Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: A Land Acquisition
Sector: 4 Construction/Installation
Item: 1 to 9 Urban, Rural and Railway ROW
Sub-item: (see page 4 of 4)

Windsor - Toronto 1995			200+, Tilting		300+, Existing ROW		300+, New ROW		weighted
Item Nb	**Item**	**Unit**	**Quantity**	**Unit Price**	**Quantity**	**Unit Price**	**Quantity**	**Unit Price**	**Av. $1993**
Item 1	Urban Land								
1.1	Residential	ha.	47,85	1 117 868	68,85	837 908	11	540 000	**917 149**
1.2	Commercial	ha.	7,75	980 645	7,75	980 645	28,5	718 947	**811 136**
1.3	Industrial	ha.	131,3	803 656	166,55	708 616	29,116	971 974	**770 233**
Item 2	Rural Land								
2.1	Agricultural	ha.	640,2	32 379	1136,5	50 583	2194	43 732	**43 863**
2.2	Natural	ha.		N/A	0	N/A	0	N/A	
Item 3	Purchase of Existing Rail ROW								
3.1	CN	ha.	31,9	415 204	200,9	83 743	54,3	318 877	**165 044**
3.2	CP	ha.	444,9	70 494	310,6	38 703	9	500 000	**62 634**
3.3	VIA	ha.		N/A	0	N/A	0	N/A	
	total		1304		1891		2326		

Toronto - Montreal 1995			200+, Tilting		300+, Existing ROW		300+, New ROW		weighted
Item Nb	**Item**	**Unit**	**Quantity**	**Unit Price**	**Quantity**	**Unit Price**	**Quantity**	**Unit Price**	**Av. $1993**
Item 1	Urban Land								
1.1	Residential	ha.	81,3	968 416	122,9	733 646	87,3	891 835	**846 499**
1.2	Commercial	ha.	2	750 000	1,7	750 000	35,4	255 326	**301 714**
1.3	Industrial	ha.	44,9	794 788	140,0	676 830	143,6	331 021	**541 765**
Item 2	Rural Land								
2.1	Agricultural	ha.	428,1	7 761	1194,8	12 014	1870,0	11 918	**11 441**
2.2	Natural	ha.	219,7	3 233	216,9	2 501	494,0	2 474	**2 659**
Item 3	Purchase of Existing Rail ROW								
3.1	CN	ha.	736,5	101 801	181,6	74 250	147,9	127 845	**100 721**
3.2	CP	ha.	3,5	700 000	23,4	2 915	17,7	3 442	**57 828**
3.3	VIA	ha.	267	3 138	205,5	2 319	0	N/A	
	total		1 783		2 087		2 796		

Montreal - Quebec 1995			200+, Tilting		300+, Existing ROW		300+, New ROW		weighted
Item Nb	**Item**	**Unit**	**Quantity**	**Unit Price**	**Quantity**	**Unit Price**	**Quantity**	**Unit Price**	**Av. $1993**
Item 1	Urban Land								
1.1	Residential	ha.	120,1	182 114	124,1	147 691	88,6	231 237	**182 356**
1.2	Commercial	ha.	7,5	453 400	7,5	453 400	5	453 400	**453 400**
1.3	Industrial	ha.	37,5	293 605	41,5	311 295	20,5	410 302	**325 026**
Item 2	Rural Land								
2.1	Agricultural	ha.	555	17 688	692,57	12 063	752,39	11 845	**13 542**
2.2	Natural	ha.	138	1 083	200,5	1 254	372,5	12 179	**6 945**
Item 3	Purchase of Existing Rail ROW								
3.1	CN	ha.	0	N/A	0	N/A	0	N/A	
3.2	CP	ha.	283,4	51 951	231,58	44 376	0	N/A	**48 545**
3.3	VIA	ha.	0	N/A	0	N/A	0	N/A	
	total		1142		1298		1239		

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: A Land Acquisition
Sector: 4 Construction/Installation
Item: 1 to 9 Urban, Rural and Railway ROW
Sub-item: (see page 4 of 4)

Determination of multiplicators for agricultural land value, from 1993 to 2009:

Value of Agricultural Land (including Buildings), (dollars) STATCAN				
	Ontario	Québec	**Ontario**	**Québec**
	per acre	per acre	per ha	per ha
1993	2144	977	5 295 $	2 413 $
1994	2134	1031	5 271 $	2 546 $
1995	2188	1114	5 404 $	2 751 $
1996	2384	1220	5 888 $	3 013 $
1997	2671	1428	6 597 $	3 527 $
1998	2813	1572	6 948 $	3 883 $
1999	2900	1696	7 162 $	4 189 $
2000	2964	1789	7 320 $	4 418 $
2001	3028	1856	7 479 $	4 584 $
2002	3248	2017	8 022 $	4 982 $
2003	3466	2126	8 560 $	5 251 $
2004	3712	2211	9 168 $	5 461 $
2005	3938	2302	9 726 $	5 685 $
2006	4201	2379	10 376 $	5 876 $
2007	4388	2429	10 837 $	5 999 $
2008	4593	2609	11 344 $	6 444 $
1996/1993		1,2487206		

1993 to 2008:	incremental factor:	2,142257	2,670420
	Annual Growth, % :	5,21%	6,77%
2009		11 935 $	6 880 $
1993 to 2009:	incremental factor:	2,254	2,851
1993 to 2009:	**retained Multiplicators:**	**2,25**	**2,85**
	annual mean, 16 years:	5,20%	6,75%

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Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: A Land Acquisition
Sector: 4 Construction/Installation
Item: 1 to 9 Urban, Rural and Railway ROW
Sub-item: (see page 4 of 4)

Determination of multiplicators for residential land (including building), from 1993 to 2009:

STATCAN Table 327-0005 : Price Index, New Household (Land and Building), Annual(1)

	Ottawa-Gatineau, Ontario/ Québec	Toronto & Oshawa, Ontario	Hamilton, Ontario	London, Ontario	Windsor, Ontario	Average, Ontario	Québec, province *
	1992=100	1992=100	1992=100	1992=100	1992=100		
1993	99,7	96,9	97,3	100,1	99,9		101,2
1994	100	96,9	96,5	100,1	99,6		101,8
1995	97,9	98,2	95,5	97,4	100,6		101,4
1996	96,5	96,5	94,6	96,3	100,6		100,4
1997	97	98,7	98,1	97,6	104,4		99,6
1998	97,3	101,8	101,7	97,7	105,3		101,7
1999	98,7	103,4	102,6	98,3	105,7		102,0
2000	104,1	106,6	105,4	101,3	106,5		104,4
2001	119,9	108,9	107,4	104	106,4		108,0
2002	129,5	112,6	111,2	106,3	106,9		114,3
2003							120,6
2004							128,0
2005			Not Available				134,0
2006							143,2
2007							148,1
2008							157,7
2009							165,0

2002/1993	1,299	1,162	1,143	1,062	1,070	*1,147*	*1,129*
2009/2002	Québec : 44,36% increase (Ontario = ?, assumed like Québec)						1,4436
2009/1993	1,875	1,677	1,650	1,533	1,545	**1,66**	**1,63**

* : Land only

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: A Land Acquisition
Sector: 4 Construction/Installation
Item: 1 to 9 Urban, Rural and Rail ROW
Sub-item: (see below)

Windsor - Toronto 1995			weighted				
Item Nb	**Item**	**Unit**	**Av. $1993**	**multiplicator 1993 -> 2009**	**Unit price (2009)**	**Say ($$_{2009}$/ha)**	**Sub-item Nb**
Item 1	Urban Land						
1.1	Residential	ha.	917 149	1,66	1 522 468	**1 500 000**	**1.4**
1.2	Commercial	ha.	811 136	1,66	1 346 486	**1 350 000**	**2.4**
1.3	Industrial	ha.	770 233	1,66	1 278 587	**1 280 000**	**3.4**
Item 2	Rural Land						
2.1	Agricultural	ha.	43 863	2,25	98 691	**100 000**	**4.4**
2.2	Natural	ha.				**N/A**	**5.4**
Item 3	Purchase of Existing Rail ROW						
3.1	CN	ha.	165 044	☼ 1,60	264 070	**265 000**	**6.4**
3.2	CP	ha.	62 634	1,60	100 215	**100 000**	**7.4**
3.3	VIA	ha.				**-**	**9**
	total						

Toronto - Montreal 1995			weighted					
Item Nb	**Item**	**Unit**	Av. $1993					
Item 1	Urban Land							
1.1	Residential	ha.	846 499	1,66	1 405 189	**1 400 000**	**1.2**	**1.3**
1.2	Commercial	ha.	301 714	1,66	500 845	**500 000**	**2.2**	**2.3**
1.3	Industrial	ha.	541 765	1,66	899 330	**900 000**	**3.2**	**3.3**
Item 2	Rural Land							
2.1	Agricultural	ha.	11 441	2,25	25 743	**26 000**	**4.2**	**4.3**
2.2	Natural	ha.	2 659	2,25	5 984	**6 000**	**5.2**	**5.3**
Item 3	Purchase of Existing Rail ROW							
3.1	CN	ha.	100 721	1,60	161 153	**160 000**	**6.2**	**6.3**
3.2	CP	ha.	57 828	1,60	92 525	**100 000**	**7.2**	**7.3**
3.3	VIA	ha.				**-**	**9**	
	total							

Montreal - Quebec 1995			weighted					
Item Nb	**Item**	**Unit**	Av. $1993					
Item 1	Urban Land							
1.1	Residential	ha.	182 356	1,63	297 240	**300 000**	**1.1**	
1.2	Commercial	ha.	453 400	1,63	739 042	**740 000**	**2.1**	
1.3	Industrial	ha.	325 026	1,63	529 793	**530 000**	**3.1**	
Item 2	Rural Land							
2.1	Agricultural	ha.	13 542	2,85	38 595	**40 000**	**4.1**	
2.2	Natural	ha.	6 945	2,85	19 792	**20 000**	**5.1**	
Item 3	Purchase of Existing Rail ROW							
3.1	CN	ha.				**N/A**	**6.1**	
3.2	CP or CGRY	ha.	48 545	1,60	77 671	**80 000**	**7.1**	**8**
3.3	VIA	ha.				**-**	9	
	total							

☼ 3.0% mean annual increase from 1993 to 2009

Date:		Page: 1 of 5

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

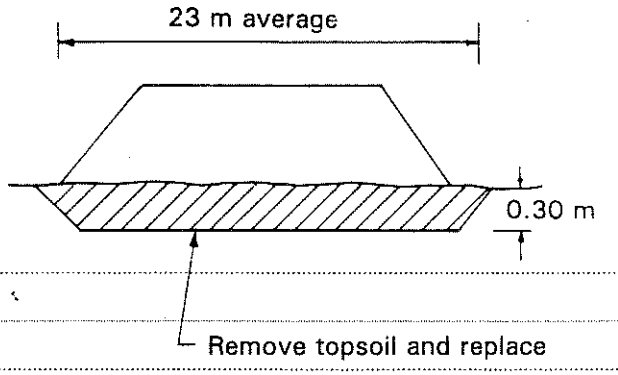
Technology:	☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W	Sub-system: 8 - EARTHWORKS Sector: 4 - CONSTRUCTION Item: 1 - CLEARING

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable:_____

1.1 - Type 1 Soils

Assume a 50 m wide corridor - (per/km)

1,000 m x 50 m = 50,000 m^2 = 5 ha



(1) Clearing - (scraper work):

5 ha @ ~~$5,000~~/ha = ~~$25,000~~/km

$8,000 **$40,000**

(2) Excavation of unsuitable material and backfill:

23 x 0.3 x 1,000 m/km = 6,900 m^3/km

Case 1 - 2a) Assuming 5 km haulage

(2.a1) Exc → 6,900 m^3/km @ ~~$2.5~~/$m^3$ = ~~$17,250~~/km

$3.5 **$24,150**

(2.a2) Disposal → assuming 5 km haulage @ $0.60 per m^3/km

$3.0/$m^3$ x 6,900 m^3/km = $20,700/km

Prepared by:	continued ☑

Revised by Eco Train - June 2009

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology: ☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W

Sub-system: B - EARTHWORKS
Sector: 4 - CONSTRUCTION
Item: 1 - CLEARING

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable: _____

Case 2 - 2b) If all backfill is borrow material, assuming 10 km avg. haulage

(2.b1) $~~17,250~~/km (same as in 2.a1)
$24,150

(2.b2) $20,700/km (same as in 2.a2)

(2.b3) Excavation, placement and compaction of selected material:

6,900 m^3 @ $~~3~~/$m^3$ = $~~20,700~~/km
$6 **$41.400**

(2.b4) Haulage @ **$0.60** ~~$0.50~~ per m^3/km

$~~5.0~~/$m^3$ x 6,900 m^3/km = $~~34,500~~/km
$6.0 **$41,400**

(3) Demolition of buildings and other structures

Lump sum $~~10,000~~/km (assuming an average of 2 houses/km)
$20,000

Total Item 1.1

Case 1 - Total = [(1)+(2a)+(3)] + 10% allowance for misc. items
$115,000
(No borrow. Free haulage) = $~~80,000~~/km

Case 2 - Total = [(1)+(2b)+(3)] + 10% allowance for misc. items
$184,000
(All borrow. 10 km haulage) = $~~142,000~~/km
$150,000
Case 3 - Average of Case 1 & Case 2 = $~~111,000~~/km

Prepared by: | continued ☑

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QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology: ☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W

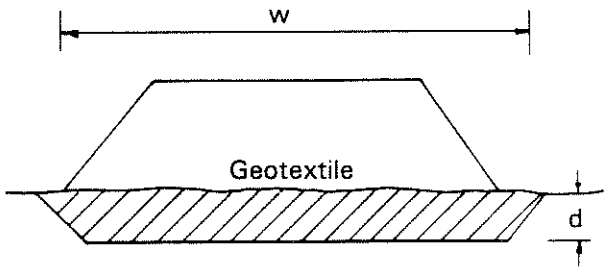
Sub-system: B - EARTHWORKS
Sector: 4 - CONSTRUCTION
Item: 1 - CLEARING

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable: _____

1.2 - Type 2 Soils; 1.3 - Type 3 Soils

Assume a 50 m wide corridor - (per km)

1,000 x 50 m = 50,000 m^2 = 5 ha



Item 1.2 : d = 1.5 m; w = 23 m

Item 1.3 : d = 2.0 m; w = 31 m

$40,000

(1) Clearing (scraper) = $~~25,000/~~km (same as in 1.1)

(2) Excavation and backfill:

for Item 1.2 : 23 x 1.5 x 1,000 = 34,500 m^3/km

for Item 1.3 : 31 x 2 x 1,000 = 62,000 m^3/km

Case 1 - (2a) If backfill material is hauled from excavation item, free haulage

$3.5 **$120.750**

Item 1.2: (2.a1) Exc → 34,500 m^3/km @ $~~2.5~~/$m^3$ = $~~86,250~~/km

(2.a2) Disposal → assuming 5 km haulage @ $0.60 per m^3/km

0.60 x 5 x 34,500 = $103,500/km

(2a) Total, item 1.2, case 1 : $224,250/km

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QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology: ☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W

Sub-system: B - EARTHWORKS
Sector: 4 - CONSTRUCTION
Item: 1 - CLEARING

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable: _____

Item 1.3: (2.a1) Exc → 62,000 m^3/km @ $~~2.5~~ 3.5/$m^3$ = $~~155,000~~ 217,000/km

(2.a2) Disposal → assuming 5 km haulage @ $0.60 per m^3/km

0.60 x 5 x 62,000 = $186,000/km

(2a) Total, item 1.3, case 1 : $403,000/km

Case 2 - (2b) If all backfill is borrow material, assuming 10 km avg. haulage

Item 1.3: (2.b1) $~~155,000~~ 217,000/km (same as in 2.a1)

(2.b2) $186,000/km (same as in 2.a2)

(2.b3) Excavation, placement and compaction of selected material:

62,000 x ~~3~~ 6 = $~~186,000~~ 372,000/km

(2.b4) Haulage @ $0.~~50~~ 60 per m^3/km

10 x 0.~~50~~ 60 x 62,000 = $~~310,000~~ 372,000/km

(2b) Total, item 1.3, case 2 : $1,147,000/km

Item 1.2: (2.b1) $~~86,250~~ 120,750/km (same as in 2.a1)

(2.b2) $103,500/km (same as in 2.a2)

(2.b3) $34,500 x ~~3~~ 6 = $~~103,500~~ 207,000/km

(2.b4) $10 x 0.~~50~~ 60 x 34,500 = $~~172,500~~ 207,000 km

(2b) Total, item 1.2, case 2 : $638,250/km

Prepared by:

continued ☑

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QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology: ☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W

Sub-system: 3 - EARTHWORKS
Sector: 4 - CONSTRUCTION
Item: 1 - CLEARING

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable: _____

(3) Demolition of structures = lump sum = $~~10,000~~ **$20,000**/km

(4) Geotextile @ $~~3~~ **$4.80**/m²

23 x 1000 x ~~3~~ **4.80** = $~~69,000~~ **$110,400**/km

Total Item 1.2

Case 1 : [(1)+(2a)+(3)+(4)] + 10% allowance for misc. items

(No borrow. Free haulage) = $~~323,000~~ **$434,000**/km

Case 2 : [(1)+(2b)+(3)+(4)] + 10% allowance for misc. items

(All borrow. 10 km haulage) = $~~627,000~~ **$890,000**/km

Case 3 : Average of Case 1 & Case 2 = $~~475,000~~ **$662,000**/km

Total Item 1.3

Case 1 : [(1)+(2a)+(3)+(4)] + 10% allowance for misc. items

(No borrow. Free haulage) = $~~490,000~~ **$631,000**/km

Case 2 : [(1)+(2b)+(3)+(4)] + 10% allowance for misc. items

(All borrow. 10 km haulage) = $~~1,035,000~~ **$1,449,000**/km

Case 3 : Average of Case 1 & Case 2 = $~~763,000~~ **$1,040,000**/km

Prepared by: | continued ☐

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Date: | Page: 1 of 2

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology: ☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W

Sub-system: B - EARTHWORKS
Sector: 4 - CONSTRUCTION
Item: 2 - EMBANKMENT

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable:_____

ITEM 2 - EMBANKMENT CONSTRUCTION

Excavation (free haulage of 500 m in either direction of embankment, along R.O.W.); placement and compaction:

2.1 - Soft excavated material (scraper; small dozer work) = $6 ~~$3~~/m³

2.2.a - Soft rock (large dozer work) = $21 ~~$15~~/m³)

2.2.b - Hard rock (blasting required) = $35 ~~$25~~/m³) Use $28 ~~$18~~/m³

2.3 - Borrow material

(soil excavation) = $6 ~~$3~~/m³

Assuming 5 km avg. hauling @ $0.60/m³/km = ~~$3~~/m³ + $3/m³

= $6 ~~$6~~/m³

$9 ~~$6~~

$0,60 $6 $6

Assuming 10 km avg. hauling @ $0.~~50~~/m³/km = ~~$5~~/m³ + $3/m³

= ~~$8~~/m³

$12

$21

Soft rock excavation = ~~$15~~/m³

$0.60

Assuming 10 km avg. hauling @ $0.~~50~~/m³/km

= ~~$5~~/m³ + ~~$15~~/m³

$6 $21

= ~~$20~~/m³

$27

Prepared by: | continued ☑

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Date:		Page: 2 of 2

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology:	☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W	Sub-system: B - EARTHWORKS Sector: 4 - CONSTRUCTION Item: 2 - EMBANKMENT

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable: _____

2.4 - Disposal of unsuitable material

Excavation = ~~$2.5~~ $3.5/m³

Disposal (assuming 5 km haulage @ $0.60/m³/km)

= $0.6 x 5

= $3/m³

Total cost = ~~$5.5~~ $6.5/m³

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Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [X] **E300+** [X] **F200+**

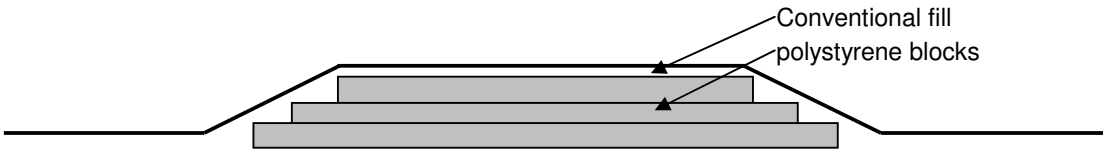
Sub-System:	B	Earthworks and drainage
Sector:	4	Construction
Item:	2	Embankement construction
Sub-item:	2.5	Extra cost for fills on sensitive clays

Alternative 1 : Light fill with polystyrene

Volume of light fill for railroad embankement

Assume: 23 m wide embankement base (15 m wide at the top)
2 m high
Replacement of portion of conventional fill by light fill
(polystyrene blocks 60 x 120 x 2400 cm (2' x 4' x 8'))

Light fill section area =	2' x (64' + 56' + 48') / 10,76 ft²/m² =	31,2 m^2
Light fill volume / km =		31 200 m^3/km
Unite price of light fill =		107 $ $/m^3$
Light fill cost / km =		3 338 400 $/km
Less conventional backfill =	-31 200 x 12 $/m³ =	-374 400 $/km
Unit Cost for Alternative 1 :		2 964 000 $/km
	say:	**3 000 000 $/km**



Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [X] **E300+** [X] **F200+**

Sub-System:	B	Earth work and drainage
Sector:	4	Construction
Item:	2	Embankement construction
Sub-item:	2.5	Extra cost for fills on sensitive clays

Alternative 2 : Consolidation of clay deposit with vertical drains

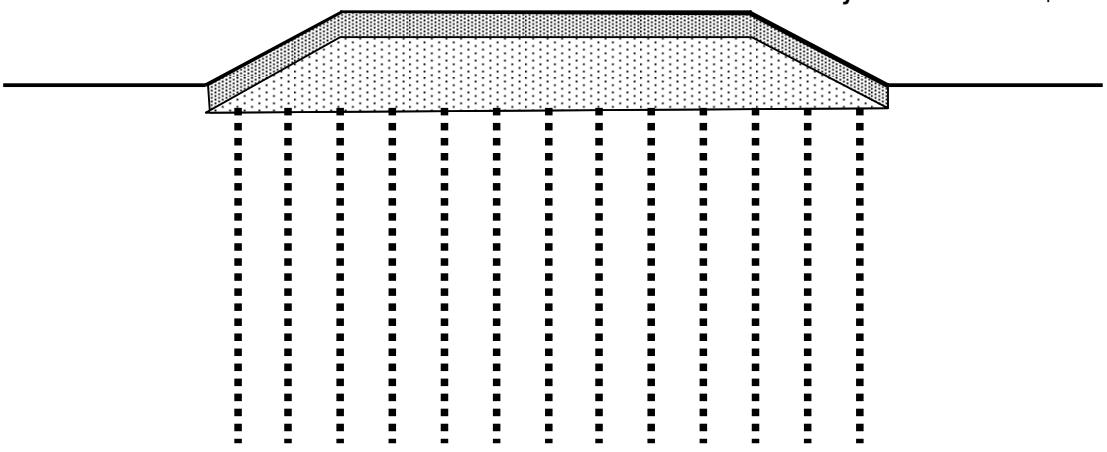
Assume: 23 m wide embankement base (15 m wide at the top)
2 m thick
Installation of vertical drains + a 2-year surcharge fill

Conventional fill section area :	38	m^2
Extra fill for compensation of settlement :	23	m^2
Total volume or extra fill material per km	23 000	m^3/km
Unite price of extra fill (borrow) material :	12,00	$/$m^3$
Total cost of fill :	276 000	$/km

Min. vertical drain depth :	33	m
Number of vertical drains / m of railroad :	16	
Vertical drain length per km :	527 083	m
Unite price of vertical drain (purchase + installation) :	5,00	$/m
Vertical drain cost per km :	2 635 417	$/km

Unit cost for alternative 2 = 2 911 417 $/km

say: 2 900 000 $/km



Recommanded solution : Alternative 1, Light fill with polystyrene : **3 000 000 $/km**

Least cost, less impact on environment (borrow pits, haulage), less impact on construction schedule.

Date:		Page: 1 of 1

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

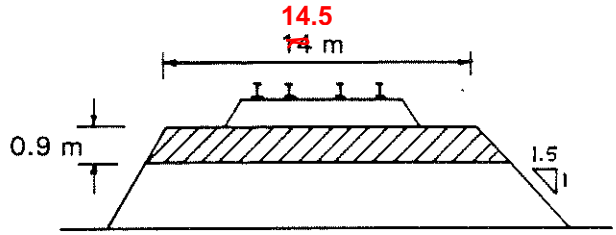
Technology:	☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W	Sub-system: 3 - EARTHWORKS Sector: 4 - CONSTRUCTION Item: 4 - SUB-BALLAST

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable:_____

ITEM 4 - SUB-BALLAST LAYER:

(i) @ $~~15~~ **$18.50**/m³ with borrow material

Assuming a 0.9 m layer



$$\left[\left[\frac{(14 + 16.7)}{2} \times 0.9 \times 1000\right] + 10\% \text{ allowance}\right] \times \$15/m^3 \quad \textbf{14.5 + 17.2} \quad \textbf{\$18.50}$$

= $~~228,000~~ **$290,000**/km

(ii) With available material, rate to be adjusted to eliminate haulage @ $0.~~50~~ **$0,60**/m³/km for average length of 10 km, i.e., use a rate of $~~15~~ **$18.5** - $~~5~~ **$6** = $~~10~~ **$12.5**/m³

= $~~152,000~~ **$196,000**/km

Prepared by:	continued ☐

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Date: | Page: 1 of 1

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology: ☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W

Sub-system: 8 - EARTHWORKS
Sector: 4 - CONSTRUCTION
Item: 5 - DRAINAGE

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable:_____

5.1 Normal R.O.W:

(1) Assuming 4 no. 450 to 900 mm balancing culverts per km

~~$75~~/m x 25 m x 4 = ~~$7,500~~/km

$350 **$35,000**

(2) Assuming 50% of the route requires 200 mm subdrains on both sides

~~$10~~/m x 1,000 m = ~~$10,000~~/km

$42 **$42,000**

(3) Assuming ~~$5,000~~/km for other drainage items

$10,000

Total Item 5.1

= [(1)+(2)+(3)] +10% allowance for miscellaneous items

= ~~$25,000~~/km

$95,000

5.2 Major Watercourse Culverts

Assume a 40 m (4 m dia.) culvert including head walls

~~$875~~/m x 40 m = ~~$35,000~~ each

$1.100 **$44,000**

5.3 Environmental Stormwater Controls

$100,000

Cost of settlement pond = ~~$70,000~~ including excavation for 50 x 30 x 2 m deep pond, one inlet, one outlet and restoration of site.

$10,000

Assume provision of one settlement pond for every 10 km, use rate of ~~$7,000~~ per route-km.

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Date:		Page: 1 of 1

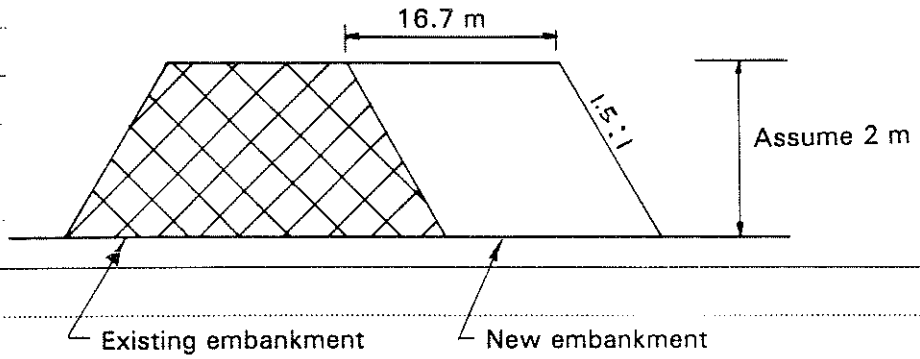
QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology:	☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W	Sub-system: 3 - EARTHWORKS Sector: 4 - CONSTRUCTION Item: 6 - ROADBED UPGRADE

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable:_____

ITEM 6 - ROADBED UPGRADE ON EXISTING R.O.W.



Benching of existing slope = ~~sqrt $2^2 + 3^2$~~

= 3.61 m^2 @ $40/$m^2$

= ~~$145~~/m

= 5 m/hr @$250/hr = $50/m

Embankment construction = 16.7 x 2

with borrow material = 33.4 m^3 @ ~~$8~~ **$12.25**/m^3

= ~~$268~~ **$409**/m

Add 50% for working in close proximity of operation

= ~~$402~~/m

Total cost = (~~$145~~ **$50** + ~~$402~~ **$614**) + 10% allowance for misc. items

= ~~$600~~ **$614**/m say **$730**

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Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	B	Earthworks and Drainage
		Sector:	4	Construction
	[x] **F200+**	**Item:**	7	Retaining Structures
		Sub-item:		7.1 - 7.2

Item 7.1 **Retaining Structure up to 3 metres in height**

Cost / Retaining Structure up to 3 metres in height = $650 / sq.m.

Assume average structure is 2.5 m in height.

$650 x 2.5 = $1,625 / m

Add 20% for difficult foundations / site constraints as per 1994 QOHSRP Preliminary Routing and Costing Study - Interim Report No. 3

$1,625 x 20% = $1,950 / m

= $1,950,000 / km

Use $2,000,000 / km

Item 7.2 **Retaining Structure over 3 metres in height**

Cost / Retaining Structure over 3 metres in height = $750 / sq.m.

Assume average structure is 10.0 m in height.

$750 x 10.0 = $7,500 / m

Add 20% for difficult foundations / site constraints as per 1994 QOHSRP Preliminary Routing and Costing Study - Interim Report No. 3

$7,500 x 20% = $9,000 / m

= $9,000,000 / km

Use $9,000,000 / km

Date:		Page: 1 of 1

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology:
- ☐ 300+ kph - new R/W
- ☐ 300+ kph - exist. R/W
- ☐ 200+ kph - exist. R/W

Sub-system: B - EARTHWORKS
Sector: 4 - CONSTRUCTION
Item: 9 - NOISE BARRIERS

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable:_____

ITEM 9 NOISE ATTENUATION STRUCTURES

9.1 Barriers

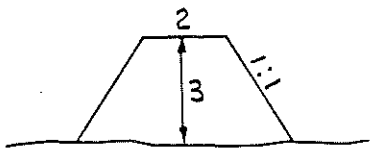
Assuming 3 m in height: **$1,200**

from MTO Unit rates = ~~$600/m~~ **$1,400,000**

Add ~~10%~~ allowance for miscellaneous items = $~~660,000~~/km

15±%

9.2 Berms



$12 (see B-2.3)

Assuming all borrow material, average hauling of 10 km @ $~~11~~/m³

12 **$180,000**

15m² x 1,000m x ~~11~~/m³ = $~~165,000~~/km

Add 15±% allowance for miscellaneous items = $210,000

Prepared by: continued ☐

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Date:		Page: 1 of 1

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology:
- ☐ 300+ kph - new R/W
- ☐ 300+ kph - exist. R/W
- ☐ 200+ kph - exist. R/W

Sub-system: 8 - EARTHWORKS
Sector: 4 - CONSTRUCTION
Item: 10 - FENCING

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable: _____

ITEM 10 ROW SECURITY FENCING (BOTH SIDES)

$65 $130,000

@ $~~28~~/m = $~~56,000~~/km

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continued ☐

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Date:		Page: 1 of 4

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology:	☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W	Sub-system: C - BRIDGES Sector: 4 - CONSTRUCTION Item: 1.1 - SMALL RIVERS

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable: _____

Small River Bridges ± 20m

Based on bridges designed and estimated, cost of such a bridge is ~~$1,300~~/m²

$2500/sq.m.

Assume width of bridge (2 tracks) = ~~13~~ m

13.5 m

$~~1,300~~ x ~~13~~ = $~~16,900~~/m

$2,500 x 13.5 = $33,750/m

or, ~~$16,900~~ x 20 = $~~340,000~~/each

$33,750 $675,000 / each

Prepared by: continued ☐

Revised by EcoTrain - June 2009

Date: | Page: 2 of 4

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology:
- ☐ 300+ kph - new R/W
- ☐ 300+ kph - exist. R/W
- ☐ 200+ kph - exist. R/W

Sub-system: C - BRIDGES
Sector: 4 - CONSTRUCTION
Item: 1.3 - INTERM. RIVERS

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable: _____

Intermediate River Bridges ~~300 - 100 m~~
30 - 100 m

Based on bridges designed and estimated, cost of such a bridge is ~~$1,800~~/m^2
$3,000/sq.m.

Assume width of bridge (2 tracks) = ~~13 m~~
13.5 m

~~$1,800~~ x ~~13~~ = ~~$23,400~~/m
$3,000 x 13.5 = $40,500/m

Prepared by: | continued ☐

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QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology: ☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W

Sub-system: C - BRIDGES
Sector: 4 - CONSTRUCTION
Item: 1.5 - 1.7 LARGE RIVERS

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable: _____

1.5) **Large River Bridges 100 - 250 m**

Based on bridges designed and estimated, cost of such a bridge is ~~$3,200~~/m²

$4,000/sq.m.

Assume width of bridge (2 tracks) = ~~13~~ m

13.5 m

~~$3,200~~/m² x ~~13~~ = ~~$41,600~~/m

$4,000 x 13.5 = $54,000/m

~~Same cost applies to the major river bridges~~.

1.7) Major River Bridges >250 m

Assume a 25% premium from the Large River Bridge Cost:
1.25 x $4,000/sq.m. = $5,000/sq.m.

Assume width of bridge (2 tracks) = 13.5 m

$5,000 x 13.5 = $67,500 ; use $70,000

Prepared by: | continued ☐

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Date:		Page: 4 of 4

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology: ☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W

Sub-system: C - BRIDGES
Sector: 4 - CONSTRUCTION
Item: 1.9 - BRIDGE MODIF.

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable:_____

New deck for 1 track existing bridge of width 4 m

Concrete volume

4m x 0.3m x ~~$400~~/m³ = ~~$480.00~~/m $600/m

$500/cu.m.

Reinforcing steel

400 kg/m³ x ~~$1.25~~/kg = ~~$500.00~~/m $700/m

$1.75/kg ~~$980.00~~/m $1,300/m

say ~~$1,000~~/m use $1,500/m

Provision shall be made to strengthen existing beam

say ~~$800~~/m $1,500/m

~~$1,800~~/m $3,000/m

Provision for maintenance access ~~$600~~/m $1000/m

~~$2,400~~/m $4,000/m

For double track HSR

Add new bridge of width 8 m @ ~~$1,300~~/m² $2,500/sq.m.

~~$1,300~~ x 8 = ~~$10,400~~/m

$2,500 x 8 = $20,000/m

Total cost = ~~$10,400~~ + ~~$2,400~~ = $20,000 + 4,000

= ~~$12,800~~ = $24,000

= ~~$13,000~~/m say use $26,000

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Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x]	**E300+**	**Sub-System:**	C	Bridges, Viaducts and Tunnels
			Sector:	4	Construction/Installation
	[x]	**F200+**	**Item:**	1	Bridges
			Sub-item:	1.2, 1.4, 1.6	Extra over for height over 10m

1.2 Extra over Unit Cost 1.1 for height over 10m

Unit Cost 1.1 (small river crossings, < 30m) $675,000 / each

Assume the same 25% premium as the QOHSRP report.

$675,000 x 25% = $168,750 **Use $170,000 / each**

1,4 Extra over Unit Cost 1.3 for height over 10m

Unit Cost 1.3 (intermediate river crossing, 30 - 100m) $40,500 / m

Assume the same 25% premium as the QOHSRP report.

$40,500 x 25% = $10,125 **Use $10,000 / m**

1,6 Extra over Unit Cost 1.5 for height over 10m

Unit Cost 1.5 (large river crossing, 100 - 250m) $54,000 / m

Assume the same 25% premium as the QOHSRP report.

$54,000 x 25% = $13,500 **Use $13,500 / m**

Updated Feasibility Study of a High Speed Rail Service
in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x]	**E300+**	**Sub-System:**	C	Bridges, Viaducts and Tunnels
			Sector:	4	Construction/Installation
	[x]	**F200+**	**Item:**	1	Bridges
			Sub-item:	1,8	Extra over for diff. found. cond.

1.8 Extra over Items 1.1, 1.3, 1.5, and 1.7 for difficult foundation conditions

No calculation in QOHSRP report.

Assume cost to be approximately 50% of Item 1.6 (proportion as in QOHSRP report)

Unit Cost 1.6 (Extra over Large Bridge Unit Cost for height over 10m) $13,500 / m

$13,500 x 50% = $6,750 **Use $7,000 / m**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	C	Bridges, Viaducts and Tunnels
		Sector:	4	Construction/Installation
	[x] **F200+**	**Item:**	2	Viaducts
		Sub-item:	2.1 - 2.3	

2.1 Viaducts exceeding 250m in length

No calculation in QOHSRP report.

Assume 66% increase from QOHSRP report unit cost

Unit Cost 2.1 (QOHSRP) $27,000 / m

$27,000 x 1.66% = $44,820 **Use $45,000 / m**

2.2 Extra over Item 2.1 for height over 10m

Assume the same 25% premium as the QOHSRP report.

$45,000 x 25% = $11,250 **Use $11,000 / m**

2.3 Extra over Item 2.1 for difficult foundation conditions

Item not used in the QOHSRP report.

Item is assumed to be site specific.

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	C	Bridges, Viaducts and Tunnels
		Sector:	4	Construction/Installation
	[x] **F200+**	**Item:**	3	Tunnels
		Sub-item:	3.1 - 3.2	

3.1 Double track tunnelling in soft ground

No calculation in QOHSRP report.

Assume 66% increase from QOHSRP report unit cost

Unit Cost 3.1 (QOHSRP) $70,000 / m

$70,000 x 1.66% = $116,200 **Use $120,000 / m**

3.2 Double track tunnelling in rock

No calculation in QOHSRP report.

Assume 66% increase from QOHSRP report unit cost

Unit Cost 3.1 (QOHSRP) $47,747 / m

$47,747 x 1.66% = $79,260 **Use $80,000 / m**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x]	**E300+**	**Sub-System:**	C	Bridges, Viaducts and Tunnels
			Sector:	4	Construction/Installation
	[x]	**F200+**	**Item:**	3	Tunnels
			Sub-item:	3.3	Modif. To Mt-Royal tunnel, Montréal

The existing 5,5 km long Mt-Royal tunnel, in Montréal, running from Gare Centrale, downtown Montréal, up to Jean-Talon Street, in the Town of Mount Royal, was inaugurated in 1918. No forced ventilation exists, and no emergency exits.

Given that the trains will be air conditioned and electrically powered, HSR should be allowed to circulate without any ventilation system in the tunnel.

But, according to NFPA-130 (Standard for Fixed Guideway Transit and Passenger Rail Systems), the tunnel should be provided with emergency exits at maximum spacing of 762 m.

To achieve this, a parallel evacuation tunnel should be built all along the existing one and not far away, to permit evacuation from the existing tunnel, with connecting tunnels every 750 m. This 5 m dia. Tunnel could allow busses to circulate in one direction to rescue evacuated passengers.

An example of the proposed arrangement could be the Katzenberg twin tunnels in Germany; in the illustration below, one of the two tubes could be the existing Mount Royal tunnel.

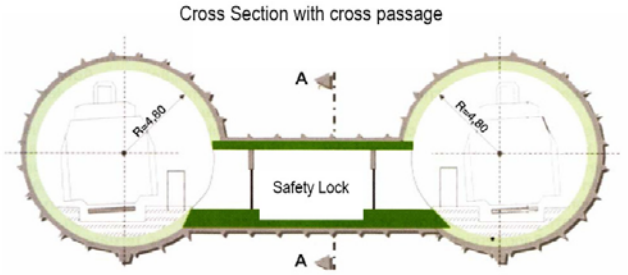


FIGURE 5 : CROSS SECTION OF THE KATZENBERG – TUNNEL (DB, NEAR BASEL)[10]

Two similar projects can be used as reference for pricing:

- Oslo-Ski, Norway : 17,85 km, built in 2008 with the new Austrian tunneling method (NOT), at an average unit cost of 52 000 CAD/m for civil works only.
- Katzenberg, Germany: 9,39 km, buit in 2009 with a tunnel boring machine (TBM), at an average unit cost of 42 000 CAD/m for civil works only.

Given the relatively short length of our project, the NOT method would be more appropriate. Taking 60 % of that cost for one 5 m tube and a cross passage every 750 m, and adding 3 % for inflation to 2009, we would get a unit cost of 32 000 $/m for civil works.

Civil works :	Longitudinal 5-m diam. tunnel plus cross passages : 4850* m X 32 000 $/m :	155 M$
	End accesses (2) (north of Maisonneuve St and north of Jean-Talon St):	7 M$
Electricity/Mechanic : jet fans (2/km), minimal lighting and electrical supply :		3 M$
		165 M$

*: From Maisonneuve St to Jean-Talon St

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: D Grade Separations
Sector: 4 Construction
Item: 1 New Rural G.S.
Sub-item: 1.1 to 1.3

1992-95			Item 1.1		Item 1.2		Item 1.3		
			2 Lane Rural over 2 Tracks		2 Lane Rural over 4 Tracks		4 Lane Rural over 2 Tracks		
	Unit	**Price $/unit**	**Q**	**$**	**Q**	**$**	**Q**	**$**	
1. Excavation	m^3	5	1760	8 800	1760	8 800	2140	10 700	
2. Borrow	m^3	5	145 730	728 650	145 730	728 650	182 560	912 800	
3. Hot Mix	t	60	2 265	135 900	2 365	141 900	4 680	280 800	
4. Gran 'A'	t	10	6 820	68 200	6 820	68 200	9 340	93 400	
5. Gran 'B'	t	8	10 925	87 400	10 925	87 400	16 000	128 000	
6. Guide Rail	m	75	1 540	115 500	1 540	115 500	1 540	115 500	
Sub Total				1 144 450		1 150 450		1 541 200	
7. Minor Items 10%				114 450		115 050		154 120	
Total Roadwork				1 258 900		1 265 500		1 695 320	
Structure									
8. Standard Conditions	m^2	1100	500	550 000	945	1 039 500	800	880 000	
9. Diff. Fnd. Conditions	m^2	1265	500	632 500	945	1 195 425	800	1 012 000	
Total Cost									
Standard Conditions				1 808 900		2 305 000		2 575 320	
Difficult Fnd. Conditions				1 891 400		2 460 925		2 707 320	
Retained value *				**2 200 000**		**2 800 000**		**3 100 000**	

* : 20±% added to total cost to compensate for low borrow unit price

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: D Grade Separations
Sector: 4 Construction
Item: 1 New Rural G.S.
Sub-item: 1.4 to 1.5

1992-95			Item 1.4 4 Lane Rural over 4 Tracks		Item 1.5 4 Lane Div. Freeway over 2 Tracks				
	Unit	**Price $/unit**	**Q**	**$**	**Q**	**$**			
1. Excavation	m^3	5	2140	10 700	3590	17 950			
2. Borrow	m^3	5	182 560	912 800	315 350	1 576 750			
3. Hot Mix	t	60	4 850	291 000	6 670	400 200			
4. Gran 'A'	t	10	9 340	93 400	14 350	143 500			
5. Gran 'B'	t	8	16 000	128 000	31 360	250 880			
6. Guide Rail	m	75	1 540	115 500	840	63 000			
Sub Total				1 551 400		2 452 280			
7. Minor Items 10%				155 140		245 230			
Total Roadwork				1 706 540		2 697 510			
Structure									
8. Standard Conditions	m^2	1100	1 150	1 265 000	920	1 012 000			
9. Diff. Fnd. Conditions	m^2	1265	1 150	1 454 750	920	1 163 800			
Total Cost									
Standard Conditions				2 971 540		3 709 510			
Difficult Fnd. Conditions				3 161 290		3 861 310			
Retained value *				**3 565 000**		**4 450 000**			

* : 20±% added to total cost to compensate for low borrow unit price

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: D Grade Separations
Sector: 4 Construction
Item: 1 New Rural G.S.
Sub-item: 1.1 to 1.3

2009			Item 1.1		Item 1.2		Item 1.3		
			2 Lane Rural over 2 Tracks		2 Lane Rural over 4 Tracks		4 Lane Rural over 2 Tracks		
	Unit	**Price $/unit**	**Q**	**$**	**Q**	**$**	**Q**	**$**	
1. Excavation	m^3	**10**	1760	17 600	1760	17 600	2140	21 400	
2. Borrow	m^3	**15**	145 730	2 185 950	145 730	2 185 950	182 560	2 738 400	
3. Hot Mix	t	**100**	2 265	226 500	2 365	236 500	4 680	468 000	
4. Gran 'A'	t	**20**	6 820	136 400	6 820	136 400	9 340	186 800	
5. Gran 'B'	t	**15**	10 925	163 875	10 925	163 875	16 000	240 000	
6. Guide Rail	m	**120**	1 540	184 800	1 540	184 800	1 540	184 800	
Sub Total				2 915 125		2 925 125		3 839 400	
7. Minor Items 10%				291 513		291 153		383 940	
Total Roadwork				3 206 638		3 216 278		4 223 340	
Structure									
8. Standard Conditions	m^2	**2500**	500	1 250 000	945	2 362 500	800	2 000 000	
9. Diff. Fnd. Conditions	m^2	**2875**	500	1 437 500	945	2 716 875	800	2 300 000	
Total Cost									
Standard Conditions				4 456 638		5 578 778		6 223 340	
Difficult Fnd. Conditions				4 644 138		5 933 153		6 523 340	
Retained value				**4 460 000**		**5 570 000**		**6 230 000**	

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: D Grade Separations
Sector: 4 Construction
Item: 1 New Rural G.S.
Sub-item: 1.4 to 1.5

2009			Item 1.4 4 Lane Rural over 4 Tracks		Item 1.5 4 Lane Div. Freeway over 2 Tracks				
	Unit	**Price $/unit**	**Q**	**$**	**Q**	**$**			
1. Excavation	m^3	**10**	2140	21 400	3590	35 900			
2. Borrow	m^3	**15**	182 560	2 738 400	315 350	4 730 250			
3. Hot Mix	t	**100**	4 850	485 000	6 670	667 000			
4. Gran 'A'	t	**20**	9 340	186 800	14 350	287 000			
5. Gran 'B'	t	**15**	16 000	240 000	31 360	470 400			
6. Guide Rail	m	**120**	1 540	184 800	840	100 800			
Sub Total				3 856 400		6 291 350			
7. Minor Items 10%				385 640		629 135			
Total Roadwork				4 242 040		6 920 485			
Structure									
8. Standard Conditions	m^2	**2500**	1 150	2 875 000	920	2 300 000			
9. Diff. Fnd. Conditions	m^2	**2875**	1 150	3 306 250	920	2 645 000			
Total Cost									
Standard Conditions				7 117 040		9 220 485			
Difficult Fnd. Conditions				7 548 290		9 565 485			
Retained value				**7 120 000**		**9 230 000**			

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

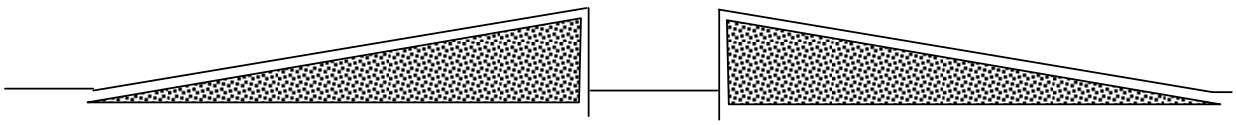
Technology: [X] **E300+** [X] **F200+**

Sub-System: D Grade separation
Sector: 4 Construction
Item: 1 and 2 New grade separations, rural & urban
Sub-item: 1.7 and 2.5 Extra cost for fills on sensitive clays

Alternative 1 : Construction of light fills with polystyrene

Assume: 60 m wide embankement base (12 m wide at the top) for a 2-lane cross road
11 m high
200 m approach length

Fill area at max height:	(60+12)*11/2 =	396	m²
polystyrene volume / approach:	(396 - 60*1)*200/2 =	33 600	m³
Unite price of polystyrene :		105	$/m³
Total cost of polystyrene per grade separation:		7 056 000	$
Less: cost of replaced normal fill	2 * 33 600 * 12 $ =	-806 400	$
Net additional cost per 2-lane grade separation:		6 249 600	$
		say: 6 300 000	**$ per 2-lane grade separation**
Increase for a 4-lane grade separation (7 m extra width): = 7m x 11m x 200m/2 x 2 x(105-12)$		1 432 200	$
Net additional cost per 4-lane grade separation:		7 681 800	
		say: 7 700 000	**$ per 4-lane grade separation**



Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [X] **E300+** [X] **F200+**

Sub-System: D Grade separation
Sector: 4 Construction
Item: 1 and 2 New grade separations, rural & urban
Sub-item: 1.7 and 2.5 Extra cost for fills on sensitive clays

Alternative 2 : Consolidation of clay deposit with vertical drains

Assume: 60 m wide embankement base (12 m wide at the top) for a 2-lane cross road
12 m high
200 m approach length

Extra fill for compensation of settlement:

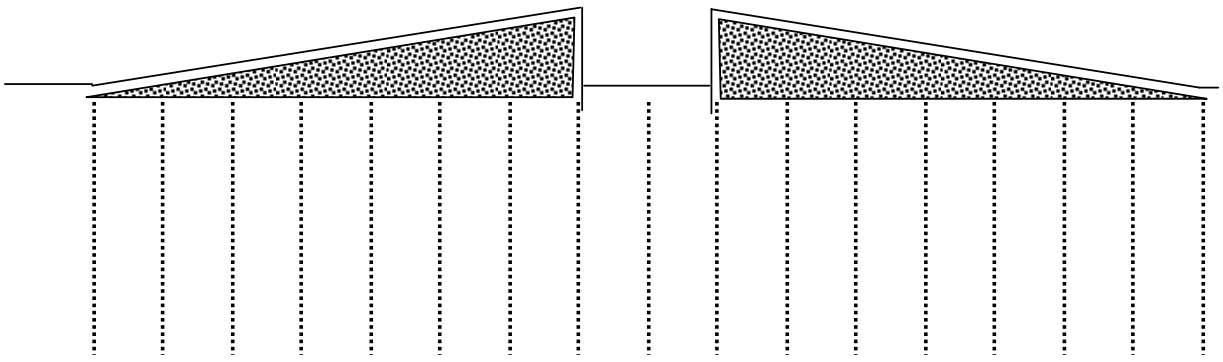
4 m at max height of approach fill:	240	m2
0 m at beginning of approach fill :	0	m2
Total extra fill volume, 2 approaches:	35 200	m3
Unite price of extra fill material (borrow) :	12	$/m³
Total cost of fill :	422 400	$/structure, 2-lane

Min. vertical drain depth :	45	m
Number of vertical drains per approach (at 1.2 m apart):	51,84	
Vertical drain length per structure :	4 666	m
Unite price of vertical drain (purchase + installation) :	5	$/m
Vertical drain cost per km :	1 049 760	$/structure, 2-lane

Total cost per 2-lane structure: 1 472 160 $
Say: 1 500 000 $

Additional cost for 4-lane structure (7 m wider):
2*(7*4*200*12/2 + 7*200*45*5/1,44) 504 700 $

Total cost per 4-lane structure: 1 976 860 $
Say: 2 000 000 $



Recommanded solution : Alternative 2, Consolidation of clay deposit with vertical drains

Unit Price D-4-1.7 :
1 500 000 $ per 2-lane grade separation

Unit Price D-4-2.5 :
2 000 000 $ per 4-lane grade separation

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: D Grade Separations
Sector: 4 Construction
Item: 2 New Urban G.S.
Sub-item: 2.1 to 2 4

1992-95			Item 2.1 Secondary High-ways (2-4 lanes)		Item 2.2 Secondary High-ways (2-4 lanes) Dual ROW		Item 2.3 Major Highways (over 4 lanes)		Item 2.4 Extra for Difficult Foundation Cond.
	Unit	**Price $/unit**	**Q**	**$**	**Q**	**$**	**Q**	**$**	
1. Borrow	m^3	5	198 000	990 000	198 000	990 000	233 330	1 166 650	
2. Hot Mix	t	60	4 445	266 700	4 495	269 700	6 610	396 600	
3. Gran 'A'	t	10	5 640	56 400	5 640	56 400	8 670	86 700	
4. Gran 'B'	t	8	14 100	112 800	14 100	112 800	25 000	200 000	
5. Guide Rail	m	75	1 540	115 500	1 540	115 500	1 540	115 500	
6. Curbs	m	32	1 880	60 160	1 880	60 160	3 760	120 320	
6. Sidewalks	m^2	35	2 820	98 700	2 820	98 700	2 820	98 700	
Sub Total				1 700 260		1 703 260		2 184 470	
8. Minor Items 30%				510 080		510 980		655 340	
Total Roadwork				2 210 340		2 214 240		2 839 810	
Structure									
9. Standard Conditions	m^2	1100	800	880 000	1 090	1 199 000	1 160	1 276 000	
10. Diff. Fnd. Conditions	m^2	1265	800	1 012 000	1 090	1 378 850	1 160	1 467 400	
11. Traffic Maintenance				100 000		100 000		100 000	
12, Detours				150 000		150 000		150 000	
13. Mitigations - Private Property				50 000		50 000		50 000	
Total Cost									
Standard Conditions				3 390 340		3 713 240		4 415 810	
Difficult Fnd. Conditions				3 522 340		3 893 090		4 607 210	
Retained value *				**4 068 000**		**4 456 000**		**5 300 000**	**200 000**

* : 20±% added to total cost to compensate for low borrow unit price

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: D Grade Separations
Sector: 4 Construction
Item: 2 New Urban G.S.
Sub-item: 2.1 to 2 4

2009			Item 2.1 Secondary Hhwys (2-4 lanes)		Item 2.2 Secondary Highways (2-4 lanes) Dual		Item 2.3 Major Highways (over 4 lanes)		Item 2.4 Extra for Difficult Foundation Cond.
	Unit	**Price $/unit**	**Q**	**$**	**Q**	**$**	**Q**	**$**	
1. Borrow	m³	**15**	198 000	2 970 000	198 000	2 970 000	233 330	3 499 950	
2. Hot Mix	t	**100**	4 445	444 500	4 495	449 500	6 610	661 000	
3. Gran 'A'	t	**20**	5 640	112 800	5 640	112 800	8 670	173 400	
4. Gran 'B'	t	**15**	14 100	211 500	14 100	211 500	25 000	375 000	
5. Guide Rail	m	**120**	1 540	184 800	1 540	184 800	1 540	184 800	
6. Curbs	m	**50**	1 880	94 000	1 880	94 000	3 760	188 000	
6. Sidewalks	m²	**55**	2 820	155 100	2 820	155 100	2 820	155 100	
Sub Total				4 172 700		4 177 700		5 237 250	
8. Minor Items 30%				1 251 810		1 253 310		1 571 175	
Total Roadwork				5 424 510		5 431 010		6 808 425	
Structure									
9. Standard Conditions	m²	**2 500**	800	2 000 000	1 090	2 725 000	1 160	2 900 000	
10. Diff. Fnd. Conditions	m²	**2 875**	800	2 300 000	1 090	3 133 750	1 160	3 335 000	
11. Traffic Maintenance				150 000		150 000		150 000	
12, Detours				250 000		250 000		250 000	
13. Mitigations - Private Property				75 000		75 000		75 000	
Total Cost									
Standard Conditions				7 900 000		8 640 000		10 190 000	
Difficult Fnd. Conditions				8 200 000		9 040 000		10 620 000	
Retained value				**7 430 000**		**8 160 000**		**9 710 000**	**350 000**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: D Grade Separations
Sector: 4 Construction
Item: 3 Modification of Existing G.S.
Sub-item: 3,1

1992-95

	Unit	Price $/unit	Item 3.1a 4 Lane Urban Road over 4 tracks Q	Item 3.1a $	Item 3.1b Urban Minor Modification Q	Item 3.1b $			
1. Roadway	L.S.		L.S.	200 000	L.S.	60 000			
2. Detour	km	280 000	0,0	0	0	0			
Sub Total				200 000	2 365	60 000			
Minor Items 10%				20 000	6 820	6 000			
Total Roadwork				220 000	10 925	66 000			
3. Structure		1100	1 090	1 199 000	0	0			
			Bridge Removal	100 000					
4. Existing Bridge Rehabilitation	m²	250	0	0	300	75 000			
5. Crossing Protect, Signals, etc.	EA.	250 000	0	0	0	0			
Total Cost				1 519 000		141 000			
Unit Cost for 3.1 assumed to be the average of 3.1a and 3.1b.									
Average of 3.1a and 3.1b						830 000			
Retained value						**830 000**			

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: D Grade Separations
Sector: 4 Construction
Item: 3 Modification of Existing G.S.
Sub-item: 3,2

1992-95

	Unit	Price $/unit	Item 3.2a 4 Lane Rural over 4 Tracks Q	Item 3.2a $	Item 3.2b 4 Lane Div. Freeway over 2 Tracks Q	Item 3.2b $			
1. Roadway	L.S.		L.S.	100 000	L.S.	30 000			
2. Detour	km	280 000	0,7	196 000	0	0			
Sub Total				296 000	2 365	30 000			
Minor Items 10%				29 600	6 820	3 000			
Total Roadwork				325 600	10 925	33 000			
3. Structure		1100	500	550 000	0	0			
4. Existing Bridge Rehabilitation	m²	250	190	47 500	190	47 500			
5. Crossing Protect, Signals, etc.	EA.	250 000	1	250 000	0	0			
Total Cost				1 173 100		80 500			
Unit Cost for 3.1 assumed to be the average of 3.1a and 3.1b.									
Average of 3.1a and 3.1b						626 800			
Retained value						**627 000**			

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: D Grade Separations
Sector: 4 Construction
Item: 3 Modification of Existing G.S.
Sub-item: 3,1

2009			Item 3.1a 4 Lane Urban Road over 4 tracks		Item 3.1b Urban Minor Modification				
	Unit	**Price $/unit**	**Q**	**$**	**Q**	**$**			
1. Roadway	L.S.		L.S.	**500 000**	L.S.	**150 000**			
2. Detour	km	**700 000**	0,0	0	0	0			
Sub Total				500 000	2 365	150 000			
Minor Items 10%				50 000	6 820	15 000			
Total Roadwork				550 000	10 925	165 000			
3. Structure		**2500**	1 090 Bridge Removal	2 725 000 **250 000**	0	0			
4. Existing Bridge Rehabilitation	m^2	**600**	0	0	300	180 000			
5. Crossing Protect, Signals, etc.	EA.	**300 000**	0	0	0	0			
Total Cost				3 525 000		345 000			
Unit Cost for 3.1 assumed to be the average of 3.1a and 3.1b.									
Average of 3.1a and 3.1b						1 935 000			
Retained value						**1 940 000**			

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: D Grade Separations
Sector: 4 Construction
Item: 3 Modification of Existing G.S.
Sub-item: 3,2

2009			Item 3.2a 4 Lane Rural over 4 Tracks		Item 3.2b 4 Lane Div. Freeway over 2 Tracks				
	Unit	**Price $/unit**	**Q**	**$**	**Q**	**$**			
1. Roadway	L.S.		L.S.	**250 000**	L.S.	**75 000**			
2. Detour	km	**700 000**	0,7	490 000	0	0			
Sub Total				740 000	2 365	75 000			
Minor Items 10%				74 000	6 820	7 500			
Total Roadwork				814 000	10 925	82 500			
3. Structure		**2500**	500	1 250 000	0	0			
4. Existing Bridge Rehabilitation	m^2	**600**	190	114 000	190	114 000			
5. Crossing Protect, Signals, etc.	EA.	**300 000**	1	300 000	0	0			
Total Cost				2 478 000		196 500			
Unit Cost for 3.1 assumed to be the average of 3.1a and 3.1b.									
Average of 3.1a and 3.1b						1 337 250			
Retained value						**1 340 000**			

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: D Grade Separations
Sector: 4 Construction
Item: 5 Closure and Diversion of Roads
Sub-item:

2009

	Unit	Price $/unit	Item 5 Closure and Diversion of Road Q	$					
1. Excavation	m^3	10	10 000	100 000					
2. Hot Mix	t	100	1 524	152 400					
3. Gran 'A'	t	20	4 500	90 000					
4. Gran 'B'	t	15	8 750	131 250					
5. Removal of Detour	L.S.	N/A	1	40 000					
Total Cost				513 650					
Retained value				**520 000**					

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QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology:
- ☑ 300+ kph - new R/W
- ☑ 300+ kph - exist. R/W
- ☑ 200+ kph - exist. R/W

Sub-system: E - Other Accom. Work
Sector: 4 - Construction
Item: 1 - Track Removal

Geographical Variation ? ☑ no ☐ yes If yes, indicate segments applicable: _____

Price developed by CANARAIL

Work consists of 3 steps - picking up other track material, picking up rail, and picking up ties. Each has been estimated separately on the assumption of lifting track built with 115 lb/yd rail and are presented below:

Other Track Materials: (tie plates, spikes, rail anchors, joint bars)

40 tonnes/km @ ~~$143~~/tonne $200/tonne	~~$ 5,720~~	$8,000
Rail:		
115 tonnes/km @ ~~$43.40~~/tonne $110/tonne	~~$ 4,991~~	$12,650
Ties:		
2000 ties/km @ ~~$2.65~~/tie $6.50/tie	~~$ 5,300~~	$13,000
Contractor's overhead and profit: @ 32% of above cost	~~$ 5,123~~	$10,768
TOTAL (/km)	~~$ 21,134~~	$44,418
		Use $45,000/km

Prepared by:

continued ☐

Revised by EcoTrain - June 2009

Date: 93.04.20 | Page: 1 of 1

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology: ☑ 300+ kph - new R/W ☑ 300+ kph - exist. R/W ☑ 200+ kph - exist. R/W

Sub-system: E - Other Accom. Works
Sector: 4 - Construction
Item: 2 - New Access Tracks

Geographical Variation ? ☑ no ☐ yes If yes, indicate segments applicable: _____

Price developed by SNC-Lavalin + DELCAN + CANARAIL

Subgrade:

Grading @ 40,000 cu.m/km @ $ ~~5.00~~/cu.m.	$10/cu.m.	$ ~~200,000~~	$400,000
Sub-ballast @ 1,600 cu.m/km @ $ ~~15.00~~/cu.m.	$22/cu.m.	~~24,000~~	$35,200
Other costs @ 15%		~~33,600~~	$65,280
Total		$ ~~257,600~~	$500,480

Track Materials:

Rail @ 120 tonnes/km @ ~~$680~~/tonne	$870/tonne	$ ~~81,600~~	$104,400
Fastenings @ 40 tonnes/km @ ~~$850~~/tonne	$1,050/tonne	~~34,000~~	$42,000
Wood ties @ 2,000/km @ ~~$32.00~~/tie	$39/tie	~~64,000~~	$78,000
Ballast @ 2080 m^3/km @ ~~$21.37~~/$m^3$	$34/cu.m.	~~44,400~~	$70,720
Turnouts - assume 2/km @ ~~$46,000~~/turnout	$60,000/turnout	~~92,000~~	$120,000
Total		$ ~~316,000~~	$415,120

Track Construction: (overhead and profit already included in unit prices)

Build 1 km of track @ ~~$44,171~~/km	$55,200/km	$ ~~44,170~~	$55,200
Install turnouts - 2 @ ~~$4,680~~/turnout	$6,100/turnout	~~9,360~~	$12,200
Ballast and surface 2080 m^3/km @ ~~$8.47~~/$m^3$	$14/cu.m.	~~17,620~~	$29,120
Total		$ ~~71,150~~	$96,520

TOTAL (/km) $ ~~644,750~~ $1,011,920

Use $1,050,000/km

Prepared by: | continued ☐

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Date:		Page: 1 of 1

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology:	☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W	Sub-system: E - OTHER ACC. WORKS Sector: 4 - CONSTRUCTION Item: 3 - RAIL/RAIL G/S

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable: _____

3.2 ~~ii)~~ **Rail/Rail Grade Separation in Rural Area**

At crossings with existing rail tracks, the HSR tracks will be carried over or under the existing tracks with earthworks to be covered by linear measurement under Sub-system B.

13.5

Assume an average bridge length of 30m and a width of ~~13~~ m for 2 tracks,

13.5

cost of bridge structure = ~~13~~ x 30 @ ~~$1,800~~/m² $3,000/sq.m.

= ~~$702,000~~ $1,215,000

Allow 15% for rail diversions, miscellaneous temporary works, etc.

= ~~$800,000 say~~ Use $1,400,000

3.1 ~~ii)~~ **Rail/Rail Grade Separation in Urban Area**

13.5

Assume an average bridge length of 36m and a width of ~~13~~ m for 2 tracks,

13.5

cost of bridge structure = ~~13~~ x 36 @ ~~$1,800~~/m² $3,000/sq.m.

= ~~$842,400~~ $1,458,000

15%

Allow ~~20~~% for rail diversions, retaining structures in constrained areas, miscellaneous temporary works, etc. = ~~$1,000,000 say~~ Use $1,680,000

Prepared by:	continued ☐

Revised by EcoTrain - June 2009

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: F Track
Sector: 4 Construction
Item: 1 Ballast track on earthworks
Sub-item: none

1,1	**Rail**: UIC 60	Mass: 60 kg/m rail				
1,1		Steel price: 1 555 $/t	x 60/1000	per m rail	$	93
1,1		Procurement/Delivery :		per m rail	$	3
1,1				Total per m rail	$	96
1,1	**Total cost for 1 m of double track:**			**Say:**	**$**	**385**
1,2	**Tie**	Precast monoblock concrete tie				
1,2		approx.: 380 kg/ tie		per m track	$	196
1,2		Procurement/Delivery :		per m track	$	12
1,2				Total per m track	$	208
1,2	**Total costs for one m double track:**			**Say:**	**$**	**415**
1,3	**Fastening**	Type: Ioarv 300		per m track	$	158
1,3		Procurement/Delivery :		per m track	$	1
1,3				Total per m track	$	574
1,3	**Total costs for one m double track:**			**Say:**	**$**	**318**
1,4	**Ballast**	**H**igh quality crushed and washed granite				
1,4		Price: 16,3 $/t				
1,4	a:= 0.5m shoulder + 1.3m half tie + 5m distance centerline + 1.3m half tie +0.5m shoulder = 8.6m					
1,4	a=8.6m; h=0.6m; b=10.4m;					
1,4	Trapezoid area=5.7m²					
1,4	1.65 t/m³ - new ballast	**9,4 t/m double track**				
1,4				per m track	$	77
1,4				per m track	$	70
1,4	**Total costs for one m double track:**			**Say:**	**$**	**295**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	F	Track
		Sector:	4	Construction
	[x] **F200+**	**Item:**	1	Ballast track on earthworks
		Sub-item:		none

1,5 **Track Construction**

1,5

1,5 Costs for track construction include all works to lay new tracks and are also taking welding and initial rail grinding into account.

1,5

1,5 **Total costs for one m double track:** **$ 464**

Overall costs of ballast track on earthworks

$	385	Rail per m double track
$	415	Ties per m double track
$	318	Fastening system per m double track
$	295	Ballast per m double track
$	464	Track construction m double track
$	1 877	Overall per m double track

Total costs for one m double track: **$ 1 877**

Note: Source: Cooperation HSO/CR-Eurotrain; HSR Beijing - Shanghai;
LCC as approach to decide on investment for transportation; DE-Consult 1999;
Crosschecked with current DB Procurement data;
Inflation 2% per year; Exchange rate CAN - EUR: 1.566

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: F Track
Sector: 4 Construction
Item: 2 Ballastless track on earthworks
Sub-item: none

1,1	**Rail**: UIC 60	Mass: 60 kg/m rail				
1,1		Steel price: 1 555 $/t	x 60/1000	per m rail	$	93
1,1		Procurement/Delivery :		per m rail	$	3
1,1				Total per m rail	$	96
1,1	**Total cost for 1 m of double track:**			**Say:**	**$**	**385**
1,2	**Tie**	Precast concrete **tie for balastless track**				
1,2		approx.: 380 kg/ tie		per m track		210
1,2		Procurement/Delivery :		per m track		11
1,2				Total per m track		221
1,2	**Total costs for one m double track:**			**Say:**	**$**	**442**
1,3	**Fastening**	Type: Ioarv 300		per m track	$	158
1,3		Procurement/Delivery :		per m track	$	1
1,3				Total per m track	$	601
1,3	**Total costs for one m double track:**			**Say:**	**$**	**318**
1,4	**Bonded support layer and drainage**					
1,4		Costs for bonded support layer construction include material, transport and works.				
1,4						
1,4	**Total costs for one m double track:**				**$**	**315**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	F	Track
		Sector:	4	Construction
	[x] **F200+**	**Item:**	1	Ballastless track on earthworks
		Sub-item:		none

1,5 **Concrete slab manufacturing** Type: Rheda

1,5 Costs for construction include setting up sleepers with a lattice truss,
1,5 concrete casting, transport and works for installation of the track
1,5 components. They are also taking into account welding and initial rail grinding.

1,5 **Total costs for one m double track:** **$ 1 010**

Overall costs of ballastless track on earthworks

$	385	Rail per m double track
$	442	Ties per m double track
$	318	Fastening system per m double track
$	315	Bonded support layer and drainage
$	1 010	Concrete slab manufacturing m double track
$	2 470	Overall per m double track

Total costs for one m double track: **$ 2 470**

Note: Source: Cooperation HSO/CR-Eurotrain; HSR Beijing - Shanghai;
LCC as approach to decide on investment for transportation; DE-Consult 1999;
Crosschecked with current DB Procurement data;
Inflation 2% per year; Exchange rate CAN - EUR: 1.566

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: F Track
Sector: 4 Construction
Item: 3 Ballastless track in tunnels
Sub-item: none

1,1	**Rail**: UIC 60	Mass:	60 kg/m rail			
1,1		Steel price: 1 555 $/t	x 60/1000	per m rail:	$	93
1,1		Procurement/Delivery :		per m rail:	$	3
1,1				per m rail Total:	$	96
1,1	**Total cost for 1 m of double track:**			**Say:**		**385**
1,2	**Tie**	Precast concrete **tie for balastless track**				
1,2		approx.: 380 kg/ tie		per m track		210
1,2		Procurement/Delivery :		per m track		11
1,2				Total per m track		221
1,2	**Total costs for one m double track:**			**Say:**		**442**
1,3	**Fastening**	Type: Ioarv 300		per m track	$	158
1,3		Procurement/Delivery :		per m track	$	1
1,3				Total per m track	$	601
1,3	**Total costs for one m double track:**			**Say:**	**$**	**318**
1,4	**Concrete slab manufacturing**	Type: Rheda				
1,4	Costs for construction include setting up sleepers with a lattice truss, concrete casting, transport and works for installation of the track components. They are also taking into account welding and initial rail grinding.					
1,4	**Total costs for one m double track:**				**$**	**1 010**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	F	Track
		Sector:	4	Construction
	[x] **F200+**	**Item:**	3	Ballastless track in tunnels
		Sub-item:		none

1,5 **Savings From Reduced Tunnel Cross Section**

1,5

1,5 Due to smaller construction height of ballastless track in tunnels compared to ballast track, the cross section of tunnels can be reduced.

1,5

1,5 **Total costs for one m double track:** **$ -142**

Overall costs of ballastless track in tunnels

$	385	Rail per m double track
$	442	Ties per m double track
$	318	Fastening system per m double track
$	1 010	Concrete slab manufacturing m double track
$	-142	Savings per m double track
$	2 013	Overall per m double track

Total costs for one m double track: **$ 2 013**

Note: Source: Cooperation HSO/CR-Eurotrain; HSR Beijing - Shanghai;
LCC as approach to decide on investment for transportation; DE-Consult 1999;
Crosschecked with current DB Procurement data;
Inflation 2% per year; Exchange rate CAN - EUR: 1.566

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: F Track
Sector: 4 Construction
Item: 4 Ballastless track on long bridges (> 25 m)
Sub-item: none

1,1	**Rail**: UIC 60	Mass:	60 kg/m rail			
1,1		Steel price: 1 555 $/t	x 60/1000	per m rail:	$	93
1,1		Procurement/Delivery :		per m rail:	$	3
1,1				per m rail Total:	$	96
1,1	**Total cost for 1 m of double track:**			Say:	**$**	**385**
1,2	**Tie**	Precast concrete **tie for balastless track**				
1,2		approx.: 380 kg/ tie		per m track		210
1,2		Procurement/Delivery :		per m track		11
1,2				Total per m track		221
1,2	**Total costs for one m double track:**			**Say:**		442
1,3	**Fastening**	Type: loarv 300		per m track	$	158
1,3		Procurement/Delivery :		per m track	$	1
1,3				Total per m track	$	601
1,3	**Total costs for one m double track:**			**Say:**	**$**	**318**
1,4	**Concrete slab manufacturing**	Type: Rheda				
1,4	Costs for construction include setting up sleepers with a lattice truss,					
1,4	concrete casting, transport and works for installation of the track					
1,4	components. They are also taking into account welding and initial rail grinding.					
1,4	**Total costs for one m double track:**				**$**	**4 040**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	F	Track
		Sector:	4	Construction
	[x] **F200+**	**Item:**	1	Ballastless track on long bridges (> 25 m)
		Sub-item:		none

Overall costs of ballastless track on long bridges

$	385	Rail per m double track
$	442	Ties per m double track
$	318	Fastening system per m double track
$	4 040	Concrete slab manufacturing m double track
$	5 185	Overall per m double track

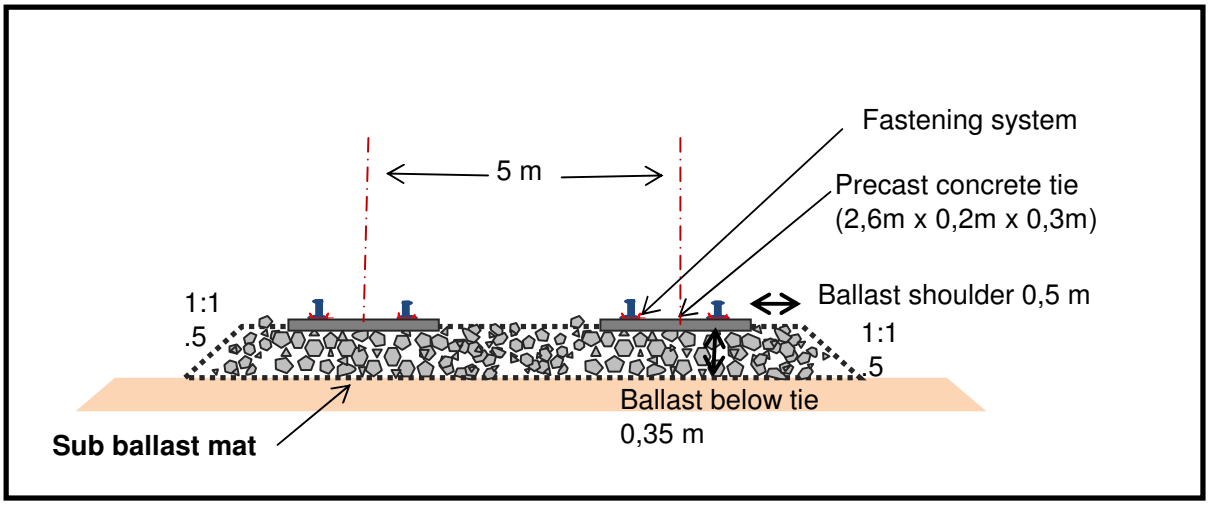
Total costs for one m double track: **$ 5 185**

Note: Source: Cooperation HSO/CR-Eurotrain; HSR Beijing - Shanghai;
LCC as approach to decide on investment for transportation; DE-Consult 1999;
Crosschecked with current DB Procurement data;
Inflation 2% per year; Exchange rate CAN - EUR: 1.566

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	x	**E300+**	**Sub-System:**	F Track
			Sector:	4 Construction
	x	**F200+**	**Item:**	5 Sub Ballast Mats
			Sub-item:	none



noise attenuation where necessary and for ballast protection on structures

Type: sub ballast mat

approx: 11 m² / m

Optional For ballast track only

Costs:

Total costs for one m double track: **2 140 $**

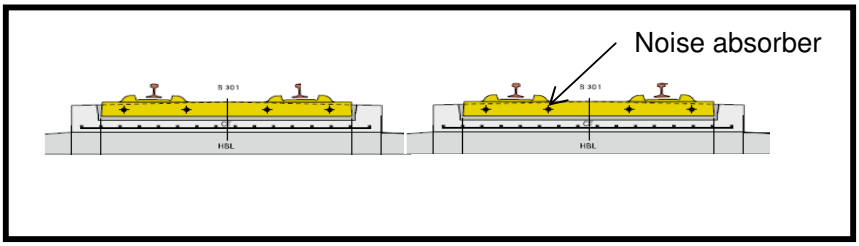
Note: Source: Cooperation HSO-Eurotrain; HSR Beijing - Shanghai;
LCC as approach to decide on investment for transportation; DE-Consult 1999;
Crosschecked with current DB Procurement data;
Inflation 2% per year; Exchange rate CAN - EUR: 1.566

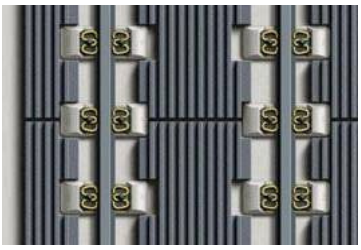
Date:	2009-08-05		Page: 1 of 1

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs	Development of Capital Unit Cost, CAD

Technology:	x	**E300+**	**Sub-System:**	F Track
			Sector:	4 Construction
	x	**F200+**	**Item:**	6 Noise Absorber for balastless track
			Sub-item:	none





Type: noise attenuation where necessary

11 m² / m

Optional For ballastless track only

Costs:

Total costs for one m double track (estimation) : **177 $**

Note: Source: Cooperation HSO-Eurotrain; HSR Beijing - Shanghai;
LCC as approach to decide on investment for transportation; DE-Consult 1999;
Crosschecked with current DB Procurement data;
Inflation 2% per year; Exchange rate CAN - EUR: 1,566

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	F	Track
		Sector:	4	Construction
	[x] **F200+**	**Item:**	7	Turnouts (deviation speed 60 km/h)
		Sub-item:		none

Type: Turnout for side protection and connections to e.g. yards.

Radius of deviation	500	m
Allowed deviation speed of :	60	km / h

approx. 90 m length

Assessment includes procurement, delivery and installation of turnouts; for slab track and ballast track

Costs:

Total costs for one Turnout: **200 000 $**

Note: Source: DB KoRII 808.0212 Listing of characteristic unit costs for railway projects, 1998;
Crosschecked with current DB Procurement data;
Inflation 2% per year; Exchange rate CAN - EUR: 1.566

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	F	Track
		Sector:	4	Construction
	[x] **F200+**	**Item:**	8	Turnouts (deviation speed 100 km/h)
		Sub-item:		none

Type: Turnout for cross overs and station platforms

Radius of deviation 1200 m

Allowed deviation speed of : 100 km / h

approx. 130 m length

Assessment includes procurement, delivery and installation of turnouts; for slab track and ballast track

Costs:

Total costs for one Turnout: **310 000 $**

Note: Source: DB KoRII 808.0212 Listing of characteristic unit costs for railway projects, 1998;
Crosschecked with current DB Procurement data;
Inflation 2% per year; Exchange rate CAN - EUR: 1.566

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	F	Track
		Sector:	4	Construction
	[x] **F200+**	**Item:**	9	Switch Heaters
		Sub-item:		none

Type: switch heating equipment for turnouts, to prevent malfunction due to snow between switch points and stock rails and at the movable point frogs.

Costs:

Total costs for equipment at one turnout:

Switch 1200 - 1:18,5 / 500 - 1:12	**130 000 $**
Switch 190 - 1:9	**100 000 $**

Note: Source: DB KoRII 808.0212 Listing of characteristic unit costs for railway projects, 1998;
Crosschecked with current DB Procurement data;
Inflation 2% per year; Exchange rate CAN - EUR: 1.566

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	F	Track
		Sector:	4	Construction
	[x] **F200+**	**Item:**	10	Turnouts (deviation speed 40 km/h)
		Sub-item:		none

Type: Turnout for side protection and connections to e.g. yards.

Radius of deviation	190	m
Allowed deviation speed of :	40	km / h
approx. 50 m length		

Assessment includes procurement, delivery and installation of turnouts; for slab track and ballast track

Costs:

Total costs for one Turnout: **140 000 $**

Note: Source: DB KoRII 808.0212 Listing of characteristic unit costs for railway projects, 1998;
Crosschecked with current DB Procurement data;
Inflation 2% per year; Exchange rate CAN - EUR: 1.566

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [ ] **F200+**

Sub-System: G Power Supply
Sector: 4 Construction
Item: 1 Overhead Catenary System (OCS)
Sub-item: 1.1 High Speed OCS at grade

Delivery, installation and testing of

OCS at grade up to 350 km/h

cost per km single line - independent structure

Catenary (CW, CatW, etc)	$130 000
Supply, delivery and installation of contact wire, messenger wire, dropper, stitchwire, tensioning device	
Addional Wires	$86 000
Supply, delivery and installation of additional wires including feeder return cable and electrical connectors	
Mechanical Equipment	$260 000
Supply, delivery and installation of mechanical equipment including supports, masts, cantelever	
Electrical Equipment	$65 000
Supply, delivery and installation of electrical equipment including disconnector switches, earthing switches, insulators	
Total	**$541 000**

Source: DB AG - DB International - market prices

€/CAD 1,566 2009-06-15

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [ ] **F200+**

Sub-System: G Power Supply
Sector: 4 Construction
Item: 1 Overhead Catenary System (OCS)
Sub-item: 1.2 High Speed OCS tunnel

Delivery, installation and testing of

OCS in tunnel up to 350 km/h

cost per km single line - independent structure

Catenary (CW, CatW, etc) $130 000

Supply, delivery and installation of contact wire, messenger wire, dropper, stitchwire, tensioning device

Addional Wires $86 000

Supply, delivery and installation of additional wires including feeder return cable and electrical connectors

Mechanical Equipment $173 000

Supply, delivery and installation of mechanical equipment including supports, masts, cantelever

Electrical Equipment $65 000

Supply, delivery and installation of electrical equipment including disconnector switches, earthing switches, insulators

Total **$454 000**

Source: DB AG - DB International - market prices

€/CAD 1,566 2009-06-15

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [ ] **F200+**

Sub-System: G Power Supply
Sector: 4 Construction
Item: 1 Overhead Catenary System (OCS)
Sub-item: 1.3 OCS up to 100 km/h

Delivery, installation and testing of

OCS up to 100 km/h - yards, stations

cost per km single line - independent structure

Catenary (CW, CatW, etc)	$108 000
Supply, delivery and installation of contact wire, messenger wire, dropper, stitchwire, tensioning device	
Addional Wires	$72 000
Supply, delivery and installation of additional wires including feeder return cable and electrical connectors	
Mechanical Equipment	$144 000
Supply, delivery and installation of mechanical equipment including supports, masts, cantelever	
Electrical Equipment	$54 000
Supply, delivery and installation of electrical equipment including disconnector switches, earthing switches, insulators	
Total	**$378 000**

Source: DB AG - DB International - market prices

€/CAD 1,566 2009-06-15

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [ ] **F200+**

Sub-System: G Power Supply
Sector: 4 Construction
Item: 2 Sub station
Sub-item:

Delivery, installation and testing of

Traction power station 25 kV AC

	cost per unit	units	
HV Equipment	252000	5	$1 260 000
Transformer Unit	540000	2	$1 080 000
25kV AC Cabinet	216000	8	$1 728 000
Auxililary Equipment	180000	2	$360 000
Total			**$4 428 000**

Autotransformer Station **$1 800 000**

Source: DB AG - DB International - market prices

€/CAD 1,566 2009-06-15

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: ☐ **E300+** ☒ **F200+**

Sub-System: G Power Supply
Sector: 4 Construction
Item: 3 Diesel Filling Station
Sub-item:

Delivery, installation and testing of

Diesel Filling Station

Filling construction	$630 000
Fuel tanks 2 x 100 000 l	$240 000
Pipes, oil trap, construction	$190 000
Buildings for administration and attendant	$250 000
Total	**$1 310 000**

Source: DB AG - DB Energie Tankdienste (DB Energy - Filling Services) 2009

€/CAD 1,566 2009-06-15

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: H Stations
Sector: 4 Construction/Installation
Item: 1 Station Modifications
Sub-item: 1.1 to 1.3 Gare du Palais, Centrale, Ottawa VIA

The Preliminary Routing Assessment and Costing Study (PRACS) reports of the QOHSRPS did not provide any estimation details for those 3 existing stations to be modified, and the lump sum costs where not obvious in the various Interim and Final Reports. The present worksheet's objective is to determine those 1995 lump sum costs and their 2009 updated modification costs.

The PRACS Final Report, Appendix, Tables 6.1 and 6.2 give the following costs of stations, in 1993 dollars, including Professional Fees and Contingencies:

	300 km/h Composite Repr. Route	200 km/h Composite Repr. Route
Windsor - Toronto	27 160 104	18 832 714
Toronto - Montreal	103 712 097	91 601 296
Montreal - Quebec	29 466 151	37 793 542
Total	160 338 352	**148 227 552**

The 200 km/h Composite Representative Route was composed of the same station combination as the present Updating study.
Out of the 13 stations, the individual costs for 10 of them were available from thre PRACS Reports :

	Lump Sum Costs as provided by PRACS Interim Rep. No.3 (excluding Prof. Fees)	Lump Sum Costs as provided by PRACS Int. Rep. No.3 (including Prof. Fees and Contingencies)
L'Ancienne-Lorette	6 500 000	8 327 391
Trois-Rivières	6 500 000	8 327 391
Laval	6 500 000	8 327 391
Dorval*	6 500 000	8 327 391
Kingston	6 500 000	8 327 391
East Toronto	6 500 000	8 327 391
Union Station (modif.)	20 000 000	25 622 740
Pearson* or Hamilton	6 500 000	8 327 391
London	6 500 000	8 327 391
Windsor	8 200 000	10 505 323
*: Excluding people movers	80 200 000	**102 747 187**

That leaves for the 3 "unknown" stations : 148 227 552 - 102 747 187 = **45 480 365**

Table 4.3 of Interim Report no.4 of PRACS is giving the costs of the various line segments and of the sta-tions, those costs including an integration of subsystems A to H. From this table, we extracted the following :

Gare du Palais	20 952 005	24,79%	Which gives:	11 273 260
Gare Centrale	36 636 302	43,34%		19 712 222
Ottawa Station	26 939 577	31,87%		14 494 883
	84 527 884	100,00%		45 480 365

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: H Stations
Sector: 4 Construction/Installation
Item: 1 Station Modifications
Sub-item: 1.1 to 1.3 Gare du Palais, Centrale, Ottawa VIA

The results of preceeding page are including Professional Fees and Contingencies. In the PRACS, those added costs where representing an increase of 28,1137% of the base cost of each station. We thus obtain the following 1993 base costs for the 3 modified stations :

Gare du Palais:	11 273 260	divided by 1,281137 :	8 799 418	say: 8 800 000
Gare Centrale:	19 712 222		15 386 506	15 400 000
Ottawa Station:	14 494 883		11 314 077	11 300 000

The preceeding worksheets for the 10 other stations gave the following results

	PRACS, $\$_{1993}$	**EcoTrain, $\$_{2009}$**
L'Ancienne-Lorette	6 500 000	11 000 000
Trois-Rivières	6 500 000	11 000 000
Laval	6 500 000	11 000 000
Dorval	6 500 000	11 000 000
Kingston	6 500 000	11 000 000
East Toronto	6 500 000	11 000 000
Union Station	20 000 000	33 000 000
Pearson	6 500 000	11 000 000
London	6 500 000	11 000 000
Windsor	8 200 000	14 000 000
	80 200 000	135 000 000 →

mean inflation factor: 1,6832918

Thus :

				EcoTrain, $\$_{2009}$
Gare du Palais:	8 800 000	14 812 968	say:	**15 000 000 $**
Gare Centrale:	15 400 000	25 922 693		**26 000 000 $**
Ottawa Station:	11 300 000	19 021 197		**19 000 000 $**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	H	Stations
		Sector:	4	Construction/Installation
	[x] **F200+**	**Item:**	1	Station Modifications
		Sub-item:	1.1 to 1.3	Gare du Palais, Centrale, Ottawa VIA

The results of preceeding page are including Professional Fees and Contingencies. In the PRACS, those added costs where representing an increase of 28,1137% of the base cost of each station. We thus obtain the following 1993 base costs for the 3 modified stations :

Gare du Palais:	11 273 260	divided by 1,281137 :	8 799 418	say:	8 800 000
Gare Centrale:	19 712 222		15 386 506		15 400 000
Ottawa Station:	14 494 883		11 314 077		11 300 000

The preceeding worksheets for the 10 other stations gave the following results

	PRACS, $\$_{1993}$	**EcoTrain, $\$_{2009}$**
L'Ancienne-Lorette	6 500 000	11 000 000
Trois-Rivières	6 500 000	11 000 000
Laval	6 500 000	11 000 000
Dorval	6 500 000	11 000 000
Kingston	6 500 000	11 000 000
East Toronto	6 500 000	11 000 000
Union Station	20 000 000	33 000 000
Pearson	6 500 000	11 000 000
London	6 500 000	11 000 000
Windsor	8 200 000	14 000 000
	80 200 000	135 000 000 → mean inflation factor: 1,6832918

Thus:

				EcoTrain, $\$_{2009}$
Gare du Palais:	8 800 000	14 812 968	say:	**15 000 000 $**
Gare Centrale:	15 400 000	25 922 693		**26 000 000 $**
Ottawa Station:	11 300 000	19 021 197		**19 000 000 $**

Date: | Page: __ of __

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology: ☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W

Sub-system: H - STATIONS
Sector: 4 - CONSTR./INSTALLATION
Item: ~~1~~ - 1.4

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable: _____

C) MODIFICATIONS AT UNION STATION

i) Reconstruction of platform access tunnel and vertical circulation to platforms

Area of tunnel to be reconstructed = 2000m²

Total cost including new finishes = 2000 x ~~1250~~ $2,500	=	~~$2,500,000~~	$5,000,000
Assume 5 new elevators at ~~$100,000~~ each $300,000 ea.	=	~~$ 500,000~~	$1,500,000
Assume 5 x 2 new escalators at ~~$225,000~~ each $500,000 ea.		~~$2,250,000~~	$5,000,000
Total access modification direct cost	=	~~$5,250,000~~	
Allowance for O/H and profit (15%)	=	~~$ 750,000~~	
Total access modification cost		~~$6,000,000~~	$10,500,000

ii) Upgrading and alternations to Main Concourse area — allow $5,000,000

iii) Modification and upgrading of train services area — allow ~~$2,000,000~~ $4,000,000

iv) Expansion of parking structure 100 bays at ~~$10,000~~ $25,000 — ~~$1,000,000~~ $2,500,000

v) Modification to five HSR platforms 5 x ~~1,200,000~~ $2,000,000 — ~~$6,000,000~~ $10,000,000

Total order-of-magnitude cost ~~$20,000,000~~ $33,000,000

Prepared by: | continued ☐

Date:		Page: 1 of 5

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology:	☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W	Sub-system: H - STATIONS Sector: 4 - CONSTR./INSTALLATION Item: ~~1~~ - 2.1

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable: _____

A) LINE STATIONS AT INTERMEDIATE CENTRES

i) Stations in this category:

a) London

b) Kitchener - Waterloo (new ROW only)

c) Hamilton - Burlington (ex ROW only)

d) Pickering - Whitby (ex ROW only)

e) Hwy 407/Markham E. (new ROW only)

f) Kingston

g) Ottawa - Merivale

h) Laval

i) Trois - Riviere

j) Ancienne - Lorette

ii) Primary components:

a) Property

b) Station Bldg.

c) Access Roads

d) Grading & Drainage

e) Parking Area/Bus Bays/Kiss & Ride

f) Platforms and canopies

g) Vertical circulation (Escalators/elevators)

h) Pedestrian Tunnels

i) Fencing

Prepared by:	continued ☑

Date: | Page: 2 of 5

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology: ☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W

Sub-system: 4 - STATIONS
Sector: 4 - CONSTR./INSTALLATION
Item: ~~4~~ 2.1

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable:_____

iii) Development of unit costs for Line Stations

Item	Est. Cost
a) Property	
Area assumed: 200 metres x 100 metres = 2ha	
Land costs are included in sub-system A	-
b) Station Bldg.	
Passenger concourse containing:	
• Ticketing	
• Waiting Areas	
• Washrooms	
• Service Rooms	
• Concessions	
• Circulation	
Area assumed for above elements = 1,000m^2	
Based on GO Transit stat. costs, allow ~~$2,600~~/m^2	~~$2,600,000~~
$3,500/sq.m.	$3,500,000
c) Access Roads	
Allow 200 m of 2 lane road to access parking/kiss & ride/bus bays etc	
Cost at ~~$400~~/m	~~$80,000~~
$2000/m	$400,000
d) Drainage	
• Allowance for storm sewers, sub-drains, surface ditches, manholes, catchbasins.	~~$400,000~~ $600,000

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QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology: ☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W

Sub-system: H - STATIONS
Sector: 4 - CONSTR./INSTALLATION
Item: ~~1~~ 2.1

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable:

- Assume general site and station track grading earthworks

averaging 1 metre over area required.

i.e. (200 x 100) + (1,000 x 2 x 8) = 20,000 + 16,000 @ ~~$5~~/m³ ~~$180,000~~

$10/cu.m. $360,000

e) Parking/Bus pays

- Assume 250 spaces at ~~$1,600~~ ea. $2,800 ea. ~~$400,000~~ $700,000
- Assume 6-bay bus terminal/loop ~~$100,000~~ $200,000
- Kiss & Ride area (Approx. 30 spaces) + circ.lanes ~~$ 70,000~~ $150,000

f) Platforms & Canopies/Shelters

As per CIGGT Fax 13/4/93:

2 single sided platforms required: - 400 m long (+300)

- 300 m long (200 - 250)

400 m platforms : 2 @ ~~$160,000~~ $300,000 ~~$320,000~~ $600,000

Canopies/Shelters : Allowance ~~$200,000~~ $275,000

g) Vertical Circulation $500,000

Escalators : 2 at ~~$350,000~~ (mechanical and structures) ~~$700,000~~ $1,000,000

Elevators : 2 at ~~$150,000~~ (mechanical and structures) ~~$300,000~~ $600,000

$300,000

h) Pedestrian Tunnels

Structure and finishes to provide access from concourse

to platforms (under or over 4 tracks) ~~$600,000~~ $1,200,000

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continued ☑

Date: | Page: 4 of 5

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology: ☐ 300+ kph - new R/W ☐ 300+ kph - exist. R/W ☐ 200+ kph - exist. R/W

Sub-system: H - STATIONS
Sector: 4 - CONSTR/INSTALLATION
Item: ~~1~~ 2 - 2.1.

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable: _____

i) Fencing		
Assume 500 m @ ~~$20~~/m	$40.000	~~$10,000~~
	$80/m	
j) Miscellaneous items (allow 10%)	$962,500	~~540,000~~
TOTAL STATION COST (All components)		~~$6,500,000~~
	$10,587,500	
	use $11,000,000	

Prepared by: | continued ☑

Date:		Page: 5 of 5

QUEBEC-ONTARIO HIGH SPEED RAIL PROJECT

UNIT COSTS FOR PRELIMINARY ROUTING

Technology:
- ☐ 300+ kph - new R/W
- ☐ 300+ kph - exist. R/W
- ☐ 200+ kph - exist. R/W

Sub-system: H - STATIONS
Sector: 4 - CONSTR./INSTALLATION
Item: 1 - 2.2

Geographical Variation ? ☐ no ☐ yes If yes, indicate segments applicable:_____

B) TERMINAL STATION AT WINDSOR

i) Primary components assumed to be as for Line Stations with additions as follows:

a) 2 side platforms replaced by 3 island platforms between 4 tracks i.e. equivalent to 4 side platforms.

b) Vert. Circulation:

Escalators - 2 for 3rd platform

Elevators - 1 for 3rd platform

c) Pedestrian Tunnels:

Additional stair/escalator structure for 3rd platform length as for Line Stations.

d) Station Bldg:

Assume 20% increase in Bldg. area.

ii) Summary of Unit Cost Components

a) Line station total cost	$9,800,000	$ ~~6,500,000~~
b) Addition for platforms	$600,000	$ ~~320,000~~
c) Allowance for additional canopies/shelters	$200,000	$ ~~120,000~~
d) Vert. Circ.	$1,300,000	$ ~~850,000~~
e) Pedestrian Tunnels	$33,000	$ ~~20,000~~
f) Add for larger station bldg.	$600,000	$ ~~260,000~~
g) Additional misc. items	$1,253,300	$ ~~130,000~~
TOTAL STATION COST (All components)	$13,800,000	$ ~~8,200,000~~
	Use $14,000,000	

Prepared by:

continued ☐

Date: 2009-08-05		Page: 1 of 1

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs	Development of Capital Unit Cost, CAD

Technology:	[x] **E300+**	**Sub-System:**	I	Signals / Telecom
		Sector:	4	Construction
	[x] **F200+**	**Item:**	1	Interlocking System
		Sub-item:	1.1	Adaptation to Existing Stations

Modification and adaptation with delivery, installation and testing of

A <u>Existing Indoor Installations</u>

Local panels or workstation

Control-units or relay groups (incl. frames, indoor cabling, interfaces etc.) for:

- Main signals and shunting signals
- switchmachine control-unit
- Track vacancy installations

Power supply signalling

B <u>Outdoor Installations</u>

Light signals with all components for

- Main signals
- Shunting signals

Switchcontrol (incl. switchmachines, rodding sets and detectors)

Track vacancy installations

Cabling (delivery, burying, installation, testing etc.)

- Main cables
- Branch cables
- Cable accesories

Total costs for one existing station (estimation) : **8 000 000 $**

Note: Exact costs can be calculated after the assessment of the existing signaling technology and the detailed connection design of the individual stations only.

Date: 2009-08-05		Page: 1 of 1

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs	Development of Capital Unit Cost, CAD

Technology:	[x] **E300+**	**Sub-System:**	I	Signals / Telecom
		Sector:	4	Construction
	[x] **F200+**	**Item:**	1	Interlocking System
		Sub-item:	1.2	Intermediate Stations

Delivery, installation and testing of :

A Indoor Installations

- Local workstation
- CBI (Computer based interlocking) basic hard- and software
- Control-units (hard- and software) incl. frames, indoor cabling, interfaces etc. for:
  - Signals as main signals and shunting signals (fictive)
  - Switchmachine control-unit
  - Track vacancy installations
- Power supply signalling
- Service and diagnostic system

Costs for indoor installations **3 600 000 $**

B Outdoor Installations

- Main signal (fictive) resp. signal board
- Shunting signal (fictive) resp. bsignal board
- Switchcontrol (incl. switchmachines, rodding sets and detectors)
- Track vacancy installations based on axle counting systems
- Cabling (delivery, burying, installation, testing etc.)
  - Main cables
  - Branch cables
  - Cable accesories
- Building construction civil works

Costs for outdoor installations $2 400 000

Total costs for one intermediate station $6 000 000

Date: 2009-08-05		Page: 1 of 1

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs	Development of Capital Unit Cost, CAD

Technology:	[x]	**E300+**	**Sub-System:** I	Signals / Telecom
			Sector: 4	Construction
	[x]	**F200+**	**Item:** 1	Interlocking System
			Sub-item: 1.3	Cross Overs

Delivery, installation and testing of :

A Indoor Installations

CBI (Computer based interlocking) basic hard- and software

Control-units (hard- and software) incl. frames, indoor cabling, interfaces etc. for:

- Main signals
- Switchmachine control-unit
- Track vacancy installations

Power supply signalling

Service and diagnostic system

Costs for indoor installations	$1 900 000

B Outdoor Installations

Mainsignal (fictive) resp. Signalboard

Switchcontrol complete (incl. switchmachines, rodding sets and detectors)

Track vacancy installations based on Axle Counting Systems

Cabling (delivery, burying, Installation, testing etc.)

- Main cables
- Branch cables
- Cable accesories

Building prefabricated

Costs for outdoor installations	$900 000

Total costs for one cross over	**2 800 000 $**

EcoTrain	By: Wolfgang Kriener, DBI	Continued: [ ]

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: I Signals / Telecom
Sector: 4 Construction
Item: 1 Interlocking System
Sub-item: 1.4 Fictive Block Installations

Delivery, installation and testing of :

A Indoor Installations

CBI (Computer based interlocking) basic hard- and software

Control-units (hard- and software) incl. frames, indoor cabling, interfaces etc. for:

- Block signals (fictive)
- Track vacancy installations

Power supply signalling

Service and diagnostic system

Costs for indoor installations	325 000 $

B Outdoor Installations

Light signal with all components for block signals (fictive) incl. signal board

Track vacancy installations based on axle counting systems

Cabling (delivery, burying, installation, testing etc.)

- Main cables
- Branch cables
- Cable accesories

Building prefabricated

Costs for outdoor installations	325 000 $
Total costs one fictive block installation	**650 000 $**

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Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs	Development of Capital Unit Cost, CAD

Technology:	[x] **E300+**	**Sub-System:**	I	Signals / Telecom
		Sector:	4	Construction
	[x] **F200+**	**Item:**	2	Automatic Train Controll
		Sub-item:	2.1	Total Installations ETCS

Delivery, installation and testing of :

A Radio Block Centre Installations

Basic hard- and software

Interface to the GSM-R system

Service and diagnostic system

Power supply

B Installations at Stations and Outdoor

Interfaces to the interlocking installations

Balises as passive positioning beacons

Average total costs ETCS per km double track line **220 000 $**

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Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs	Development of Capital Unit Cost, CAD

Technology:	[x] **E300+**	**Sub-System:**	I	Signals / Telecom
		Sector:	4	Construction
	[x] **F200+**	**Item:**	2	Automatic Train Controll
		Sub-item:	2.2	Total Installations GSM-R

Delivery, installation and testing of :

A GSM-R Installations (centralised and line dependent)

Basic hard- and software including

- Mobile switching centre
- Base station controller
- Multiplexer dropouts
- Mast & antenna kit
- Handheld
- Base transceiver station
- Cabling
- Interface to the ETCS system
- Service and diagnostic system
- Power supply telecommunications

B Optical Fibre Cables (OFC) along the line including

- Cable laying, trenching and splicing
- Polyethylen pipes

Average total costs GSM-R per km double track line **140 000 $**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	I	Signals / Telecom
		Sector:	4	Construction
	[x] **F200+**	**Item:**	3	Operation Control Center
		Sub-item:	3.1	Building and Basic Installations

Delivery, installation and testing of:

Basic hard- and software incl. indoor cabling system
Basic workstations
Basic plotter, printers and peripherical equipment
Basic panorama projection of the entire line incl. hard- and software
Basic system of service and diagnostic of interlocking incl. hardware and software
Interface installations for data transmission
Power supply CTC signalling
Civil works for the OCC building

Total costs for the basic installations of the OCC	**6 300 000 $**

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Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs	Development of Capital Unit Cost, CAD

Technology:	[x] **E300+**	**Sub-System:**	I	Signals / Telecom
		Sector:	4	Construction
	[x] **F200+**	**Item:**	3	Operation Control Center
		Sub-item:	3.2	Technical Installations (Length dependent)

Delivery, installation and testing of :

Hard- and software incl. indoor cabling system

Hard- and software of all remote controlled stations in relation to the installations on the line

Workstations for operators incl. hardware such as monitors, keyboard etc.

Plotter, printers and peripherical equipment

Supplements of the panorama projection of the entire line incl. hard- and software

Average total costs OCC per km double track line	**9 400 $**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	I	Signals / Telecom
		Sector:	4	Construction
	[x] **F200+**	**Item:**	4	Telecommunication Installations
		Sub-item:		

Delivery, installation and testing of :

General Communication Installations

Basic hard- and software including

- Adaptation to the GSM-R systems
- Passenger information systems
- Telephone installations

Cabling

- Service and diagnostic system
- Power supply telecommunications

Average total costs telecommunication per km double track line	**47 000 $**

Date: 2009-08-05		Page: 1 of 1

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs	Development of Capital Unit Cost, CAD

Technology:	[x] **E300+**	**Sub-System:**	I	Signals / Telecom
		Sector:	4	Construction
	[x] **F200+**	**Item:**	5	ERTMS Level 2 Train Equipment
		Sub-item:		

Delivery, installation and testing of :

Equipment of conventional trains with ERTMS Level 2

ETCS Level 2 a GSM-R - On board unit

Cost for locomotives with two stands	**450 000 $**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [ ] **F200+**

Sub-System: J Rolling Stock
Sector: 4 Construction
Item: 1 Capital Unit Cost
Sub-item: 1.1 E300+ Trainset

The following chart provides published rolling stock prices of actual projects. Prices for high speed trains are usually compared by cost per seat. There are no significant differences between distributed and concentrated propulsion systems.

	Train	Year	Company	Cost per train Mio €	Numer of Seats	Cost per train Mio CAD	Cost per Seat T CAD	Source
A	AGV	2008	NTV (Italiy)	26.0	500	40.7	81	Wikipedia
B	Talgo 350	2005	RENFE (Spain)	21.8	361	34.1	95	http/www.hochgeschwindigkeitszüge.com
C	Velaro E	2001	RENFE (Spain)	25.2	404	39.5	98	DB AG
D	Velaro D (ICE 407)	2008	DB AG (Germany)	33.3	480	52.2	109	DB AG

Exchange rate € - CAD 1.566 (15.06.2009)

These prices do not include

- the adaption for FRA requirements
- the adaption of the profile
- major changings of train length (standard: 200m)

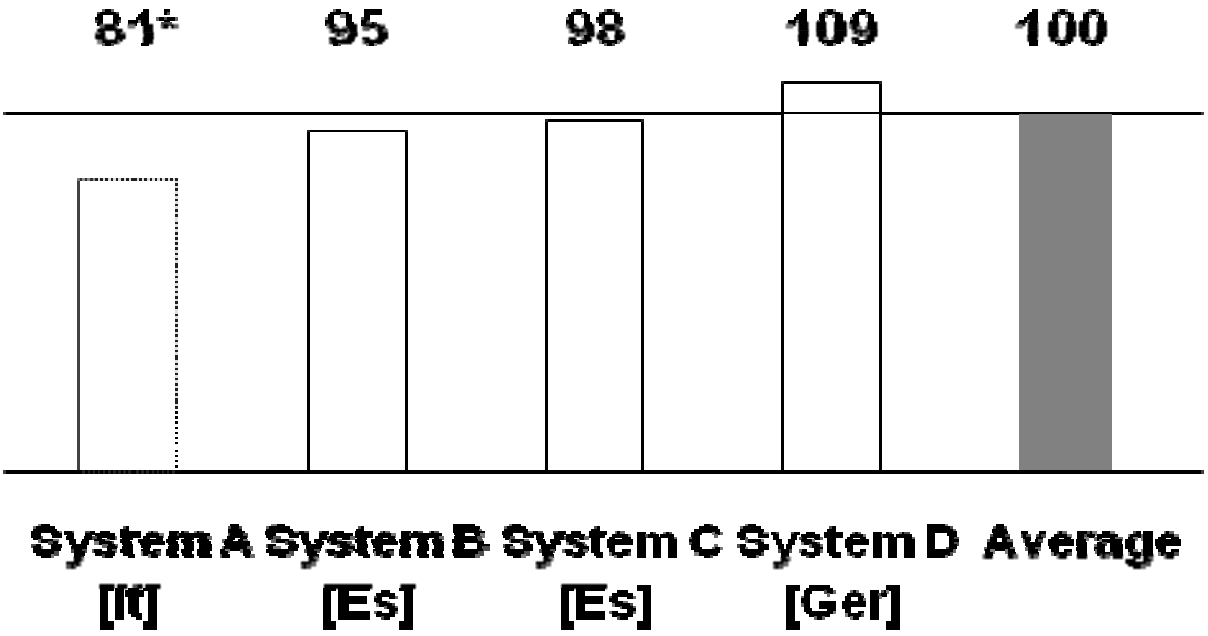
Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [ ] **F200+**

Sub-System:	J	Rolling Stock
Sector:	4	Construction
Item:	1	Capital Unit Cost
Sub-item:	1.1	E300+ Trainset

Average price per train seat (in thousand CAD)



*System excluded - price level modified by cross-subsidy

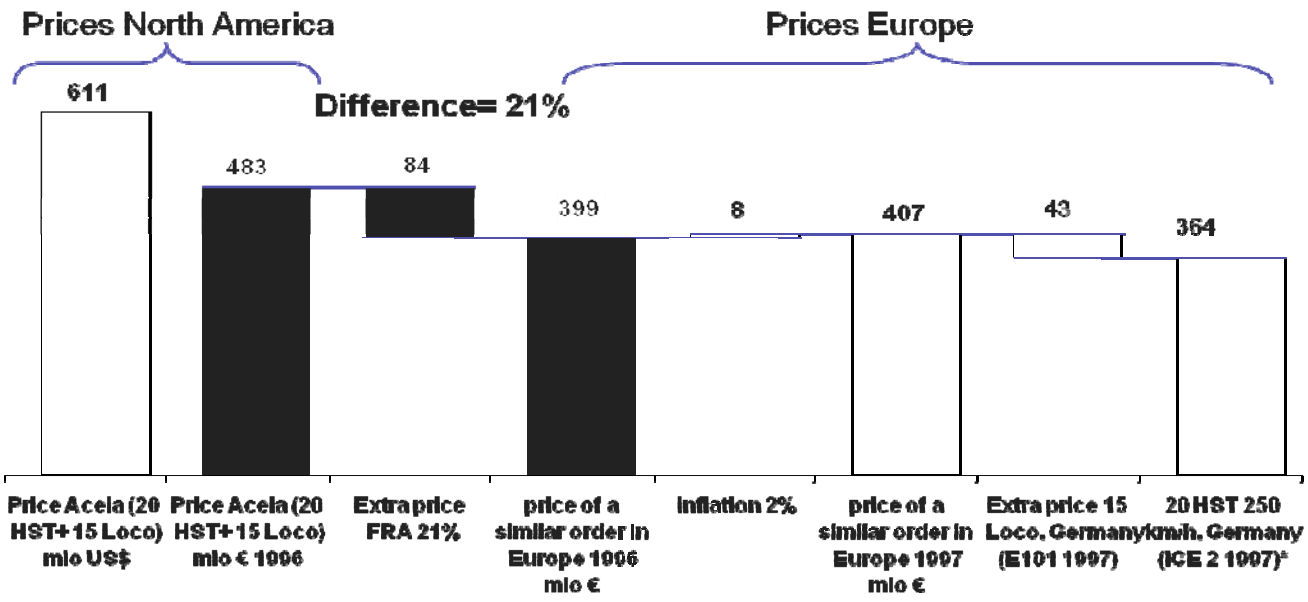
Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [ ] **F200+**

Sub-System:	J	Rolling Stock
Sector:	4	Construction
Item:	1	Capital Unit Cost
Sub-item:	1.1	E300+ Trainset

Estimation of additional cost for adjusting rolling stock for the North American market:



The price of FRA compatible train sets will be about 20% higher then comparable trains in Europe.

Source North America: International Railway Journal Okt 1999

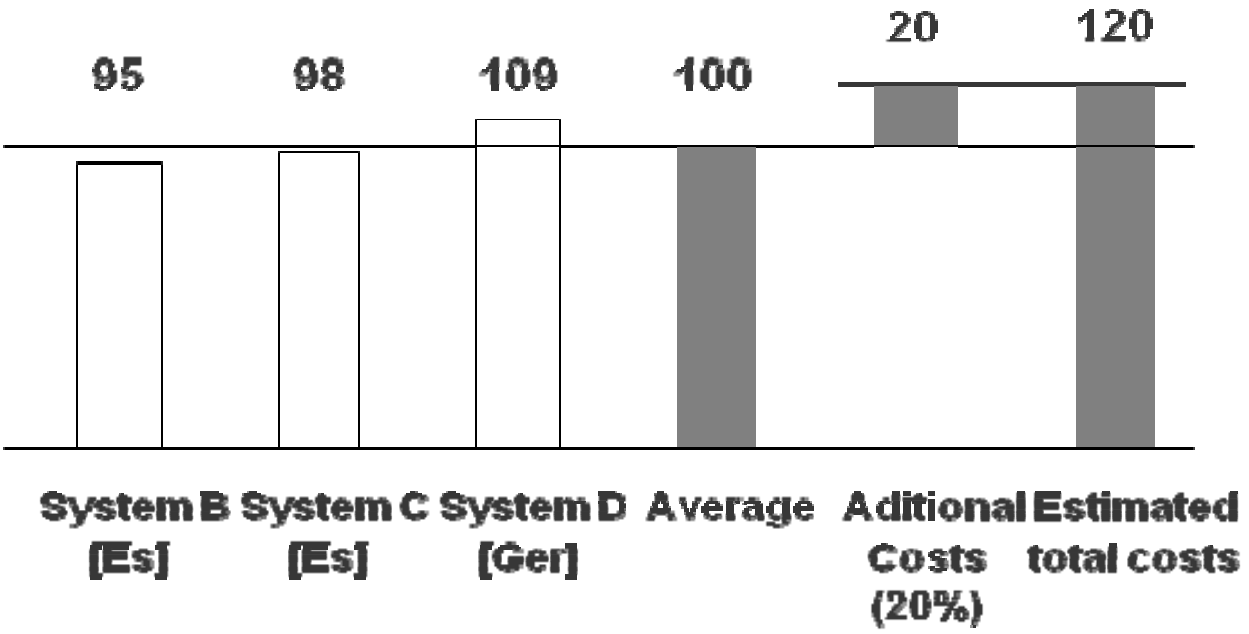
Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [ ] **F200+**

Sub-System:	J	Rolling Stock
Sector:	4	Construction
Item:	1	Capital Unit Cost
Sub-item:	1.1	E300+ Trainset

Total construction cost (in thousands CAD) per seat including adaption to North American conditions:



Total cost for one train with 400 seats: $48 000 000

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	☐	**E300+**	**Sub-System:**	J Rolling Stock
			Sector:	4 Construction
	☒	**F200+**	**Item:**	1 Capital Unit Cost
			Sub-item:	1.2 F200+ Diesel Trainset

The following chart provides published rolling stock prices of actual projects. Prices for high speed trains are usually compared by cost per seat.

	Train	Year	Company	Cost per train Mio €	Numer of Seats	Cost per train Mio CAD	Cost per Seat T CAD	Source
A	Agila Super Express diesel (10 trailors)	2008	Dpt. of Transport UK	35.7	581	55.9	96	DB AG

Exchange rate € - CAD 1.566 (15.06.2009)

These prices do not include

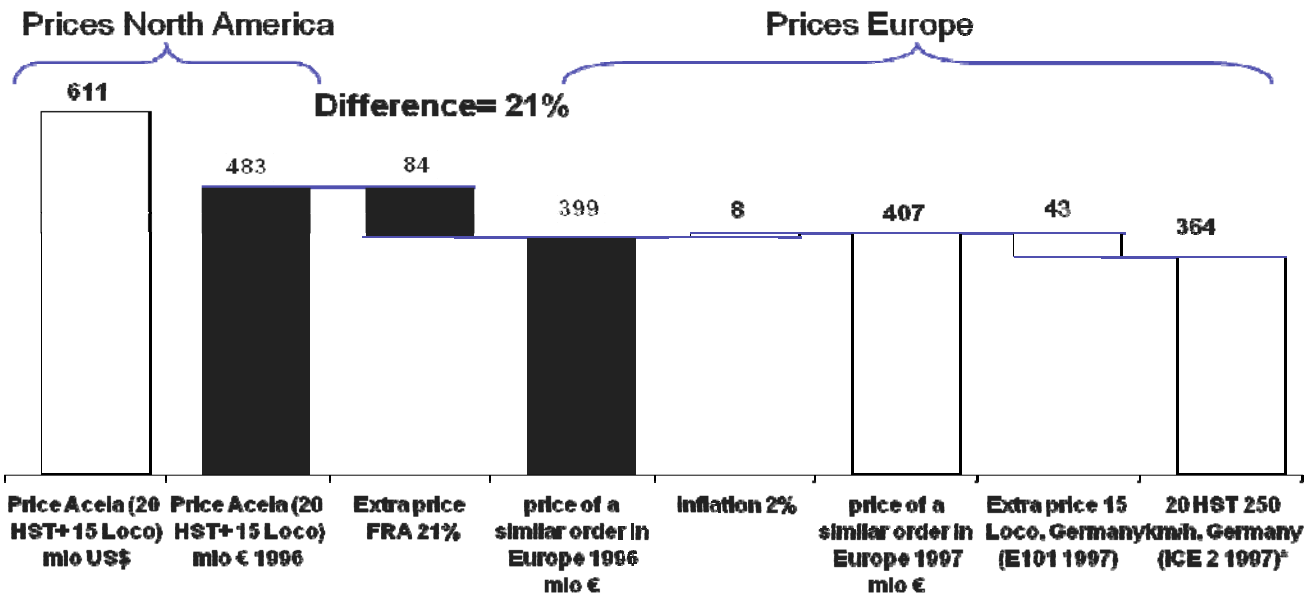
- the adaption for FRA requirements
- the adaption of the profile
- major changings of train length (standard: 200m)

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	☐	**E300+**	**Sub-System:** J	Rolling Stock
			Sector: 4	Construction
	☒	**F200+**	**Item:** 1	Capital Unit Cost
			Sub-item: 1.2	F200+ Diesel Trainset

Estimation of additional cost for adjusting rolling stock for the North American market:



The price of FRA compatible train sets will be about 20% higher then comparable trains in Europe.

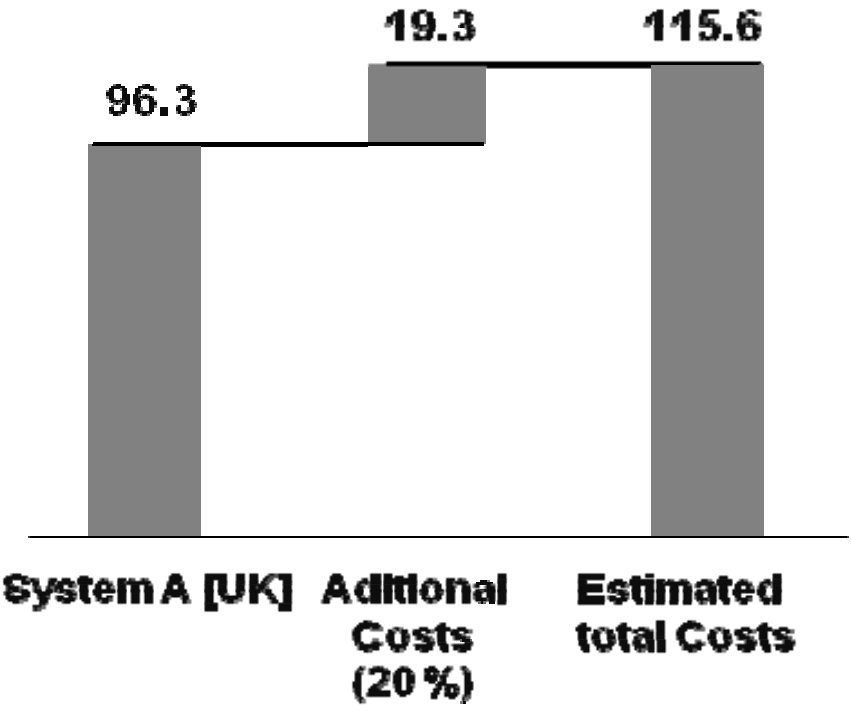
Source North America: International Railway Journal Okt 1999

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	☐	**E300+**	**Sub-System:** J	Rolling Stock
			Sector: 4	Construction
	☒	**F200+**	**Item:** 1	Capital Unit Cost
			Sub-item: 1.2	F200+ Diesel Trainset

Total construction cost (in thousands CAD) per seat including adaption to North American conditions:



Total cost for one train with 400 seats: $46 240 000

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: ☐ **E300+** ☒ **F200+**

Sub-System: J Rolling Stock
Sector: 4 Construction
Item: 1 Capital Unit Cost
Sub-item: 1.1 F200+ Hybrid Trainset

Diesel in the Mont-Royal-Tunnel at Montreal is not possible due to insufficient ventilation. Thus F200+ trainsets must run through the tunnel under electric power. That means that hybrid trainsets (diesel and electric powered) are required. This is technically feasible (see the recent orders of hybrid locomotives Diesel / 25 kV by AMT Montreal and NJT New Jersey).

The costs for hybrid locomotives is about the double of comparable diesel locomotives.

Based on the estimate for the diesel trainset (sub-item 1.1) and a assumed dsitribution of costs for power and passenger cars, the cost estimate for the hybrid trainset is as follows:

Item	Number	Diesel trainset		Hybrid trainset	
		Unit cost	Total cost	Unit cost	Total cost
Power cars	2	10 M$	20 M$	20 M$	40 M$
Passenger cars	8	3 M$	24 M$	3 M$	24 M$
Total			44 M$		64 M$

Total cost for one train with 400 seats: $64 000 000

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: ☐ **E300+** ☒ **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 1 Maintenance Vehicles Power Supply
Sub-item: none

Number of maintenance vehicles per maintenance base

Maintenance Base [km]	Catenary Measuring Car (CMC)	OCS Installation Car (OIC)	Drum Car (DC)	Multi-purpose vehicles (Road-Rail)	OCS Maintenance Car (MC)	Diesel Locomotive	Road Vehicles
1222.237							
1207.557							1
1149.657							1
1091.757							1
1029.807							1
967.857							1
929.843							1
830.715							1
764.629							1
673.917							1
613.442							1
555.256							1
497.069							1
409.790							1
359.278							1
303.645							1
243.430							1
183.215							1
97.447							1
11.679							1
Total							**19**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: ☐ **E300+** ☒ **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 1 Maintenance Vehicles Power Supply
Sub-item: none

Item	No	Unit price [$]	Total
Catenary Measuring Car (CMC)		7 500 000	
OCS Installation Car (OIC)		2 500 000	
Drum Car (DC)		800 000	
Multi-purpose vehicles (Road-Rail)		800 000	
OCS Maintenance Car (MC)		1 500 000	
Diesel Locomotive		4 000 000	
Road Vehicles	19	80 000	1 520 000
Total	**79**		**1 520 000**

Total costs for maintenance vehicles **$ 1 520 000**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 2 Maintenance Vehicles Signalling/Telecom
Sub-item: none

Number of maintenance vehicles per maintenance base

Maintenance Base [km]	km	Road Vehicles	Multi- purpose vehicles (MPV)
1213.480	14.200	1	1
1155.580	57.900	1	1
1097.680	57.900	1	1
1035.730	61.950	1	1
973.780	61.950	1	1
935.766	38.014	1	1
836.885	98.881	1	1
770.964	65.921	1	1
680.252	90.712	1	1
619.777	60.475	2	1
560.772	59.005	1	1
501.768	59.005	1	1
413.261	88.507	1	1
362.749	50.512	1	1
307.115	55.634	1	1
243.807	63.309	1	1
180.498	63.309	1	1
96.089	84.410	1	1
11.679	84.410	1	1
Total	**1216.001**	**20**	**19**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 2 Maintenance Vehicles Signalling/Telecom
Sub-item: none

Item	No	Unit price [$]	Total
Road Vehicles	20	80 000	1 600 000
Multi- purpose vehicles (MPV)	19	800 000	15 200 000
Total	**39**		**16 800 000**

Total costs for maintenance vehicles **$ 16 800 000**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 3 Maintenance Vehicles Track
Sub-item: none

Number of maintenance vehicles per maintenance base

Maintenance Base [km]	Multi-purpose vehicles	Ultrasonic meassurement vehicle	Geometric meassurement vehicle	Track Working Vehicle	Road Vehicles
1213,480	1	-	-	-	1
1155,580	1	-	-	-	1
1097,680	-	-	-	1	1
1035,730	1	-	-	-	1
973,780	1	-	-	-	1
935,766	-	-	-	1	1
836,885	1	-	-	-	1
770,964	1	-	-	-	1
680,252	1	-	-	-	1
619,777	-	1	1	1	1
560,772	1	-	-	-	1
501,768	1	-	-	-	1
413,261	1	-	-	-	1
362,749	-	-	-	1	1
307,115	1	-	-	-	1
243,807	1	-	-	-	1
180,498	-	-	-	1	1
96,089	1	-	-	-	1
11,679	1	-	-	-	1
Total	**14**	**1**	**1**	**5**	**19**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 3 Maintenance Vehicles Track
Sub-item: none

Item	No	Unit price [$]	Total
Multi- purpose vehicles (MPV)	14	800 000	11 200 000
Ultrasonic meassurement vehicle	1	3 200 000	3 200 000
Geometric meassurement vehicle	1	3 200 000	3 200 000
Track working vehicle (GAF)	5	2 300 000	11 500 000
Road Vehicles	19	80 000	1 520 000
Total		**40**	**30 620 000**

Total costs for maintenance vehicles **$ 30 620 000**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 4 Snow Fighting Vehicles
Sub-item: none

Number of snow fighting vehicles per maintenance base

Maintenance Base [km]	Snow jet	Snow fighter	Snow blower
1213.480	-	-	2
1155.580	-	-	2
1097.680	-	-	2
1035.730	-	-	2
973.780	-	-	2
935.766	-	-	2
836.885	-	-	2
770.964	-	-	2
680.252	-	-	2
619.777	-	-	2
560.772	-	-	2
501.768	-	-	2
413.261	-	-	2
362.749	-	-	2
307.115	-	-	2
243.807	-	-	2
180.498	-	-	2
96.089	-	-	2
11.679	-	-	1
Total	**0**	**0**	**37**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 4 Snow Fighting Vehicles
Sub-item: none

Item	No	Unit price [$]	Total
Snow jet	0	700 000	0
Snow fighter	0	400 000	0
Snow blower	37	5 000 000	185 000 000
Total	**37**		**185 000 000**

Total costs for maintenance vehicles **$ 185 000 000**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: ☐ **E300+** ☒ **F200+**

Sub-System:	K	Maintenance facilities
Sector:	4	Construction
Item:	5	Maintenance bases
Sub-item:	5.1	Maintenance bases - Diesel operation

Buildings - Unit Costs

Space per person	20	m²/person
Construction cost*	3 500	$/m²

Maintenance Base [km]	Personnel Track	Personnel Electrification	Personnel Signals / Telecom	Total Personnel	Area [m²]	Cost [$]
1207.557	4	4	4	12	240	840 000
1149.657	4	4	4	12	240	840 000
1091.757	4	4	4	12	240	840 000
1029.807	4	4	4	12	240	840 000
967.857	4	4	4	12	240	840 000
929.843	4	4	4	12	240	840 000
830.715	4	4	4	12	240	840 000
764.629	4	4	4	12	240	840 000
673.917	4	4	4	12	240	840 000
613.442	4	4	4	12	240	840 000
555.256	4	4	4	12	240	840 000
497.069	4	4	4	12	240	840 000
409.790	4	4	4	12	240	840 000
359.278	4	4	4	12	240	840 000
303.645	4	4	4	12	240	840 000
243.430	4	4	4	12	240	840 000
183.215	4	4	4	12	240	840 000
97.447	4	4	4	12	240	840 000
11.679	4	4	4	12	240	840 000
Total	**76**	**76**	**76**	**228**	**4 560**	**15 960 000**

(*) Source MMM

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: ☐ **E300+** ☒ **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 5 Maintenance bases
Sub-item: 5.1 Maintenance bases - Diesel operation

Covering - Quantities and Costs

Maintenance Base [km]	Rail Vehicles total	No. of Storage Tracks	Storage Track Length [m]	Storage Area [m²]	Cost of Covering [$]
1207.557	4	3	180	720	720 000
1149.657	4	3	180	720	720 000
1091.757	4	3	180	720	720 000
1029.807	4	3	180	720	720 000
967.857	4	3	180	720	720 000
929.843	4	3	180	720	720 000
830.715	4	3	180	720	720 000
764.629	4	3	180	720	720 000
673.917	4	3	180	720	720 000
613.442	6	3	180	720	720 000
555.256	4	3	180	720	720 000
497.069	4	3	180	720	720 000
409.790	4	3	180	720	720 000
359.278	4	3	180	720	720 000
303.645	4	3	180	720	720 000
243.430	4	3	180	720	720 000
183.215	4	3	180	720	720 000
97.447	4	3	180	720	720 000
11.679	3	2	120	480	480 000
Total	**77**	**56**	**3 360**	**13 440**	**13 440 000**

Buildings total **$ 15 960 000**

Covering total **$ 13 440 000**

Total costs for maintenance bases **$ 29 400 000**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [ ] **F200+**

Sub-System:	K	Maintenance facilities
Sector:	4	Construction
Item:	5	Maintenance bases
Sub-item:	5.2	Maintenance bases - Electric operation

Buildings - Unit Costs

Space per person	20	m²/person
Construction cost*	3 500	$/m²

Buildings - Quantities and Costs

Maintenance Base [km]	Personnel Track	Personnel Electrification	Personnel Signals / Telecom	Total Personnel	Area [m²]	Cost [$]
1227.680						
1213.480	4	8	4	16	320	1 120 000
1155.580	4	8	4	16	320	1 120 000
1097.680	4	33	4	41	820	2 870 000
1035.730	4	8	4	16	320	1 120 000
973.780	4	8	4	16	320	1 120 000
935.766	4	33	4	41	820	2 870 000
836.885	4	8	4	16	320	1 120 000
770.964	4	8	4	16	320	1 120 000
680.252	4	8	4	16	320	1 120 000
619.777	4	33	4	41	820	2 870 000
560.772	4	8	4	16	320	1 120 000
501.768	4	8	4	16	320	1 120 000
413.261	4	8	4	16	320	1 120 000
362.749	4	33	4	41	820	2 870 000
307.115	4	8	4	16	320	1 120 000
243.807	4	8	4	16	320	1 120 000
180.498	4	33	4	41	820	2 870 000
96.089	4	8	4	16	320	1 120 000
11.679	4	8	4	16	320	1 120 000
Total	**76**	**277**	**76**	**429**	**8 580**	**30 030 000**

(*) Source MMM

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [ ] **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 5 Maintenance bases
Sub-item: 5.2 Maintenance bases - Electric operation

Covering - Quantities and Costs

Maintenance Base [km]	Rail Vehicles total	No. of Storage Tracks	Storage Track Length [m]	Storage Area [m²]	Cost of Covering [$]
1213.480	6	3	180	720	720 000
1155.580	6	3	180	720	720 000
1097.680	9	4	240	960	960 000
1035.730	6	3	180	720	720 000
973.780	6	3	180	720	720 000
935.766	10	5	300	1 200	1 200 000
836.885	6	3	180	720	720 000
770.964	6	3	180	720	720 000
680.252	6	3	180	720	720 000
619.777	11	5	300	1 200	1 200 000
560.772	6	3	180	720	720 000
501.768	6	3	180	720	720 000
413.261	6	3	180	720	720 000
362.749	10	5	300	1 200	1 200 000
307.115	6	3	180	720	720 000
243.807	6	3	180	720	720 000
180.498	9	4	240	960	960 000
96.089	6	3	180	720	720 000
11.679	5	3	180	720	720 000
Total	**132**		**3 900**	**15 600**	**15 600 000**

Buildings total **$ 30 030 000**

Covering total **$ 15 600 000**

Total costs for maintenance bases **$ 45 630 000**

Date: 2010-06-30		Page: 1 of 1

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs	Development of Capital Unit Cost, CAD

Technology:	[x] **E300+**	**Sub-System:**	K	Maintenance facilities
		Sector:	4	Construction
	[x] **F200+**	**Item:**	6	Central Administration Building
		Sub-item:		none

Basic assumptions:	min	max
Net area per working place	6 m²	12 m²
Gross area per working place	13.5 m²	22 m²
Average area per working place	20 m²	

Source: DBI

Mean capital cost per m²	$3 500

Source: MMM

Total costs for central administration building per person **$ 70 000**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 7 Train Wash
Sub-item: none

Numer of train wash	2	at shop
Cost per train wash	20 000 000	$
Total cost	**40 000 000**	**$**

Total costs for train wash **$ 40 000 000**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	x	**E300+**	**Sub-System:**	K Maintenance facilities
			Sector:	4 Construction
	x	**F200+**	**Item:**	8 Central Maintenance Depots
			Sub-item:	none

Numer of depots	4	
Cost per depot	5 000 000	$
Total cost	**20 000 000**	**$**

Total costs for central maintenance depots **$ 20 000 000**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: ☐ **E300+** ☒ **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 9 Yards (Roof)
Sub-item: none

Unit cost per m² of covering

Length of storage track	220	m
Spare tracks	1	
Track distance	4	m
Cost per m² covering	**1 000**	**$/m²**

F200+

Station	Storage Tracks	Spare tracks	Storage Area [m²]	Cost of Coverage [$]
Québec	6	1	6 160	6 160 000
Montreal	20	1	18 480	18 480 000
Ottawa	4	1	4 400	4 400 000
Toronto	25	1	22 880	22 880 000
Windsor	7	1	7 040	7 040 000
Total	**62**	**5**	58 960	58 960 000

E300+

Station	Storage Tracks	Spare tracks	Storage Area [m²]	Cost of Coverage [$]
Québec	5	1	5 280	5 280 000
Montreal	18	1	16 720	16 720 000
Ottawa	3	1	3 520	3 520 000
Toronto	22	1	20 240	20 240 000
Windsor	6	1	6 160	6 160 000
Total	**54**	**5**	51 920	51 920 000

Date: 2010-06-30		Page: 1 of 1

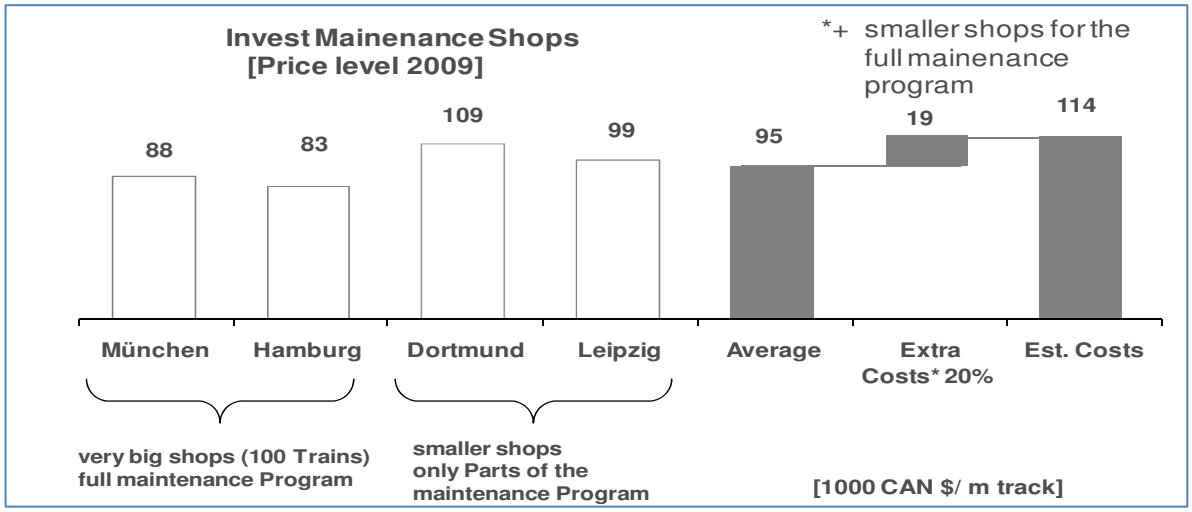
Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs	Development of Capital Unit Cost, CAD

Technology:	[x] **E300+**	**Sub-System:**	K	Maintenance facilities
		Sector:	4	Construction
	[x] **F200+**	**Item:**	10	Shops
		Sub-item:		none

Unit cost per shop

including tracks, building, equipment



Number of shops	2	
Length of working track	200	m
Unit cost	114 000	$/working m

Location	No of Working Tracks	Total Length of Working Tracks [m]	Total Cost [$]
Montreal	3	600	68 400 000
Toronto	3	600	68 400 000
Total	**6**	**1 200**	**136 800 000**

Total costs for shops **$ 136 800 000**

EcoTrain	By: Hans Frank Förster, DBI	Continued:

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: ☐ **E300+** ☒ **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 11 Track and Power Supply
Sub-item: 11.1 Ballast Track on earthworks

Tracks in Maintenance bases

Maintenance Base [km]	Storage Track Length [m]	Mainline Access [m]	Additional Track for Crossovers [m]	Total Length of Track [m]
1207.557	180	500	150	830
1149.657	180	500	150	830
1091.757	180	500	150	830
1029.807	180	500	150	830
967.857	180	500	150	830
929.843	180	500	150	830
830.715	180	500	150	830
764.629	180	500	150	830
673.917	180	500	150	830
613.442	180	500	150	830
555.256	180	500	150	830
497.069	180	500	150	830
409.790	180	500	150	830
359.278	180	500	150	830
303.645	180	500	150	830
243.430	180	500	150	830
183.215	180	500	150	830
97.447	180	500	150	830
11.679	120	500	50	670
	3 360	**9 500**	**2 750**	**15 610**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: ☐ **E300+** ☒ **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 11 Track and Power Supply
Sub-item: 11.1 Ballast Track on earthworks

Tracks in Yards

Station	Mainline Access [km]	Storage Tracks	Spare tracks	Storage Track Length [m]	Additional Tracks for Crossovers [m]	Total Length of single Track [m]
L'Áncienne-Lorette	4	6	1	1 540	700	6 240
Montreal	5	20	1	4 620	5 775	15 395
Ottawa	2	4	1	1 100	375	3 475
Toronto	7	25	1	5 720	8 450	21 170
Windsor	2	7	1	1 760	800	4 560
Total	**20**	**62**	**5**	**14 740**	**16 100**	**50 840**

Mainline Access to Shops

Location	Mainline Access [km]
Montreal	5
Toronto	7
Total	**12**

Tracks in Maintenance bases	15 610 m
Tracks in Yards	50 840 m
Tracks in Shops	12 000 m
Total	**78 450 m**
Unit price per km track (see worksheet F-4-1)	**938 500 $**

Total cost for F200+: 78.450 km x 938 500 $ = 73 625 325 $

Total costs for Ballast Track on earthworks **$ 73 625 325**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [ ] **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 11 Track and Power Supply
Sub-item: 11.1 Ballast Track on earthworks

Tracks in Maintenance bases

Maintenance Base [km]	Storage Track Length [m]	Mainline Access [m]	Additional Track for Crossovers [m]	Total Length of Track [m]
1213.480	180	500	150	830
1155.580	180	500	150	830
1097.680	240	500	200	940
1035.730	180	500	150	830
973.780	180	500	150	830
935.766	300	500	375	1 175
836.885	180	500	150	830
770.964	180	500	150	830
680.252	180	500	150	830
619.777	300	500	375	1 175
560.772	180	500	150	830
501.768	180	500	150	830
413.261	180	500	150	830
362.749	300	500	375	1 175
307.115	180	500	150	830
243.807	180	500	150	830
180.498	240	500	200	940
96.089	180	500	150	830
11.679	180	500	150	830
Total	**3 900**	**9 500**	**3 625**	**17 025**

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [ ] **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 11 Track and Power Supply
Sub-item: 11.1 Ballast Track on earthworks

Tracks in Yards

Station	Mainline Access [km]	Storage Tracks	Spare Tracks	Storage Track Length [m]	Additional Tracks for Crossovers [m]	Total Length of single Track [m]
L'Ancienne-Lorette	4	5	1	1 320	450	5 770
Montreal	5	18	1	4 180	4 750	13 930
Ottawa	2	3	1	880	200	3 080
Toronto	7	22	1	5 060	6 900	18 960
Windsor	2	6	1	1 540	700	4 240
Total	**20**	**54**	**5**	**12 980**	**13 000**	**45 980**

Mainline Access to Shops

Location	Mainline Access [km]
Montreal	5
Toronto	7
Total	**12**

Tracks in Maintenance bases	17 025 m
Tracks in Yards	45 980 m
Tracks in Shops	12 000 m
Total	**75 005 m**
Unit price per km track (see worksheet F-4-1)	**938 500 $**

Total cost for E300+: 75.005 km x 938 500 $ = 70 392 193 $

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [X] **E300+** [ ] **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 11 Track and Power Supply
Sub-item: 11.2 Turnout - 60 km/h deviation speed

Turnouts in maintenance bases

Maintenance Base [km]	Switches EW500
1213.480	1
1155.580	1
1097.680	1
1035.730	1
973.780	1
935.766	1
836.885	1
770.964	1
680.252	1
619.777	1
560.772	1
501.768	1
413.261	1
362.749	1
307.115	1
243.807	1
180.498	1
96.089	1
11.679	1
Total	**19**

Turnouts in Yards

Station	Switches EW500
Québec	1
Montreal	1
Ottawa	1
Toronto	1
Windsor	1
Total	**5**

Maint. bases	19
Yards	5
Total	**24**

Unit price/switch (see worksheet F-4.7)	**200 000 $**
Unit price/switch heater (see worksheet F-4.9)	**130 000 $**

24 x 200 000 $ = 4 800 000 $ Switches

24 x 130 000 $ = 3 120 000 $ Switch Heaters

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: ☐ **E300+** ☒ **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 11 Track and Power Supply
Sub-item: 11.2 Turnout - 60 km/h deviation speed

Turnouts in maintenance bases

Maintenance Base [km]	Switches EW500
1207.557	1
1149.657	1
1091.757	1
1029.807	1
967.857	1
929.843	1
830.715	1
764.629	1
673.917	1
613.442	1
555.256	1
497.069	1
409.790	1
359.278	1
303.645	1
243.430	1
183.215	1
97.447	1
11.679	1
Total	**19**

Turnouts in Yards

Station	Switches EW500
Québec	1
Montreal	1
Ottawa	1
Toronto	1
Windsor	1
Total	**5**

Maint. bases	19
Yards	5
Total	**24**

Unit price/switch (see worksheet F-4.7)	**200 000 $**
Unit price/switch heater (see worksheet F-4.9)	**130 000 $**

24 x 200 000 $ = 4 800 000 $ Switches

24 x 130 000 $ = 3 120 000 $ Switch Heaters

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: ☐ **E300+** ☒ **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 11 Track and Power Supply
Sub-item: 11.3 Turnout -40 km/h deviation speed

Turnouts in maintenance bases

Maintenance Base [km]	Switches EW190
1207.557	2
1149.657	2
1091.757	2
1029.807	2
967.857	2
929.843	2
830.715	2
764.629	2
673.917	2
613.442	2
555.256	2
497.069	2
409.790	2
359.278	2
303.645	2
243.430	2
183.215	2
97.447	2
11.679	1
Total	**37**

Turnouts in Yards

Station	Switches EW190
Québec	6
Montreal	20
Ottawa	4
Toronto	25
Windsor	7
Total	**62**

Maint. bases	37
Yards	62
Total	**99 turnouts 40km/h**

Unit price switch (see worksheet F-4.10)	**140 000 $**
Unit price switch heater (see worksheet F-4.11)	**100 000 $**

99 x 140 000 $ = 13 860 000 $ Switches
99 x 100 000 $ = 9 900 000 $ Switch Heaters

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [X] **E300+** [ ] **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 11 Track and Power Supply
Sub-item: 11.4 Catenary - OCS yards, stations

Tracks in Yards

Station	Mainline Access [km]	Storage Tracks	Spare Tracks	Storage Track Length [m]	Additional Tracks for Crossovers [m]	Total Length of single Track [m]
L'Ancienne-Lorette	4	5	1	1 320	450	5 770
Montreal	5	18	1	4 180	4 750	13 930
Ottawa	2	3	1	880	200	3 080
Toronto	7	22	1	5 060	6 900	18 960
Windsor	2	6	1	1 540	700	4 240
Total	**20**	**54**	**5**	**12 980**	**13 000**	**45 980**

Mainline Access to Shops

Location	Mainline Access [km]
Montreal	5
Toronto	7
Total	**12**

Tracks in yards:	45 980 m
Tracks for access to shops:	12 000 m
Total Length of Catenary (OCS)	57 980 m
Unit price per km OCS (see worksheet G-4-1.3)	**378 000 $**

57.980 km x 378 000 $ = 21 916 440 $

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [ ] **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 11 Track and Power Supply
Sub-item: 11.5 Catenary above switches

Catenary above switches

Unit Price (*) **80 000 $** per switch

(*) Source: DB KoRil 808.0212 Listing of characteristic unit costs for railway projects, 1998; Crosschecked with current DB Procurement data; Inflation 2% per year; Exchange rate CAN - EUR: 1.566

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [X] **E300+** [X] **F200+**

Sub-System: K Maintenance facilities
Sector: 4 Construction
Item: 12 Land acquisition
Sub-item: none

For each geographic or functional segment, the mean unit price per ha will be derived from Items 1 to 5 of Sector 4 of Subsystem A (Land Acquisition) in the Cost Model (rounded to the nearest 1000 $)

Areas of Land Acquisition for O&M Facilities:

F200+

	Maintenance Bases	Central Administration Building	Yards	Shops	Total	Hectares
	[m^2]	[m^2]	[m^2]	[m^2]	[m^2]	
Québec-Montreal	26 600		24 960		**51 560**	5
Montreal-Ottawa	15 960	704	103 480	40 000	**160 144**	16
Ottawa-Toronto	31 920		112 680	56 000	**200 600**	20
Toronto-Windsor	25 960		26 240		**52 200**	5
Total	**100 440**	**704**	**267 360**	**96 000**	**464 504**	46

E300+

	Maintenance Bases	Central Administration Building	Yards	Shops	Total	
	[m^2]	[m^2]	[m^2]	[m^2]	[m^2]	
Québec-Montreal	27 040		23 080		**50 120**	5
Montreal-Ottawa	17 340	791	96 040	40 000	**154 171**	15
Ottawa-Toronto	34 680		103 840	56 000	**194 520**	19
Toronto-Windsor	27 040		24 960		**52 000**	5
Total	**106 100**	**791**	**247 920**	**96 000**	**450 811**	45

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Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: L Information - Ticketing
Sector: 1 Professional Services / Project Management
Item: 1 Engineering
Sub-item: none

Man power in man days

Field of Activity	Preparation, specification and planning	Implementation of project over 18 month.
Passenger Transportation Back End SW	1 320	11 550
Ticketing Machines & SW Integration	880	1 320
POS OTC Sales at Stations & SW Integration	880	1 320
Internet Server, SW-Development & Integration	440	660
eTicketing	440	660
IT Operations and IT Support	660	1 110
Roll-Out & Training	220	330
Total	**4 840**	**16 950**
Grand total	**21 790**	
Total [manmonths)	**1 038**	

Costs per manmonth **31 500 $**

1 038 x 31 500 $ = 32 697 000 $

Total costs for Engineering **$ 32 697 000**

Source: DB Systel, Septenber 2009

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology: [x] **E300+** [x] **F200+**

Sub-System: L Information - Ticketing
Sector: 1 Professional Services / Project Management
Item: 4 Project Management
Sub-item: none

Field of Activity	Man power in man days: Preparation, specification and planning	Implementation of project over 18 month.
Project Management	920	3 221
Total	**920**	**3 221**
Grand total	**4 140**	
Total [manmonths)	**197**	

Costs per manmonth **31 500 $**

197 x 31 500 $ = 6 205 500 $

Total costs for Project Management **$ 6 205 500**

Source: DB Systel, Septenber 2009

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	L	Information - Ticketing
		Sector:	4	Construction
	[x] **F200+**	**Item:**	1	Passenger Transportation Backend Software
		Sub-item:		none

Software licenses for application servers, e-mail oftware, firewalls, portal server, time table and routing engines, pricing engines, reservation system)

150 000 €

1 € = 1.50 $

Unit price	225 000 $
Units	1
Total costs	225 000 $

Total costs for Passenger Transportation Backend Software **225 000 $**

Source: DB Systel, Septenber 2009

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	L	Information - Ticketing
		Sector:	4	Construction
	[x] **F200+**	**Item:**	2	Ticketing Machines
		Sub-item:		none

Ticketing machine 80 000 €

1 € = 1.50 $

Unit price 120 000 $

Source: DB Systel, Septenber 2009

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Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	L	Information - Ticketing
		Sector:	4	Construction
	[x] **F200+**	**Item:**	3	Hardware for Counters at Stations
		Sub-item:		none

Counter hardware 8 000 €

1 € = 1.50 $

Unit price 12 000 $

Source: DB Systel, Septenber 2009

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Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	L	Information - Ticketing
		Sector:	4	Construction
	[x] **F200+**	**Item:**	4	Internet Server
		Sub-item:		none

1 central website for reservation and ticket sales 80 000 €

1 € = 1.50 $

Unit price	120 000 $
Units	1
Total costs	120 000 $

Total costs for Internet Server **120 000 $**

Source: DB Systel, Septenber 2009

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	L	Information - Ticketing
		Sector:	4	Construction
	[x] **F200+**	**Item:**	5	eTicketing
		Sub-item:		none

SMS and Email Server Infrastructure 50 000 €

1 € = 1.50 $

Unit price	75 000 $
Units	1
Total costs	75 000 $

Total costs for eTicketing **75 000 $**

Source: DB Systel, Septenber 2009

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Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	L	Information - Ticketing
		Sector:	4	Construction
	[x] **F200+**	**Item:**	6	IT Data Center
		Sub-item:		none

Initial setup costs 120 000 €

1 € = 1.50 $

Unit price	180 000 $
Units	1
Total costs	180 000 $

Total costs for IT Data Center **180 000 $**

Source: DB Systel, Septenber 2009

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	M	Startup
		Sector:	4	Construction
	[x] **F200+**	**Item:**	1	Commissioning
		Sub-item:		

Commissioning includes the final testing and adjustment of all components of an HSR-System after the infrastructure and the rolling stock has been handed over from suppliers to client.

Special points of interest are tests of the interaction of different components:

- High speed test runs to prove save interaction between rail and wheel as well as catenary and pantograph
- Intensive tests of high voltage systems and their impacts on other sub-systems.
- Tests of safety systems and their interaction with other sub-systems
- Signal / Communication test with running vehicles
- Rescue simmulations (training)

QOHSRP (System Operation and Costs, 1994) quoted the costs for commissioning as 2 % of the cost for the railway technical infrastructure.
This can be confirmed by latest figures. The Swiss Loetschberg Base Tunnel is in operation since Dezember 2007:

Railway technical infrastructure	1.07	bil. Swiss Francs
Commissioning	20	mil. Swiss Francs
Percentage	1.9	%

Not included is the approval of rolling stock, wich has to be provided by the supplier

Commissioning will trail the construction work in each section for about half a year.

Planning of commissioning has to start in an early phase of the project.

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Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	M	Startup
		Sector:	4	Construction
	[x] **F200+**	**Item:**	2	Administration Allowance
		Sub-item:		

The 1995 study has made the following assumptions for the build-up of the HSR administration:

- The administration during the construction period has been estimated in the initial year of construction at five per cent of the final expenses developed for the executive and administration categories. The administrative expenses have been allowed to increase as construction proceeds so that the full number of executive and administrative employees are in place the year before each segment is open for operations.

- The second component of administration includes the employment of the functional administrative staff (for example, the Chief of Transportation, maintenance supervisors, marketing professionals). Twenty per cent of these employees are put in place three years before a line segment is open for operations, with the remainder being brought on in the next two years so that the entire administrative and supervisory staff is in place the year each segment opens.

This is a reasonable approach, which can be confirmed.

Staff quantities are still not known as they depend on the results if the demand forecast

Updated Feasibility Study of a High Speed Rail Service in the Québec City – Windsor Corridor

Del. 6 : Updating Construction and Operating Costs | **Development of Capital Unit Cost, CAD**

Technology:	[x] **E300+**	**Sub-System:**	M	Startup
		Sector:	4	Construction
	[x] **F200+**	**Item:**	3	Training
		Sub-item:		

Appropriate training of hourly-rated staff is a key element to the successful implementation of an HSR system. In the 1995 study the following approach has been followed:

- All of the train crews and dispatchers will go through the pre-opening training, as will all customer service staff that fill front-line positions. A training allowance of five per cent was made for only seventy-five per cent of the equipment maintenance staff on the grounds there are no special skills or knowledge required for helpers and labourers. For infrastructure maintenance staff, only 60 per cent of the total staff are trained, again since labourers require no special knowledge that cannot be acquired on the job, and that a number of the specialized tradesmen require no additional specialized skills. The training allowances reflect standard overseas practice and are based on the use of existing railway (VIA) staff.

- Employee training starts four years before commissioning the first line segment for the key staff and continues until each segment opens, with the bulk of the expenditures being undertaken during the two years immediately before each segment opens.

- Training allowances were reduced by 25 per cent for last segment, on the grounds that the other sectors of the Corridor would already be in operation.

This reasonable approach can also be confirmed. However, the average training allowance per person stated in the 1995 study has to be adapted to the actual salary levels as follows:

Staff Group	1995	average increase	2009
Train crews	$115 000	42%	$164 000
Dispatchers	$110 000	42%	$157 000
Customer services	$6 000	42%	$9 000
Equip.maintenance	$55 000	42%	$79 000
Infrastruc. maintenance	$85 000	42%	$121 000

Staff quantities are still not known as they depend on the results if the demand forecast