnel Construction (2 tunnels each 2 lane)	4.7	km	70,000,000	\$ 329,000,000	
2.3	Tunnel Construction (I/C ramps, single lane)	3.0	km	27,000,000	\$ 81,000,000	
2.4	Tunnel Portal, Eastern Freeway	Item			\$ 30,000,000	
2.5	Tunnel Portal, Elliott Avenue	Item			\$ 20,000,000	
3.00	ROADWORK (realign Alexandra/Royal @ I/C)					\$ 484,200
3.01	Stripping topsoil	13,200	m ²	5	\$ 66,000	
3.02	Excavation	6,600	m ³	25	\$ 165,000	
3.03	Disposal of excavated material	6,600	m ³	15	\$ 99,000	
3.04	Compaction of sub grade	13,200	m ²	6	\$ 79,200	
3.05	Soft areas - excavation, remove and replace	Item			\$ 75,000	
4.00	PAVEMENT					\$ 2,359,500
4.01	Deep Strength Asphalt	13,200	m ²	175.00	\$ 2,310,000	
4.02	Granular with Asphalt Surfacing		m ²	125.00	\$ -	
4.03	Asphalt Surfacing (40mm)	3,300	m ²	15.00	\$ 49,500	
5.00	DRAINAGE					\$ 312,000
5.01	subsoil drains 100mm dia	2,400	m	35	\$ 84,000	
5.02	375 RCP (Class 2)	1,200	m	160	\$ 192,000	
5.03	Pits/Inspection Openings	24	no	1500	\$ 36,000	
6.00	SM2 & SM3 Kerb & channel	2,400	m	35	\$ 84,000	\$ 84,000
7.00	POWER & LIGHTING					
7.01	Design & Installation (60m spacing)	Item			\$ 100,000	\$ 100,000
8.0	SIGNING	13,200	m ²	1.50	\$ 19,800	\$ 19,800
9.0	LINEMARKING	13,200	m ²	1.50	\$ 19,800	\$ 19,800
10.0	MISCELLANEOUS					
10.1	Signalised intersection works	6	no	100,000	\$ 600,000	\$ 600,000
10.2	Other intersection works at Royal Pde	Item			\$ 100,000	\$ 100,000
TOTAL A - D						\$ 578,300,633
E	Contingency					
	Lower Bound Contingency (10%)	Item		10%		\$ 57,830,063
	Upper Bound Contingency (30%)	Item		30%		\$ 173,490,190
PROJECT BUDGET						
	Lower Bound Estimate					\$ 636,130,696
	Upper Bound Estimate					\$ 751,790,823
	Project Budget (75% Confidence)					\$ 722,875,791

NORTHERN CENTRAL CITY CORRIDOR STUDY

Strategy G4 - Driven Tunnel, Hoddle St to Elliott Ave (2 x 2 lane)

ITEM	DESCRIPTION OF WORK	QUANTITY	UNIT	RATE	AMOUNT	SUMMARY
A	Project Management					\$ 34,686,080
	Project Management	Item		8%	34,686,080	
B	Design and Investigation					\$ 16,676,000
	Detailed Design & Investigation	Item		4%	16,676,000	
C	Land Acquisition					\$ 5,000,000
	Acquire land	Item			\$ 5,000,000	guess
D	Construction					\$ 416,900,000
1.0	GENERAL ITEMS					\$ 37,900,000
1.1	Site Establishment	Item		5%	\$ 18,950,000	
1.2	Site Management & Supervision (including QA)	Item		5%	\$ 18,950,000	
2.0	STRUCTURES					\$ 379,000,000
2.1	Bridge Construction		m ²			
2.2	Tunnel Construction (2 tunnels each 2 lane)	4.7	km	70,000,000	\$ 329,000,000	
2.3	Tunnel Portal, Eastern Freeway	Item			\$ 30,000,000	
2.4	Tunnel Portal, Elliott Avenue	Item			\$ 20,000,000	
3.00	ROADWORK					\$ -
3.01	Stripping topsoil		m ²	5	\$ -	
3.02	Excavation		m ³	25	\$ -	
3.03	Disposal of excavated material		m ³	15	\$ -	
3.04	Compaction of sub grade		m ²	6	\$ -	
3.05	Soft areas - excavation, remove and replace	Item			\$ -	
4.00	PAVEMENT					\$ -
4.01	Deep Strength Asphalt		m ²	175.00	\$ -	
4.02	Granular with Asphalt Surfacing		m ²	125.00	\$ -	
4.03	Asphalt Surfacing (40mm)		m ²	15.00	\$ -	
5.00	DRAINAGE					\$ -
5.01	subsoil drains 100mm dia		m	35	\$ -	
5.02	375 RCP (Class 2)		m	160	\$ -	
5.03	Pits/Inspection Openings		no	1500	\$ -	
6.00	SM2 & SM3 Kerb & channel					\$ -
			m	35	\$ -	
7.00	POWER & LIGHTING					\$ -
7.01	Design & Installation (60m spacing)	Item			\$ -	
8.0	SIGNING					\$ -
			m ²	1.50	\$ -	
9.0	LINEMARKING					\$ -
			m ²	1.50	\$ -	
10.0	MISCELLANEOUS					\$ -
10.1	Signalised intersection works		no	100,000	\$ -	
10.2	Other intersection works at Royal Pde	Item			\$ -	
TOTAL A - D						\$ 473,262,080
E	Contingency					
	Lower Bound Contingency (10%)	Item		10%	\$ 47,326,208	
	Upper Bound Contingency (30%)	Item		30%	\$ 141,978,624	
PROJECT BUDGET						
	Lower Bound Estimate				\$ 520,588,288	
	Upper Bound Estimate				\$ 615,240,704	
	Project Budget (75% Confidence)				\$ 591,577,600	

Appendix C E W Russell Estimate

Option D

Heavy Rail to Doncaster Shoppingtown via Eastern Freeway to Bulleen Road and Underground to Shoppingtown

SUMMARY

The work for the heavy rail option along the Clifton Hill rail alignment is similar to that required for the high performance train ie. an extra platform at Flinders Street, crossing works at Jolimont, a new station and crossing work at Victoria Park and excavation of the existing tunnel between Victoria Park and the freeway. The train would travel along the freeway median to Bulleen Road. There would be simple stops at Chandler Highway, Burke Road and at Bulleen Road. Each would involve bridge widening and the provision of escalators down to the train stations. There would be new bridges over Merri Creek and the Yarra River.

Immediately west of Bulleen Road, the train tracks would begin to grade downwards to travel underneath the freeway as far as Alfreda Avenue where the train would continue in tunnel to a new station at the corner of High Street and Village Avenue. Here there would be a deep underground station (NB: the station site is at the top of a hill) built underneath an at-grade car park. The train would then continue in tunnel to Doncaster Shoppingtown where there would be an underground station with car park and bus interchange. Except for a short section of tunnel underneath the eastern golf club which may possibly be constructed by cut and cover, the 5km tunnel would need to be bored. There would be four 6-car train sets at a cost of \$40M required for this option. The infrastructure would cost \$336M.

SCOPE OF WORKS	COST
1.0 Development	\$200,000
2.0 Stabling (4 trains)	\$410,000 (Nom)
3.0 Track (12 route kms) \$1500/route m	\$18.0M
4.0 Overhead (12 route kms) \$600/route m	\$7.2M
5.0 Substations	
5.1 Substations 2 No. at \$1.5M each.	\$3.0M
5.2 Tie stations 2 No. at \$900,000 each.	\$1.8M
6.0 Signalling \$300/track m	\$7.2M

SCOPE OF WORKS (cont)	COST
7.0 Stations/Interchanges	
7.1 Above ground (includes platform, shelters, escalators and buildings)	
7.1.1 Chandler Hwy	\$1.5M
7.1.2 Burke Road	\$1.5M
7.1.3 Bulleen Road	\$1.5M
7.2 Underground (Based upon figures for Flagstaff Station)	
7.2.1 High Street	\$40M
7.2.2 Doncaster Central	\$40M
8.0 Services	\$2.0M
9.0 Bridgeworks	
9.1 Merri Creek	\$3.0
9.2 Yarra River	\$3.0M
10.0 Civil Works	
10.1 Tunnel up to Victoria Park Station	\$14M (Nom)
10.2 Relocation of Victoria Park Station	\$5M (Nom)
10.3 New junction at Victoria Park	\$5M (Nom)
10.4 Underground tunnel from Bulleen Road to Doncaster Central (Based upon \$15m/km) 5 route kms.	\$75M
10.5 Grade separation at Jolimont station to provide for loop access	\$10M (Nom)
10.6 Increased platform capacity at Flinders St and Princess Bridge stations	\$10M (Nom)
11.0 Roadworks	
11.1 Eastern Fwy (east bound) east of Bulleen Road.	\$500,000 (Nom)
12.0 Misc (includes landscaping etc)	\$200,000
Sub Total	\$250.00M

Option E

Heavy Rail to Blackburn Road / George Street East Doncaster

SUMMARY

This option is similar in all regards to option D as far as Doncaster Shoppingtown.

Beyond Shoppingtown, the train would travel underground in tunnel to cross to the south of Doncaster Road a little west of Church Road and a further underground station would be provided underneath Doncaster Bus Depot, just east of Weiberby Road. Car parking and bus interchange facilities would be provided.

The train would then travel underground in tunnel to the corner of Blackburn Road and George Street in East Doncaster. Just east of this intersection, an underground station would be provided on Board of Works land, again accompanied with a bus interchange and car park.

There would be five trains at a cost of \$50M under this option. Infrastructure would cost \$471M.

SCOPE OF WORKS

SCOPE OF WORKS	COST
1.0 Development	\$50,000
2.0 Track (3.5 route kms) \$1500/route m	\$5.25M
3.0 Overhead (3.5 route kms) \$600 route m	\$2.1M
4.0 Substations	
4.1 Substations 1 No. \$1.5M each	\$1.5M
4.2 Tie stations 1 No. \$900,000 each	\$900,000
5.0 Signalling \$150/track m	\$1.05M
6.0 Underground Stations	
6.1 Waldau	\$40M
6.2 East Doncaster	\$40M
7.0 Services	\$2.0M
8.0 Tunnelling	\$52.5M
9.0 Misc \$100,000	
Sub Total	\$145.45M

SCOPE OF WORKS (cont)	COST
13.0 Design 6% of construction costs	\$15.00M
14.0 Project Management 6% of construction costs	\$15.00M
Sub Total	\$280.00M
15.0 Contingency 20%	\$56.00M
TOTAL	\$336.00M
16.0 Vehicle Acquisition. 4 No. Comeng trains at \$10.0M each.	\$40.00M
GRAND TOTAL	\$376.00M

ASSUMPTIONS

- Resources available.
- 4 No. trains required.
- Extra stabling required.
- Soil conditions suitable for tunneling.
- Underground station costs based upon Flagstaff station costs updated to 1991 dollars.
- Nom. means nominal cost.
- Civil work required at Jolimont to allow for loop access.

Appendix D NCCCS Heavy Rail Estimate

NORTHERN CENTRAL CITY CORRIDOR STUDY

Strategy F1c - Eastern Freeway Mass Rapid Transit (Heavy Rail Vehicles)

ITEM	DESCRIPTION OF WORK	QUANTITY	UNIT	RATE	AMOUNT	SUMMARY
A	Project Management					\$ 25,488,320
	Project Management	Item		8%	25,488,320	
B	Design and Investigation					\$ 12,254,000
	Detailed Design & Investigation	Item		4%	12,254,000	
C	Land Acquisition					\$ -
	Acquire land		m ²			
D	Construction					\$ 306,350,000
1.0	GENERAL ITEMS					\$ 27,850,000
1.1	Site Establishment	Item		5%	\$ 13,925,000	
1.2	Site Management & Supervision (including QA)	Item		5%	\$ 13,925,000	
2.0	DONCASTER HILL STATION					\$ 50,000,000
2.1	Underground Rail Station				\$ 50,000,000	
3.00	HEAVY RAIL INFRASTRUCTURE					\$ 44,000,000
3.01	Track	8	km	1900000	\$ 15,200,000	
3.02	Overhead	8	km	800000	\$ 6,400,000	
3.03	Signalling	8	km	800000	\$ 6,400,000	
3.04	Rail Bridge to Freeway Median	2,000	m ²	2000	\$ 4,000,000	
3.05	Merri Creek Bridge	1,000	m ²	2000	\$ 2,000,000	
3.06	Yarra River Bridge	1,500	m ²	2000	\$ 3,000,000	
3.07	Connection to Existing Rail Network		Item		\$ 7,000,000	
4.00	RAIL TUNNEL					\$ 180,000,000
4.01	Bulleen Road to Doncaster Hill	4.5	km	40000000	\$ 180,000,000	
5.00	NEW SUBSTATIONS					\$ 4,500,000
5.01	Allowance for 3 sub stations	3	no	1500000	\$ 4,500,000	
6.0	SIGNING		m ²		\$ -	\$ -
7.0	LINEMARKING		m ²		\$ -	\$ -
8.0	MISCELLANEOUS					
8.1	Traffic Signal Priority (4 No.)		no		\$ -	\$ -
	TOTAL A - D					\$ 344,092,320
E	Contingency					
	Lower Bound Contingency (10%)	Item		10%		\$ 34,409,232
	Upper Bound Contingency (30%)	Item		30%		\$ 103,227,696
	PROJECT BUDGET					
	Lower Bound Estimate					\$ 378,501,552
	Upper Bound Estimate					\$ 447,320,016
	Project Budget (75% Confidence)					\$ 430,115,400