Addendum - 2 February 2006

Previously this project was named 'Harbour Bridge to City' project and there may be references in this document referring to this name or its abbreviation: HBTC.

The name of this project has since changed and is now referred to as 'Vic Park Tunnel'. Therefore, any reference to 'Harbour Bridge to City' or HBTC should now be taken to refer to Vic Park Tunnel or VPT.

- Technical Report No. 6

Harbour Bridge to City Project, Assessment of Land Disturbing Activities

▪ Technical Report No. 6

Harbour Bridge to City Project, Assessment of Land Disturbing Activities

Prepared for

Transit New Zealand

By

Beca Infrastructure Ltd

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Revision History

Revision Nº	Prepared By	Description	Date
A	Ross Winter	Initial Draft, Viaduct Option	April 2003
B	Aroha Russell	Revised Draft, Tunnel Option	22 Sept 2005
B	Aroha Russell	Final	26 Oct 2005

Document Acceptance

Action	Name	Signed	Date
Prepared by	Aroha Russell		
Reviewed by	Brian Johnston		
Approved by	Brent Meekan		
on behalf of	**Beca Infrastructure Ltd**		

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Appendices

Appendix A - Areas of Construction

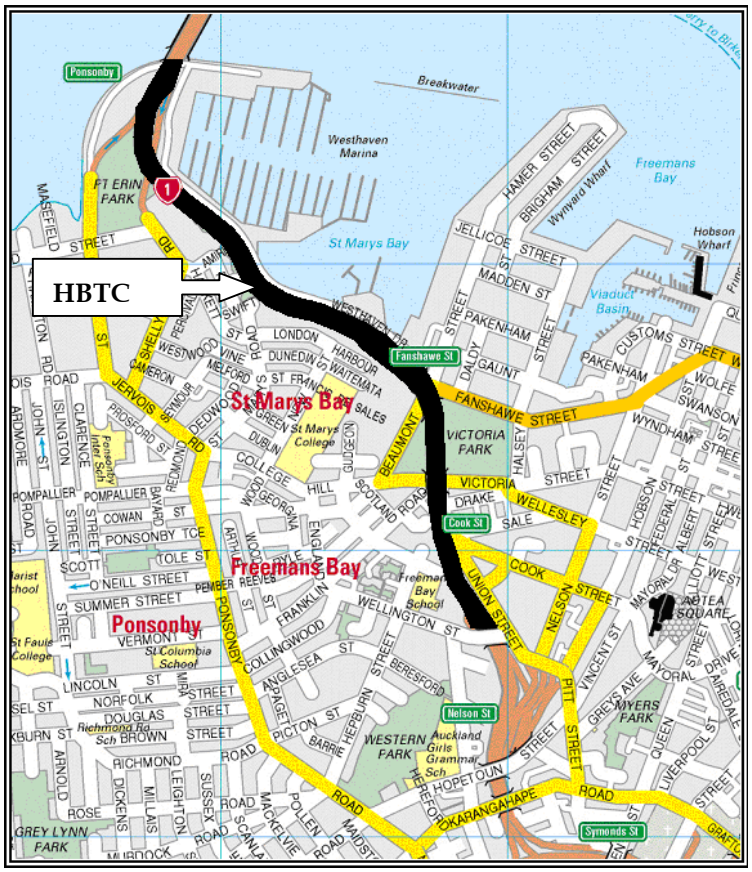
Appendix B - ARC Correspondence

1 Introduction

This report comprises information for the assessment of the land disturbing activities associated with the Harbour Bridge to City project (HBTC). This information may be used when considering construction methodologies including erosion and sediment control requirements. The primary objective is to assess the areas of earthworks and therefore the need or otherwise for a land use consent from the Auckland Regional Council (ARC) for earthworks. The potential for sediment generation is also considered and erosion and sediment control measures and methodologies proposed.

Should it be determined that a land use consent from ARC be sought, the content of this report is suitable to form the basis of the information supporting such an application.

Figure 1.1 HBTC Location[1]



[1] Source: Wises Streetwise Mapping Software, **Copyright (c) Wises Publications, New Zealand**

1.1 Central Motorway Improvements

Transit New Zealand (Transit) has identified three projects to ease traffic congestion within the greater Auckland area, known collectively as the Central Motorway Improvements. These projects are part of implementing the Auckland State Highway Strategy and are very briefly outlined as follows:

Harbour Bridge to City (HBTC)

This project addresses the balancing of the capacity of the Auckland Harbour Bridge traffic by widening the motorway through St. Mary's Bay and providing a Northbound tunnel across Victoria Park.

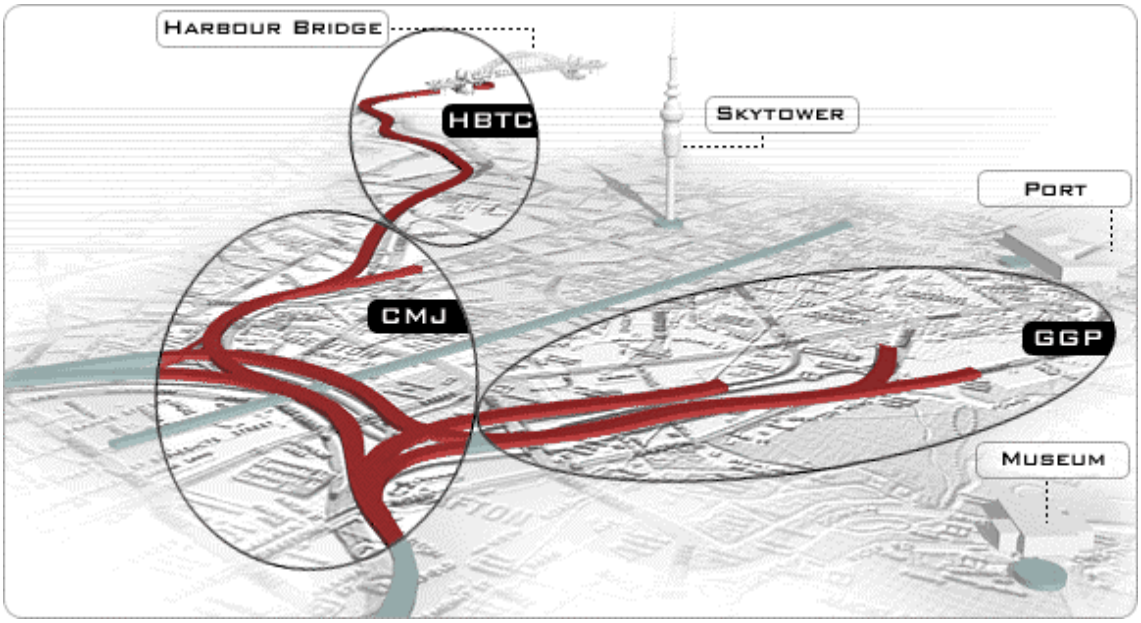
Central Motorway Junction (CMJ)

The project is partly complete and aims to improve the efficiency of the junction by solving alignment deficiencies in its approaches, and to provide all the required motorway-to-motorway connections to the central area.

Grafton Gully Project (GGP)

The project has been completed, and provides new links to provide direct access between the Northern Motorway, Grafton Gully, and the Port of Auckland

Figure 1.2 Central Motorway Improvement Projects



1.2 HBTC Project

This report specifically addresses the proposed earthworks and other land disturbance activities associated with the HBTC Project. The HBTC Project comprises of the following works:

- Widening the existing at grade section of the motorway corridor through St Mary's Bay. Widening is achieved by making better use of the existing motorway shoulder and median areas;
- Construction of a new 3 lane tunnel for Northbound traffic. The tunnel will pass through Victoria Park to the west of the existing viaduct. The tunnel southern approach (no roof) starts from just north of Wellington St Overbridge and has a 6% gradient. The tunnel roof starts at the location of the Birdcage Hotel on the south side of Victoria St, and continues through Victoria Park until opposite Victory Christian Church at the corner of Fanshawe St and Beaumont St. The tunnel exits (no roof) at a gradient of about 4% to join the existing motorway opposite Ngapona. The section of the tunnel through Victoria Park will be constructed by the 'cut and cover' method;
- The existing viaduct has only minor improvements made to it and all four lanes will be used for Southbound traffic;
- Realignment of the Fanshawe St onramp to the west of the new tunnel.

1.3 Purpose

The purpose of this report is to assess the following matters:

- Area of soil disturbance likely to occur as a result of construction activities necessary to complete HBTC;
- Potential sediment generation and discharge from disturbed soil surfaces;
- The need for ARC resource consent for land disturbing activities;
- Erosion and sediment control measures required to meet ARC Guidelines and environmental obligations.

The means to avoid, remedy or mitigate sediment related effects have been addressed in generic terms in the HBTC Environmental Management Plan (EMP), however, this report offers more detailed information associated with the construction activities likely to take place. The content and conclusions of this report are intended to form the basis of a land use consent application to ARC.

2 Areas of Land Disturbance

2.1 Extent of Disturbance

The Auckland Regional Plan: Sediment Control (ARP: SC) identifies statutory 'tests' based upon (amongst other matters):

- Proximity to sensitive water bodies, including the coastal marine area (CMA). These areas are defined as sediment control protection areas (SCPA).
- Site slope. ARP: SC identifies different thresholds for works that occur on slopes greater than 15°.
- Exposed or unstabilised area. A definition of 'stabilisation' is contained within the Glossary. Based on that (ARC) definition, works that include exposure of compacted metal (e.g. roading basecourse) would not therefore be included in any assessment of exposed area. The RP: SC defines earthworks to be:

  "The disturbance of land surfaces by blading, contouring, ripping, moving, removing, placing or replacing soil or earth, or by excavation, or by cutting and filling operations."

The extent of the earthworks for the HBTC Project, is shown on drawings attached in Appendix A and summarised in Table 2.1. The chainages and description of areas listed in Table 2.1 correspond to project distances and notes as shown in Appendix A. As the design is yet to be finalised, the exposed areas are subject to changes. However, given the limited room within the designation, this is unlikely to change significantly. The tunnel will be constructed using a 'cut and cover' method, broadly outlined as follows:

- Piling (constructing the walls of the tunnel without excavation of the tunnel first),

- Shallow Excavation to roof level,

- Roof Placement (constructing the roof of the tunnel, prior to excavation under the roof),

- Backfill and stabilise over the roof,

- Continue excavation of tunnel under the roof, once in place,

- Returning the surface as close to original ground level and appearance as possible.

Therefore for the purposes of this assessment, the tunnel footprint is considered to be exposed up until completion of backfilling and stabilisation, and not for any subsequent stages.

In addition, other activities, such as replacement, removal or upgrading of services, installation of stormwater treatment facilities, site establishment and accessways and other activities that may cause soil or earth to be disturbed outside of the areas noted should be added to these figures as well.

Table 2.1

Areas of Land Disturbance

Description of Area	Dimensions of Disturbance	Period of Disturbance (months)	Worked all at once or Progressively	Within SCPA and/or greater than 15°
St Mary's Bay, southbound, shoulder widening	**4025m²** (3.5 x 1150), from chainage 500-1650	3	Progressively	All except southern 50m within SCPA, <15°
St Mary's Bay, northbound shoulder widening	**3150m²** (3.0 x 1050) from chainage 250-1300	3	Progressively	All within SCPA, <15°
St Mary's Bay central median construction	**2850m²** (3.0 x950) from chainage 450-1400	2	Progressively	All within SCPA, <15°
Old Fanshawe St Northbound On-ramp removal. Conversion to grass	**2500 m²** (250 x10)	3	Progressively	Outside SCPA, <15°
Fanshawe Street northbound on-ramp	**3600m²** (300 x 12)	3	All	All within SCPA, <15°
Northern Tunnel exit	**4320m²** (240mx18m) from chainage 1330-1570	3	All	Outside SCPA, <15°
Tunnel Section 1 (Northern Half)	**3195m²** **(**177.5mx18m) from tunnel chainage 1525 to 1702.5	6	All	Outside SCPA, <15°
Tunnel Section 2 (Southern Half)	**3195m²** **(**177.5mx18m) from tunnel chainage 1702.5 to 1880	6	All	Outside SCPA, <15°
Southern Approach to Tunnel	**9900m²** (495mx20m) from chainage 1930 to 2425 (off Roading plan)	3	All	Outside SCPA, <15°
Batter slope Area (Napier Street)	**3000m²** (300mx10m)	3	All	Outside SCPA(less than 15 degrees?)
Total	**3.97 ha**			

The figures in Table 2.1 are based on the excavation activities that expose soil during the works. It is noted that this is a conservative estimate, as a number of the activities (along St Mary's Bay,) have sections where works are only expected to expose the existing roading basecourse. To restrict the amount of earthworks required in this area the construction of the tunnel is expected to be progressive, but it has been conservatively estimated that each

half of the tunnel footprint will be exposed for 12 months. The assumption has also been made that part of the batter slope along the West side of the Southern Approach to the tunnel will become a permanent feature, with a slope of 3:1 from the base of the roading structure. For all other main sections of cut, it has been assumed that some form of piling will be used.

2.2 Works Programme

It has been assumed that the earthworks for the HBTC project will be undertaken over a 36-month period, including works over the winter period. It is proposed that the contractor will undertake winter works in accordance with the winter works protocols developed during the Grafton Gully Project (as detailed in section 8.2). The estimates of the period of disturbance represented in Table 2.1 are based on the HBTC estimated construction period work programme. The relative staging of the works is presented in Table 2.2.

Table 2.2

Estimated Construction Staging (Relative)

Description of Area	Estimated Period of Construction
St Mary's Bay southbound	3 months
St Mary's Bay median	4 months
St Mary's Bay northbound	3 months
Fanshawe Street northbound on-ramp	6 months
Area between existing Victoria Park Viaduct and Tunnel, removal of road conversion to grass	3 months
Northern Tunnel exit (from Church car park to northern end of Ngapona car park)	6 months
Tunnel Section 1 (Northern Half)	12 months
Tunnel Section 2 (Southern Half)	12 months
Southern Approach to Tunnel	8 months
Batter Slope Area (Western side of Southern Approach)	6 months

3 Resource Consent Assessment

Given that more than 0.25 ha of land will be disturbed at one time (refer Table 2.1) within 100m of the CMA, and more than 1.0 ha is likely to be exposed at any one time outside this management area, a restricted discretionary Land Use Consent: Sediment Control for the land disturbing activities will be required unless the works are strictly staged.

The physical works are expected to take 36 months to complete, therefore some staging of the works will occur. It is understood that only one of the three sections of work to be undertaken along St Mary's Bay is able to be undertaken at any one time due to traffic management requirements. Should the shoulder widening activities (northbound and southbound) be undertaken in more than one stage, then the works may be undertaken as a permitted activity, provided the areas earth worked within the SCPA were kept to less than 0.25 ha.

However, the ARP:SC is concerned with contiguous areas of works, or works occurring within the same title at any one time. Therefore, if the works were to be undertaken as a permitted activity then the project wide 'open area' would need to be considered as a whole. This may place unnecessary restrictions on the Contractor.

Therefore, whilst the works will be staged, consent for a restricted discretionary activity is recommended to allow construction activities to be undertaken with some flexibility.

If earthworks are considered over the winter period, approval to continue earthworks over this period should be sought from the ARC. It has been assumed within this assessment that the earthworks will continue during the winter period. This assumption is based on the successful winter works programme undertaken during the Grafton Gully Project.

4 Sediment Generation Potential

4.1 Estimating Sediment Yield

To assess the risk of sediment related effects, the three relevant aspects relating to erosion and sediment control have been considered, namely the:

- *sediment generation potential*, given the topographical characteristics of the land under consideration
- *sediment delivery,* the amount of eroded sediment that is retained on site prior to it entering sediment treatment devices
- *sediment yield*, the amount of sediment discharged from the site following treatment.

The focus of this assessment using the Universal Soil Loss Equation (USLE) is not to absolutely quantify the annual mass loading, but rather to allow the earthworks process and/or the erosion and sediment controls to be refined such that any adverse environmental effects may be appropriately avoided, remedied, or mitigated. It allows consideration of the areas of higher sediment generation potential to be targeted with more comprehensive control methodologies on site to reduce the likelihood of significant off-site discharges.

4.2 Limitations

The USLE is utilised to assess sediment yield, modified in accordance with the *ARC Erosion and Sediment Control Plan Preparers Industry Registration Programme*. The ARC has identified the modified USLE as the required means of assessing sediment yield for land disturbing activities. As noted above, the assessed yields should not be viewed as absolute values and will change should any of the assumptions, upon which it depends, alter. As such this report should not be used to administer compliance with any subsequent conditions of consent, but rather to target areas of higher sediment generation potential with more comprehensive site management practices.

The Universal Soil Loss Equation (USLE) is not considered to be appropriate for establishing sediment loss for the entire construction period of the tunnel because the "cut and cover" method will be used (see Section 7.3 for the proposed methodology). The USLE considers only the extent of earth worked surfaces that are exposed to direct rainfall, and cannot be used to determine an estimated sediment yield from the works that will occur beneath the tunnel roof.

4.3 Staging Assumptions

It is assumed that the earthworks for the HBTC project will be undertaken progressively over 36 months. Relative staging details are based on the estimated construction period programme (as contained in Table 2.2).

It is recommended that consent be sought with this flexibility built into it in order to provide greater certainty for the Contractor. The assessment of sediment yield is nevertheless expected to represent what might typically be expected as arising from the project works and is useful for comparison to background loadings. Some contingencies have been built into the assessment and are discussed in the relevant sections of this report. Other contingency measures are identified within the EMP. This report is based upon compliance with both the critical assumptions and the EMP.

5 USLE Assessment

5.1 USLE Methodology

The USLE is a predictive agricultural model of soil loss reliant on detailed statistical records and the standardisation of soil characteristics. The USLE model was derived in the USA originally to estimate sheet and rill erosion from cropland. The USLE approach is limited in its application to Auckland earthworks (ARC Erosion and Sediment Control Registration Programme, 1996), thus:

1. Empirical formulae only and not a mathematical representation of the actual erosion process.
2. Predicts average annual sediment generation, unusually light or heavy rainfall is not represented.
3. Sediment deposition is not calculated.
4. Sheet and rill erosion is calculated only. Channel erosion is not calculated and any rill erosion greater than 100 mm in depth will be underestimated.
5. USLE has not been calibrated for New Zealand conditions.

The parameters that affect the potential for erosion, and subsequently sediment generation and sediment yield are, however, still limiting issues for any earthworks site:

- Rainfall intensity and duration
- Exposed sediment erodibility
- Slope length
- Slope steepness
- Degree and nature of ground cover
- Erosion control practices

There are also other issues to consider that both influence the amount of sediment leaving the site, and the final volume that is delivered to the receiving environment. These are:

- Sediment control efficiencies
- Duration of the earthworks season
- Delivery ratio
- Channel erosion

The USLE is based upon the parameters noted as follows:

$$A = R * K * LS * C * P$$

The factors are described as:

A = Soil loss (tonnes/year)

R = Rainfall erosion index

K = soil erodibility factor

LS = slope length

C = vegetation cover (crop) factor

P = erosion control practice (protection) factor

In addition to the above, the USLE estimate needs to be amended to account for the following:

- Earthworks duration;
- Sediment delivery ratio; and
- Sediment treatment device efficiency.

5.2 Rainfall

Rainfall details obtained from ARC Technical Publication 108 (TP108) 'Guidelines for Stormwater Runoff Modelling in the Auckland Region', have been extrapolated to give a 6-hour, 2-year rainfall figure of 50.24mm, giving an R (rainfall) factor of 77.8.

5.3 Geology and K Factor

The ability of surface sediments, and those exposed underlying sediments to resist the erosive energy of rainfall affects the rate of sediment generation from an earthworks site. This factor relates to the in situ sediments rather than the sediment erodibility factor of any materials subsequently placed upon the site.

The erodibility (K) factor has been estimated by considering Waitemata group silts, clays and fine sands in a variety of lithologies. The K factor for the Waitemata materials is 0.49. It is noted however, that material to be worked north of Victoria Street is reclaimed. It is considered however, that the high erodibility or K factor for Waitemata derived soils applied to these areas as well will provide a conservative estimate of the erodibility of these areas.

5.4 Length-Slope Factor

The works consist of excavations and cut to fill. Some of this will involve some degree of retaining structure, both permanent and temporary (which can assist in providing a comparative reduction in potential yield as construction generally involves building up or excavating in even, level layers). For the purposes of assessing the length-slope (LS) factor, it has been assumed that the works will occur at an assumed 'average' grade based on

consideration of the initial and final slopes in the work areas. The length between erosion controls should reflect the work gradients.

For the purposes of this analysis, the site has been divided into ten areas of similar slope characteristics:

(i) The approach to the tunnel

(ii) The batter slope along the tunnel approach section;

(iii) The tunnel;

(iv) The tunnel exit stretch;

(v) Fanshawe St Northbound On-ramp;

(vi) The area to be converted to grass under the Viaduct, in place of the old Fanshawe St On-ramp;

(vii) The St Mary's Bay widening area (from approx chainage 1330 to approx chainage 250);

(viii) The southbound widening of the St Mary's Bay area; and

(ix) St Mary's Bay central median construction.

Area (i) is the downsloping approach to the tunnel and because of the overall length the approach has been split into 100m sub sections (assumes the use of contour drains) with a slope of 6%, giving an LS value of 1.22. Area (ii) is the battered slope which runs along the western side of the approach to the tunnel, and averages 10m in width, with a slope of 33%, giving an LS value of 5.41. Area (iii) is the tunnel, which has a slope width of 18m, and will basically be a flat (slope of 0.5%), giving an LS value of 0.09. Area (iv) is the slope of the road from the tunnel exit to the point where it meets the St Mary's Bay widening. It has a slope length of 153m (along the road), and a slope of 4%, giving an LS value of 0.76.

The approach and exit from the tunnel, although they are not flat, drain away from the receiving environment.

The St Mary's Bay widening area (vii) is slightly sloped (towards the receiving environment of the Harbour), therefore its slope length has also been taken widthways. It is also very close to the receiving environment. An average of 2.5°, or 5% slope has been applied in this area. Based on an assumed site length of 8m (widest point on Fanshawe Street on-ramp), and an average slope of 5%, LS for this area is 0.3.

All other areas (v, vi, viii and ix) are all relatively flat areas, and earthworks in these areas will follow current contours and remain at similar to the current ground level.

5.5 Cover and Erosion Practice Factors

The USLE assumes, in effect, a constant rate of sediment generation over the course of a year. Due to the nature of the works, it has been assumed that the earthworks will be carried out throughout the year. The C (cover) factor provided by the USLE for earthworks is 1.0. The P factor (protection factor) has been chosen to reflect the expected combination of smooth surfaces and surface roughening by machinery track walked up and down the contours. A factor of 1.2 has been adopted for P.

5.6 USLE Estimate

Table 5.1

USLE Sediment Generation Rates

Site Area	R (J/ha)	K (t / J / ha)	LS	C	P	A (t /ha/ yr)
Tunnel Approach	77.8	0.49	1.22	1.0	1.2	55.81
Battered Slope	77.8	0.49	5.41	1.0	1.2	247.50
Tunnel	77.8	0.49	0.09	1.0	1.2	4.12
Tunnel exit	77.8	0.49	0.76	1.0	1.2	34.77
Fanshawe St Northbound onramp	77.8	0.49	0.08	1.0	1.2	3.65
St Mary's Bay	77.8	0.49	0.30	1.0	1.2	13.72
Area to be grassed below Viaduct	77.8	0.49	0.15	1.0	1.2	6.86
St Mary's Bay, southbound, shoulder widening	77.8	0.49	0.08	1.0	1.2	3.66
St Mary's Bay Central Median construction	77.8	0.49	0.08	1.0	0.2	3.66

5.7 USLE Modification Factors and Assumptions

To reflect the site characteristics, the estimates contained in Table 5.1 need corrections to reflect the area exposed, the duration of the works, efficiency of sediment control devices and the sediment delivery ratio.

5.7.1 Area and Duration

Areas to be exposed are based upon the assumptions set out in Table 2.1. The figures given are considered to be a conservative estimate of the area likely to be disturbed at any one time as progressive stabilisation and staging of the works will occur in those areas noted as occurring progressively on Table 2.1. This is of relevance, for those areas anticipated to generate higher levels of sediment, such as the batter slope and tunnel approach. . The duration of the works is based on the construction programme (reflected in Table 2.2).

5.7.2 Sediment Control Treatment Efficiency

The principal means of removing sediments from earthworks run-off is usually a sediment treatment / retention pond at the down gradient end of the earthworks site. Other treatment devices such as silt fences and vegetative filter strips can be used in association with a pond to augment any treatment. The effectiveness of any sediment control device, if sized and located appropriately relates to the correct installation (i.e. silt fences toed in), and appropriate maintenance (i.e. removing and correctly disposing of sediment deposited within sediment ponds).

The proposed method for sediment control for HBTC proposal is the use of isolated sediment treatment devices due to the lineal nature of any areas of disturbance, consisting generally of silt fences and decanting bunds. A specific dewatering methodology (detailed in the Environmental Management Plan) will be adopted for sediment laden water trapped within the tunnel excavation.

For the purposes of the estimating levels of sediment discharge in this instance, a 50% efficiency factor is suggested. This has been selected on the basis that sediment retention ponds will not be utilised, and that silt fences and decanting bunds are not considered to be as effective as sediment retention ponds. This efficiency factor is considered to be conservative.

5.7.3 Sediment Delivery Ratio

The USLE estimates gross erosion only, and does not make any allowance for sediment retained on site prior to reaching the sediment control measures on site. The delivery ratio describes the proportion of sediment that is eroded on site that will actually be transported to these treatment measures. It also gives consideration to the proximity of the works to sensitive receiving environments.

The sediment delivery ratio is derived with consideration to site topography, the size of the drainage area and the soil textural characteristics. The sediment delivery ratio may vary between 0.1 - 0.7 (ARC Industry Registration Programme). Having regard to the nature of the works and the slope characteristics on site, the following delivery ratios are estimated:

- 0.6 (60%) for those areas to be worked along St Mary's Bay which are flat and will generally be undertaken below the surrounding level of carriageway seal, but are closer to the receiving environment;
- 0.7 (70%) for works on the batter slope on the west side of the tunnel approach, and;
- 0.4 (40%) for those works within the footprint of the tunnel and the approach and exit of the tunnel, which are highly unlikely to reach the receiving environment due to the direction of the slopes. In the case of the tunnel, the cut and cover method will maintain a flat grade within the excavation, and during the backfilling operation. Also other areas such as the area to be grassed under the viaduct and the on-ramps are flat, and away from the receiving environment.

These delivery ratios estimates are considered to be conservative given the nature of the site ground conditions.

5.8 Estimate of Sediment Generation and Yield

Having consideration for the modification factors, Table 5.2 sets out the predicted sediment generation for HBTC Option A:

Table 5.2

USLE Sediment Yield Rates

Location	Sediment Yield (t / ha / yr)	Average Area Exposed *(ha)*	Delivery Ratio	Device Efficiency Factor	Period exposed (yrs)	Predicted Yield (tonnes)
Tunnel Approach	55.81	0.99	0.4	0.5	0.25	1.40
Tunnel	4.12	0.64	0.4	0.5	1	0.53
Battered Slope	247.50	0.3	0.7	0.5	0.25	6.5
Tunnel exit	34.77	0.43	0.4	0.5	0.25	0.75
Fanshawe Street northbound on-ramp	3.66	0.36	0.4	0.5	0.25	0.07
Area to be grassed below Viaduct	6.86	0.25	0.4	0.5	0.25	0.09
St Mary's Bay widening	13.72	0.32	0.6	0.5	0.25	0.33
St Mary's Bay, southbound, shoulder widening	3.66	0.41	0.4	0.5	0.25	0.08
St Mary's Bay Central Median construction	3.66	0.29	0.4	0.5	0.17	0.08
Total Estimated Sediment Discharge						**9.76Tonnes**

5.9 Discussion

In general, the flatter areas where works are proposed offer very limited potential for sediment generation and discharge (reflected by the low sediment generation rate contained in Table 5.1). Limited runoff from these areas is likely, and may be treated by isolated sediment control measures. It is also noted that once excavated, the earthworks areas will be rapidly covered with hardfill/basecourse material, effectively stabilising these areas. The predicted sediment discharge is to occur over a period of earthwork seasons. However, should winter works occur, this period is likely to decrease with the potential to

reduce the total period that sediments are exposed, depending on the nature and extent of winter works approved and undertaken.

The batter slope section of the route represents a higher potential for sediment generation and discharge due to the steeper nature of the area to be worked and longer slope lengths. This area should be considered in more detail when the final design of erosion and sediment control measures occurs.

6 Catchment Sediment Yield

6.1 Background

For the purposes of considering the likely increase in sediment discharge to the Harbour receiving environment, consideration of the "background" levels of sediment being discharged to the Waitemata Harbour in the vicinity of the site discharges needs to occur. There are two areas of consideration, being:

i. The length of motorway along St Mary's Bay, discharging directly to Waitemata Harbour from a number of discharge points, and

ii. The section of motorway from Beaumont St to Wellington St Overbridge. This area discharges into the Auckland City Council stormwater system with runoff from the Freeman's Bay Catchment. This system discharges to the Waitemata Harbour at an outfall at the southern end of Wynyard Wharf.

6.2 Catchment Discharges

6.2.1 St Mary's Bay Section

This length of motorway discharges via a series of outfalls that pass under Westhaven Drive directly to the Harbour in the vicinity of Westhaven Marina. The USLE estimate indicates that approximately 0.45 tonnes of sediment may be discharged from these works over the 3 to 4 month period of construction.

By comparison, stormwater from this area of carriageway alone is estimated to discharge 1.0 tonne of sediment per hectare per year[2] (Table 6.1), or approximately 6.75 tonnes for this 1500 m length of motorway. The adjoining residential catchment of approximately 50 ha (the area encompassed by Shelly Beach Road, Jervois Road, St Mary's Bay Road, Green Street and New Street across to Westhaven Drive) is estimated to contribute 0.2 t/ha/yr[1], and this equates to 10 tonnes of sediment per year.

Therefore, it is estimated that approximately 16.75 tonnes per year of sediment discharges to this area of Waitemata Harbour, or approximately 5 tonnes over the 3-4 month period of construction. Whilst the increase in discharge of 0.45 tonnes (over the 3-4 month construction period) represents an increase over the background sediment loading of approximately 9%[3], the quantum of the discharge is considered to be minor in the context of discharges to the Harbour.

[2] Reference: Auckland Regional Council Draft Update of TP10 (Stormwater Treatment Devices: Design Guideline Manual, 1992).
[3] 0.45 tonnes is 9% of the 5 tonnes of sediment produced over the 3-4 month construction period

Table 6.1

Typical Contaminant Loadings (kg/ha/year) from Urban Land Uses (ARC TP 10)

Land Use	TSS	TP	TKN	NH_3-N	NO_2-N	BOD	COD	Pb	Zn	Cu
Commercial	1124	1.68	7.53	2.14	3.48	70	472	3.03	2.36	0.45
Parking Lot	449	0.79	5.73	2.25	3.26	52.8	303	0.9	0.9	0.45
High density Residential	472	1.12	4.72	0.9	2.25	30.3	191	0.9	0.79	0.34
Medium density residential	213	0.56	2.81	0.56	1.57	14.6	81	0.23	0.23	0.157
Low density residential	11	0.05	0.03	0.02	0.11			0.01	0.05	0.011
Motorway	989	1.01	8.88	1.69	4.72			5.06	2.36	0.416
Industrial	966	1.46	4.27	0.26	1.46			2.7	8.2	0.562
Reserve	3	0.03	1.69		0.34		2.25	0.006		
Construction	67,416	89.9								

6.2.2 Beaumont Street to Wellington Street Section

This section of motorway lies within the 201 ha Freeman's Bay catchment, which has a mixed land use consisting of residential, commercial and some reserve areas, including Victoria Park. The USLE estimate indicated that 9.31 tonnes of sediment might be discharged from this section of the proposed works, with approximately 85% (7.9 tonnes) predicted to come from the Tunnel Approach and Batter Slope sections.

In contrast to these estimated discharges, the overall catchment is estimated to discharge approximately 107 tonnes per annum (based on: 13.5 ha reserve; 7.5 ha motorway; 70 ha commercial; and 110 ha medium density residential), or 214 tonnes over the construction period. Over the construction period for works in this area (24 months), a discharge of 9.31 tonnes represents an increase of 4% over background.

7 Erosion and Sediment Control Methodologies

7.1 Design Approach

For the purposes of providing the ARC with a suitable level of information to determine the potential effects of the proposed HBTC construction activities, a likely scenario of earthworks and sediment control measures has been suggested. It is recognised up front that this report and the measures considered are conceptual only. However, conservative estimates have been used throughout the report to present the "worst-case" scenario. This conceptual approach has achieved ARC approval previously for significant highway works (e.g. the Grafton Gully Project and Northshore Busway), and it is considered that such a programme is suitable to be implemented for the HBTC works.

In general, this will require that the contractor provide more detailed Erosion and Sediment Control Plans (ESCP) in accordance with the conditions of consent and Construction Environmental Management Plan, over which the ARC retains approval rights.

With regard to the selection of erosion and sediment control devices, the construction programme and proposed works have been considered, and with experience obtained on similar earthworks developments, erosion and sediment control measures suggested.

7.2 Principles

The basic principles to be employed for an ESCP, is to undertake land disturbing activities in a manner that reduces the potential for erosion of bare soil surfaces to occur (Erosion Control) and to employ treatment devices to treat all sediment laden water prior to discharging from the site (Sediment Control).

Erosion control will always be focussed on ahead of sediment control, however, it is noted that the nature of the works, may preclude standard erosion control methodologies (for instance progressive stabilisation may not be achievable due to the subgrade construction requirements).

The basic erosion and sediment control principles applicable to this project are as follows (as noted in ARC Erosion and Sediment Control Guidelines for Land Disturbing Activities 'TP90'):

- *Minimise Disturbance*, only work those areas required for construction to take place.
- *Stage Construction,* carefully plan works to minimise the area of disturbance at any one time.
- *Protect Steep Slopes*, careful consideration of activities on steep slopes and the control of runoff from these areas need to occur.
- *Stabilise Exposed Areas Rapidly.*
- *Install Perimeter Controls,* divert clean water away from areas of disturbance and divert runoff from areas disturbed to sediment control measures.
- *Employ Detention Devices,* treat runoff by methods that allows sediment to settle out.

- *Undertake Training,* the ARC runs a training course that the Contractor needs to have completed (refer to EMP).
- *Modify the ESCP throughout Construction,* as construction progresses and the nature of land disturbing activities change, the ESCP needs to be modified to reflect the changing conditions on site.
- *Assess and Adjust,* inspect, monitor and maintain control measures.

The USLE estimate shows that the Tunnel Approach and Batter Slope construction activities have the highest potential for sediment generation and discharge. As a result, this area should be targeted for control during construction. The other areas assessed have minor potential for generation and discharge, and standard sediment control methodologies should be employed to treat runoff from construction areas.

7.3 Proposed Methodologies

Given the nature of the probable construction activities on site, the following methodologies are proposed to be employed to manage the generation and discharge of sediment from the site. These methodologies and management practices have been developed from those outlined in the EMP. It is expected, as stated in the EMP, that the successful contractor will use this information as the basis for an ESCP to be submitted to the ARC for approval.

For the purposes of drafting an outline ESCP, the activities on site have been separated into the following sections of similar characteristics:

- Shoulder-widening and median works (St Mary's Bay North and Southbound, and the former Fanshawe St onramp area to be grassed)
- Retaining wall construction (Fanshawe Street on-ramp, Tunnel exit past Church car park),
- Batter Slope construction
- Tunnel construction
- Tunnel Approach and Exit construction

All erosion and sediment control measures shall be constructed in accordance with TP90 to a minimum.

7.3.1 Generic Controls

All works will require the following controls and methodologies to be considered and utilised where appropriate:

- No traffic may exit construction areas onto public roads with sediment and other material attached to the undercarriage and tyres. As such, material must be removed via a 'wheel wash'. If a wheel wash is not practical, sediment should be washed from vehicles with a hose or water blaster, or running the material off along on-site access roads.
- Stabilised construction entrances.
- Clean water diversion away from worked areas.

- Rapid stabilisation, especially for isolated areas is advised. The placement of hardfill/sub-basecourse will occur for those areas worked that are to be sealed. In addition, application of hay or straw mulch on batters will reduce the need for ongoing maintenance requirements as vegetation becomes established.
- Stormwater inlet protection. Any stormwater grates that may dispose of flow from 'dirty' areas shall be protected with aggregate and/or geotextile to provide some treatment of flows prior to discharge.

7.3.2 Shoulder widening of St Mary's Bay North and Southbound, Curran St and Area to be Grassed

These works will generally be isolated from any upstream catchment areas and will involve minor excavations and backfilling with hardfill to form the required grades and surface reshaping. Runoff from this work is expected to be minimal, due to the excavation being generally below the surrounding sealed area and backfilling with aggregate.

Where shoulder-widening works have the potential to intercept runoff from the carriageway, then the emphasis will be on stabilising these areas as soon as practicable and undertaking the works within identified periods of fine weather wherever possible.

Control measures will be limited to stormwater inlet protection and construction of decanting earth bunds within the works area to collect any runoff and allow settlement and soakage into the ground, or discharge to the stormwater system.

It is noted that stormwater inlet protection must not be allowed to prevent storm flows to drain and cause flooding of the carriageway, causing potentially dangerous conditions for motorway traffic. Methods such as a series of low sand bag dams within sections of curb and channel above inlets, without any covering of the inlets may be appropriate.

7.3.3 Tunnel Approach and Exit

There are two issues that need to be addressed here:

- The first is to minimise the amount of sediment draining to the collection points within the excavation. The approach and exit will be divided into smaller sections through the installation of contour drains and sumps at the end of each section. Silt fences will be used to treat sediment where contour drains cannot be used. It is assumed that as each section is created the base will be quickly stabilised to minimise erosion.
- The second issue is to maintain separation of clean and dirty water. For runoff collected above the ground water level it may be possible to discharge this to the stormwater system (after suitable treatment). For water collected below the ground water level refer to the dewatering process outlined in the EMP.

The walls of the tunnel will be constructed using pile retaining walls (secant/bored piles or diaphragm wall). The wall will restrict the transport of sediment to the receiving environment, while a small length of adjoining cut-slope will be an area of higher risk and will require decanting bunds.

7.3.4 Tunnel Construction Prior to Installation of the Tunnel Roof

The area being worked prior to the tunnel roof being installed will remain flat, therefore limiting the opportunity for sediment to be generated, and to escape to the receiving environment. It is assumed that the tunnel roof will be constructed in practically sized sections, therefore a sump will need to be created for each section of excavation to collect stormwater until the roof of the tunnel is in place and covered. Water can then be pumped to an intermediate storage / treatment device such as a skip or container. Once the roof is secured, then backfilling will occur to return the section to as near to original ground height and character as it was prior to any construction. This will ensure stability of the ground.

7.3.5 Tunnel Construction Post Roof Installation

Any sediment-laden water collected from this area will need to be pumped away as outlined in the dewatering method (refer to the EMP for details).

7.3.6 Batter Slope in the vicinity of Napier St

The batter slope is expected to have a slope ratio of 3:1, so the use of decanting bunds at the base of the slope will be most appropriate. Collected sediment can then be redistributed on the slope or where appropriate. If practical, the slope should be benched and/or have contour drains installed to reduce the amount of sediment draining to the decanting bunds. The sections of the slope will be stabilised as soon as practicable following exposure and completion of disturbance, to minimise sediment loss.

7.3.7 Fanshawe St On-ramp

Although the actual road surface of the Fanshawe Street On-ramp will be level on completion, there will be a slope excavated to bring the area down to a similar ground level to the existing on-ramp. A retaining wall will be constructed at the extent of the works, extending through the church car park. The retaining wall will be a secant-pile wall, of similar construction to the walls of the Approach and Exit of the Tunnel.

7.3.8 Miscellaneous Activities

Stabilised haul roads will be installed where construction traffic is likely to damage existing stabilised areas. These haul roads will be constructed by excavation of topsoil, the placement of a suitable geotextile and aggregate fill.

7.3.9 Monitoring and Maintenance

The Contractor, in accordance with the Environmental Monitoring Guidelines, will undertake regular monitoring and maintenance of the erosion and sediment control measures. Monitoring will consist of regular visual inspections of all erosion and sediment control devices, including during storm events.

Where identified as required, maintenance of control measures shall be undertaken immediately.

Records of the visual inspections and any maintenance shall be kept detailing:

- Monitoring of erosion and temporary sediment control devices that has taken place;
- Erosion and sediment controls requiring maintenance;
- Personnel responsible for completing the action, and by when;
- When the maintenance required was completed;
- Areas of non-compliance with the approved ESCP together with reasons for non-compliance.

8 ARC Feedback and Winter-works

8.1 21 February 2003 Correspondence

The ARC has provided written confirmation of their acceptance of the philosophy proposed for managing earthworks activities (Appendix B). It is noted that the ARC also consider that the USLE sediment generation and discharge estimates provided are consistent with other projects of this nature.

8.2 Winter-works

The ARC has queried the need for the HBTC project to continue works through the winter period. Works throughout the winter period (1 May – 30 September inclusive) are considered necessary for works to be completed within project time frames. To continue works through this winter period, it is understood that the ARC needs a high degree of confidence that the site would be managed comprehensively in relation to the land disturbing activities that fall within the terms of any resource consent.

To meet these expectations, a threefold comprehensive environmental management approach is proposed: process and planning (environmental framework); field controls and systems; and communication and monitoring. This has been developed and implemented successfully at the Grafton Gully Project. This is briefly outlined below:

8.2.1 Environmental Management Framework

The environmental framework proposed comprises:

- A consent holder environmental management plan (EMP) prepared by the consent holder in support of the resource consents sought from ARC and the Notice of Requirement (NOR) submitted to the Auckland City Council. Its purpose is to demonstrate, at a strategic level, how the potential environmental effects identified in the Assessment of Environmental Effects report would be avoided, remedied or mitigated during the implementation of the project. Compliance with the EMP is required as a condition of consent and NOR.
- Environmental Monitoring Guidelines (EMG) prepared by the consent holder that identify field observation of the erosion and sediment control measures implemented on the site during the course of the works.
- A contractors environmental management plan (CEMP), developed by the contractor in accordance with the EMP and conditions of consent represent a more detailed set of objectives, issues, strategies and management methods to provide compliance with the overriding or relevant environmental statutory and legislative requirements.
- An Environmental Effects Register (EER) compiled to form a record of all environmental management requirements

8.2.2 Field Measures and ESCPs

ESCPs are proposed to be developed and updated for the site as works progress. The plans will consist of a site plan, on which catchment areas are marked, and individual erosion and sediment control measures highlighted. Supporting these plans will be a description of the works methodology, timing, control measures, monitoring and maintenance requirements, and stabilisation details.

It is proposed that the Contractor develop these plans and discuss on site with ARC staff. Following this discussion, the ESCPs should be amended as appropriate, and approved by the ARC and the HBTC Environmental Manager. The plans will require updating as works progress and new areas are disturbed, or works require the modification of existing control measures.

8.2.3 Winter Works Communication and Monitoring Protocols

It is expected that the ARC consent for the project will require that no works be undertaken throughout the winter period without ARC approval. Therefore, a staged approval approach is proposed requesting that works be authorised to continue on site, subject to a monthly approval process, as per the successful GGP model.

The approval procedure requires close and frequent communication between the parties and regular site visits with ARC to assess progress and compliance.

The monthly schedule of ARC site visits, meetings, reporting and approvals is proposed as follows:

(i) The winter-works approval is to be reviewed on the first Tuesday of every month, and a formal site visit with ARC staff undertaken on the Friday immediately prior to the first Monday of the month. This meeting is to determine compliance for the month and ensure any matters that require addressing have been completed. This site visit is to confirm that works may continue into the next month.

(ii) Site meeting mid-month. To make certain that the site is in a state that allows approval to occur, a site visit is proposed to occur a week prior to the final monthly site visit and includes a full site walkover with any areas of concern identified. Should only minor matters be noted during this site visit, the final site visit could be deferred in lieu of photographs being emailed to ARC with an accompanying description noting the works that have been completed.

(iii) HBTC may provide monthly reports to ARC if required, confirming the works completed the previous month, and to outline the works proposed for the following month, including how these works might be accommodated in relation to current approvals and erosion and sediment control requirements.

In addition to the formal site visit procedure as set up, it is also anticipated that ARC staff may undertake regular field visits as occurs generally on such earthworking sites. HBTC staff will also undertake regular monitoring of the construction activities and site control measures to assess compliance and identify any potential areas of concern.

9 Discussion and Conclusions

The following key points are noted from the assessment of the proposed construction activities along the HBTC alignment:

- A resource consent from ARC should be sought for land disturbing activities. This conclusion is made on the basis that more than 2500m^2 will be exposed at one time within 100m of the CMA and/or greater than 1 ha will be exposed at any one time during the project.
- The resource consent required is a restricted discretionary consent pursuant to the Auckland Regional Plan: Sediment Control. Notification will be based on whether approvals have been obtained from all potentially affected parties and whether the effects of the activity are deemed to be no more than minor.
- If land disturbing activities are necessary in the period of 1 May to 30 September inclusive, approval to work should be sought from ARC and shouldn't materially alter the mitigation proposed.
- Conservative values for the variables in the USLE, and the modification factors have been used to give a 'worst-case scenario'.
- Overall, the quantum of the sediment yield expected from the works is relatively minor (9.76 tonnes). The site involves minor areas of earthworks on generally flat slopes, with the larger excavation within the tunnel and its approach and exit (which will drain into the excavation), and a small batter-slope area representing the higher-sediment generation potential areas of the site.
- The potential for erosion in the southern section of works may be reduced by reduction in slope length (arbitrarily estimated at 100m for the purposes of this report). Tighter controls should be incorporated by the Contractor into a final ESCP for this area (this may include staging).
- The sediment mass loadings or USLE estimates have been compared against likely background yields from the catchment for the construction periods for those areas. This represents between approximately 4% and 9% increase over the background yield if the works are undertaken at the same time.
- The annual sediment mass loading may alter if winter works are undertaken, however there is the potential to reduce the overall project/earthworks timeframes should this occur.
- Erosion and sediment control measures are proposed. In general these consist of standard control measures including silt fences, decanting bunds and stormwater inlet protection. The dewatering methodology (detailed in the EMP) addresses the management of any sediment-laden water from within the tunnel excavation (before and after the roof has been constructed), and the tunnel approach and exit.
- The EMP identifies activities of risk and means to avoid or mitigate the effects from these, together with a framework for anticipating, preventing, and responding to non-compliance or emergency situations. Application of the principles and requirements

contained within the EMP will assist in managing erosion and sediment yields from the site.

- A structured monitoring procedure is proposed in the EMP. Providing this frequent monitoring and auditing of the monitoring process occurs, the likelihood of significant sediment discharge will be minimised by ensuring that all erosion and sediment control measures are constructed appropriately and that maintenance is undertaken in a timely manner.
- Implementing appropriate erosion and sediment control measures can significantly reduce the potential for sediment discharge. Overall, the sediment yield calculations indicate that the potential sediment yield from these works to be relatively minor. While treated sediment will be discharged from on-site devices, leading to some changes to the environment, the magnitude and period of the discharges together with the environmental management procedures are such that significant adverse environmental effects should be avoided, remedied, or mitigated.
- Undertaking earthworks throughout the winter period may increase the risk of sediment generation and discharge. However, if the ARC approved a winter works programme as implemented on the Grafton Gully project, then it is considered that a high level of site management can occur, and counter any increase in the potential for offsite effects as a result of instigating winter works.

▪ Appendix A

Areas of Construction

▪ Appendix B

ARC Correspondence