Territory Development Department, Hong Kong
Urban Area Development Office

TECHNICAL PAPER NO. 23

Green Island Reclamation Feasibility Study

AIR QUALITY IMPACT AND ASSESSMENT OF PLANS

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Territory Development Department
拓展署
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市區拓展處

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Appendix 1

Table 1

Table 2

Table 3

1.0 INTRODUCTION

1.1 In the initial stages of this study, emphasis was placed on consideration of air quality in planning and design. Both the development layout and the road traffic network were routed to reduce the polluting emissions from vehicles and minimise the impact of both the vehicular and industrial pollution on the local air quality.

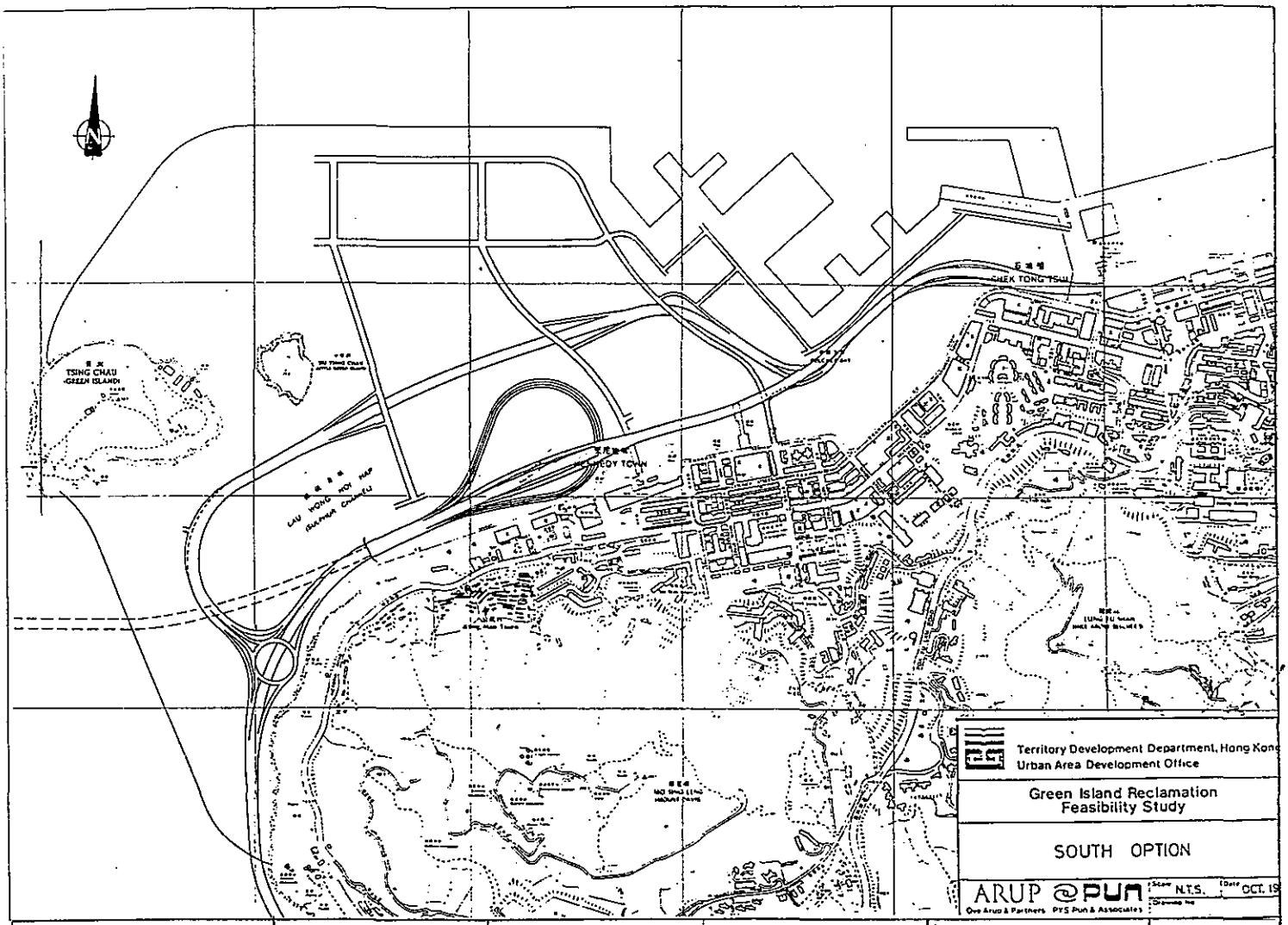
1.2 In the previous papers (TP21/TP22) existing information on the current air quality, and the main sources of pollution in the area were identified. Predictions were made of local air quality due to vehicle pollution in the Kennedy Town area. The techniques used for predicting vehicular pollution and the impact of air quality were described in TP22.

1.3 This paper will look at the potential impact on air quality of the two options which have been proposed for the development. Option North has been developed into a Recommended Outline Development Plan while the second plan has been developed to a much lesser degree. The option layouts are shown in Figure 1.

1.4 The air quality impact of the RODP (that is Option North) will be assessed in detail. The predictive techniques described in TP22 will be used in conjunction with predicted traffic volumes to provide estimates of the air quality with the RODP in the Year 2011.

1.5 Comments will be made on the expected differences in air quality impact between the North and South Options. These will be made on a qualitative basis only.

1.6 Where possible, recommendations will be made on ways to mitigate the air quality impact.


TSING CHAU
(GREEN ISLAND)
SHEK TONG TSUI
KENNEDY TOWN
LAU WONG YOI MAP
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SOUTH OPTION
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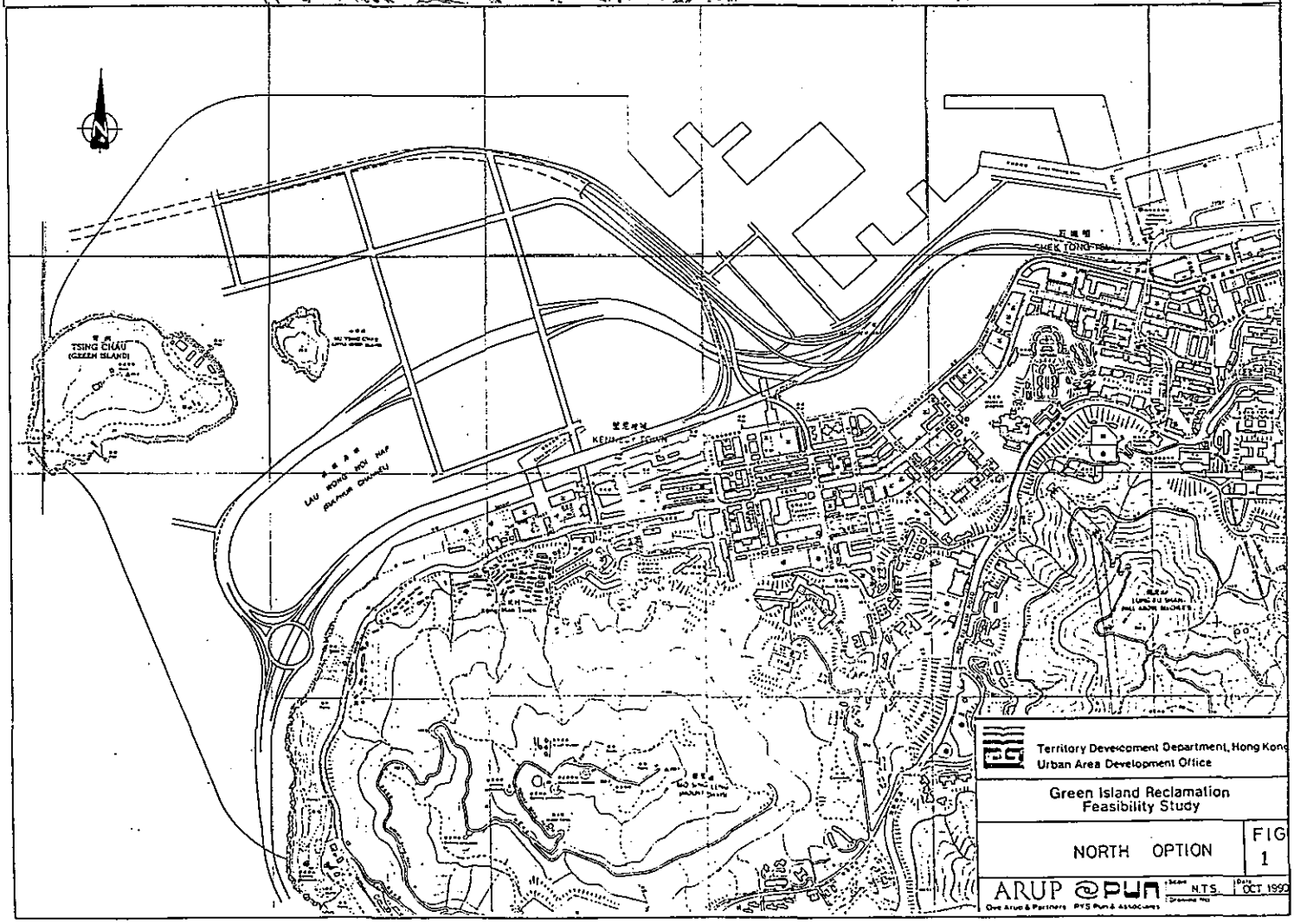
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2.0 EXISTING SITUATION

2.1 Source of Pollution - Industrial

2.1.1 Several sources of industrial air pollution in the Study area were identified in TP21; the Kennedy Town Incinerator, the Kennedy Town Abattoir and Green Island Cement.

2.1.2 Serious environmental problems were caused in the Study Area by the Incinerator and the Abattoir emissions which suffer from poor dispersion conditions due to the heights of these emissions relative to those of the surrounding buildings, and also due to the topographical conditions in the area.

2.1.3 The problems with Green Island Cement were related mainly to fugitive emissions, spillage of material and its tracking out onto the road system on the wheels of vehicles. Reentrainment of the dust into the atmosphere by the wind or moving vehicles may give rise to nuisance.

2.2 Vehicle Pollution

2.2.1 Exhaust emissions from motor vehicles are the sources of a range of pollutants. The most important of which are carbon monoxide (CO), hydrocarbons (HC), oxides of nitrogen (NO_x), particulates and lead.

2.2.2 TP22 outlined the methodology for estimating the vehicle exhaust emission rates based on US EPA emission factors, and discussed the dispersion models for predicting the air quality impact from the emissions. An assessment was made of the concentrations for the existing road network in the Study Area, using the peak hour traffic flows together with link travel times, and the vehicle mix for the 1986 Base Year.

2.2.3 In peak traffic hours, the centre of Kennedy Town suffers from traffic congestion, with slow moving traffic. Although the traffic flows are not high, the pollution emission rates can be relatively high due to the low speeds. The predicted concentrations of pollutants were generally well within the AQO standards. For NO_x however, the levels approached AQO standard for NO_2 at some locations. In TP22 the results were treated as total NO_x rather than NO_2 portion.

2.2.4 The results indicate the typical picture for an urban environment with congested traffic and a high proportion of heavy diesel vehicles.

3.0 RECLAMATION AND DEVELOPMENT

3.1 Dust

3.1.1 Dust generation, liberation and dispersion is the major potential source of air quality impact during the reclamation and development of the study area.

Reclamation

3.1.2 TP5 Reclamation Methods and Phasing identified the approaches that were feasible and identified the sources of fill that could be used to reclaim the area under consideration. The preferred recommendations of that report are summarised below as:-

(a) Complete removal of marine clay.
(b) Marine sources for fill.
(c) Use of trailing suction hopper dredger.

3.1.3 There also exists the possibility for the use of PFA and construction waste as fill material. The use of these materials does pose some environmental problems as well as engineering constraints, these are discussed below.

3.1.4 TP5 also presented a reclamation phasing programme. This programme will have some bearing on the possible incidence of dust nuisance as the reclamation proceeds.

3.1.5 The reclamation methodology proposed is the same for both Option North and Option South. It will proceed in three phases with the construction of sea walls followed by infilling with marine sourced fill. As yet it has not been determined whether it will be necessary to completely remove the marine clay which exists on the sea floor in the area to be reclaimed. The removal or otherwise of this material will have little implication in dust emission terms provided that it is disposed of at sea and is not allowed to dry out during transport to the dumping ground.

3.1.6 The use of marine fill as the primary fill material will significantly reduce the amount of dust that could be generated by this operation. The use of trailing suction hopper dredger will further reduce the likelihood of dust generation. Depending on the location of material to be used for the sea wall construction, dust could be generated during winning, transport and placement of the sea wall. It is unlikely that there would be much dust associated with this operation in the vicinity of the reclamation itself however.

3.1.7 When the depth of water over the deposited fill is insufficient for dredger access, fill will be pumped to its destination. This would also be the method of approach to obtain the desired height and landform above the sea level. The level of the reclamation will be 4.5 to 5m above sea level and will initially be higher to allow for settlement. Once filling has progressed above the water level, the fill would be pumped to discrete points on the reclamation where it would be distributed, placed and compacted with conventional earth moving plant.

3.1.8 Final filling to grade would be with approximately a metre thickness of fill from land borrow areas. It is at this stage the problems associated with wind blown material may occur. It should be noted, however, that these problems will be less at this stage than during works on associated with development of the reclamation.

3.1.9 It is possible that PFA may be used as fill material. When dry, PFA is a very dusty material, with a potential to cause severe dust nuisance. If PFA is to be used, it should be brought to site at a conditioned moisture of at least 20%. It should not be handled in a dry condition. Pumping as a slurry would be the preferred handling technique if the material were to be used. PFA will also dry out very quickly and, when dry, will blow away easily in light winds. The potential for dust nuisance with PFA is significant, particularly if used above the water level where it is likely to dry out.

3.1.10 The use of construction debris as a fill material presents a more difficult dust control problem. The availability of construction waste as fill is not thought to present a constraint. With regard to dust emissions, however, significant problems would be posed by the use of construction waste as fill material. The area to be filled would need to be kept open for a significant period of time and would require road access. The potential of this source for giving rise to dust is significant and depending on land use could give rise to nuisance complaints/problems.

3.1.11 The nuisance potential of any dust produced during the reclamation phases will be reduced by the distance of the reclamation work from centres of commercial or residential activity. Thus Phase 1 and 1a reclamation work may have the greatest potential for adverse impact although Phase 3 infilling may affect reprovisioned land uses. Phases 2a and 2b have less potential for impact due to the relatively sparse land use in the vicinity of Victoria Road and the remote nature of Phase 2b well away from existing Kennedy Town Developments. Dust from these sources will only become a potential problem once the surface has risen above the water level and has the opportunity to dry out. Dust from large open areas subject to wind erosion is difficult to control, particularly if the area is traversed by vehicles engaged in land forming.

3.1.12 Detailed construction programme and management plans should be prepared, and dust control measures should be incorporated. For day-to-day control of particularly dusty areas it will be necessary to employ water as a suppressant applied as necessary by sprinkler vehicles or pipelines. The imposition of controls on vehicle movements and speed are effective in reducing the generation of dust emissions, but can be difficult to enforce. Windbreaks and enclosures may also be effective in reducing emissions, but are often impractical due to the size of the fugitive dust sources. Coating of undistributed areas with sealant may need to be considered. The dust control measures required should be assessed as part of the development programme; however, the need for their use can be assessed on a day-to-day basis depending on local circumstances.

Development/Construction

3.1.13 The detailed development programme cannot be determined until the investment patterns for the area have been established and these may change as the economic climate fluctuates. It is possible to predict, however, that the development stages of the project may cause significant problems associated with dust liberation and subsequent deposition and interference with sensitive neighbours. The extensive strategic road network will, during their construction, provide significant dust sources both locally - for example at cement batching plant positions - and throughout the area as the preliminary routes installed are used as access roads for further development. The dust potential of the development stage will be considerable. It will be necessary to have a construction planning overview and management to ensure that the optimum development plan is operated. In this way benefits in reducing the environmental impact of dust (and noise) emissions can be realised.

3.1.14 The area of land to be developed is the same in both options and the difference between the options in terms of fugitive dust emissions during the developmental stage will be small, probably only discernible at a local level. The importance of good overall management planning is thus realised at the local level in terms of reducing the potential impact by good housekeeping, management control and locational controls. The costs and benefits of locating a cement batching station closer to occupied buildings thereby reducing the overall transport distances will need to be balanced. The need for an overview is thus apparent whilst maintaining a degree of flexibility and the ability to treat each potential dust source on its own merits.

3.1.15 A development of the scale proposed for Green Island will not be possible without some degree of adverse environmental impact. Recognition of this fact and the need for control will allow control measures to be implemented early.

3.1.16 The main source of dust generation is likely to be vehicle movements on unpaved roads. These emissions can be minimised by careful programming and by the imposition of measures to suppress dust generation and dispersion (as discussed in Section 3.1.11).

3.1.17 Dust emissions, and hence the degree of impact, are determined by the degree of effort placed on dust control. Commitment should be made by the contractors involved to the control of dust emissions. The Regulations laid down in Appendix A of the Air Pollution Control Ordinance (Dust Suppression Measures for Construction Sites) set out the practices for dust control to be observed by the contractors. Contractors should be required to describe their proposed dust control measures in detail, in particular:

(a) Methods of working to minimise dust generation or impact.

(b) Intentions in respect to maintaining surfaces/materials in a damp condition to prevent dust generation.

(c) Provisions and use of watersprays, bowsers, mobile sweeping plant, wheel and body washing for vehicles before leaving site.

(d) Control of vehicles, e.g. restriction of speed, sheeting of load.

(e) Dust controls on specific operations, e.g. filters on cement storage/batching plants, etc.

(f) Consideration of control measures for minimising dust generation e.g. reduction of surface wind speed by wind breaks, etc.

3.2 Vehicle Exhaust Emissions

Reclamation

3.2.1 Although the reclamation procedure is likely to generate additional road traffic movements the preferred reclamation procedure is to utilise marine fill and utilise trailing suction hopper dredgers which will minimise road vehicle use at this stage. The use of marine fill and hopper dredgers is the preferred option on the grounds of noise generation and dust generation.

3.2.2 During reclamation however, the atmospheric dispersion potential for vehicle emitted pollutants will be high due to the open nature of the reclamation and meteorological conditions. During reclamation, vehicle emitted pollutants are not considered likely to result in high atmospheric concentrations of these exhaust pollutants.

Development/Construction

3.2.3 The number of vehicle movements associated with the construction work that will be carried out as the reclamation proceeds cannot yet be determined. As previously, the impact of vehicle emissions is likely to be low because of the following factors:

- In early stages natural dispersion will be good.

- Phased construction should prevent sensitive areas being occupied prior to completion of surrounding construction work.

- In later stages dispersion will be good because planning strategies to promote natural dilution have been incorporated into the reclamation design.

3.3 Recommendations

3.3.1 To reduce the undesirable impact of dust during the Reclamation and Development Construction phases, it will be necessary to control its liberation and prevent its dispersion.

3.3.2 Strict guidelines should be adopted to minimise dust production and dispersion in accordance with the regulations laid down in Appendix A of the Air Pollution Control Ordinance (Dust Suppression Measures for Construction Sites). Commitment should be made by the Contractors involved in reclamation and development construction to control dust emissions. The Contractors should be required to prepare programmes for dust control measures to give acceptance dust emissions. These should include measures such as described in Section 3.1. The overall guidance concerning air quality and planning embodied within the Hong Kong Planning Standards and Guidelines should be considered when detailed planning can be undertaken.

3.3.3 In terms of overall dust generation, the difference between the two options is slight. Small differences may occur at the local level during construction due to different possible siting of stockpiles of material, material handling and vehicle movements etc. Such effects will be common to both option but will differ depending on programming and siting.

4.0 OCCUPANCY

4.1 Design Recommendations

4.1.1 In planning, the concepts of pollution control extend not only to the limitation and control of emissions of officially recognised pollutants, but also to the achievement of conditions in which the impact of pollutants generated should remain below the limit of perception.

4.1.2 The key air quality features in the planning of new urban environment are to design to:-

(a) avoid the generation of undesired pollutants in areas of poor ventilation; and

(b) to enhance the natural ventilation and aid dispersion.

4.1.3 Recommendations were made in TP22 in relation to climate and microclimate features which can affect dispersion of pollutants and therefore the resultant air quality. Recommendations were given on the provision of ventilation corridors and other features to enhance natural ventilation. These included alignment of open spaces/ventilation corridors to exploit the various wind effects: the synoptic winds, the sea breeze effects and the daytime/night-time drainage flows.

4.1.4 The study objectives on Environmental Quality included the consideration of and minimisation of air pollution impacts. Recommendations were given in Chapter 3 of the HKPS and G 'Air Quality' on siting and the need for buffer zones to provide adequate separation of sensitive areas from potential pollution sources such as from industry or from heavy traffic volumes. These, together with supplementary recommendations made in TP22 have provided a basis for planning and land use zoning.

4.1.5 These recommendations were included in the environmental design parameters and have been considered in the development of the RODP. (TP12, 13). The main issues are discussed in more detail in the following sections.

4.2 Industry Related Emissions

4.2.1 Adverse impact on the local environment and population may arise from emissions to atmosphere from industrial operations causing nuisance through odour, dust or by the risk of health effects.

4.2.2 Short or long term health implications of industrial emissions to atmosphere are largely controlled by requirements for pollution control equipment to bring pollutant concentrations to levels compatible with national and international guidelines and standards for emissions and air quality.

4.2.3 Nuisance emissions are largely considered by imposing buffer zones around the offending industry. Where the capacity for such zones is limited, the installation of more stringent pollution control measures may be necessary. With established industries (particulary with older ones) it is often difficult to fit modern pollution control equipment retrospectively, partly due to technical and space limitations and partly due to economic restraints.

4.2.4 Existing industries causing considerable environmental problems in the Kennedy Town Area were identified in TP22, namely the abattoir and the incinerator. The incinerator in Kennedy Town will be closed and will not be relocated in the Study Area. This closure will not only provide a vacant site for development but will also bring a substantial improvement in air quality to the surrounding area.

4.2.5 The abattoir and its related facilities in Kennedy Town will also be closed. The by-products plant and cremation facilities will not be sited in the Study Area but relocated elsewhere. The removal of these operations will provide a major improvement. The relocated abattoir will require a buffer zone, but less than if the other facilities were relocated with it.

4.2.6 In both the RODP and Option South the relocated abattoir is sited on a peninsula in the Port Area with buffer zones on both sides, PCWA to the South and China Merchants Wharf to the North. The location should provide good ventilation and ensure a buffer zone from sensitive uses. A distance of 200m has been allowed between the abattoir and the nearest sensitive developments, the residential areas to the West and South. These proposals will provide substantial air quality benefits in the Kennedy Town Area, while the relocation in the Port Area should not result in adverse impact on the neighbouring residential areas.

4.2.7 The proposed Sewage Treatment works and the Refuse Transfer Station are not included in the Green Island Reclamation Area. The current proposals are to locate these within caverns with access from Victoria Road and/or Sai Ning Street.

4.2.8 Both the Sewage Treatment Works and the Refuse Transfer Station have the potential for adverse atmospheric impact from odorous gaseous emissions. The enclosure of these plants within cavern facilities will provide the opportunity to collect the fumes and allow either treatment or dilution before discharge to atmosphere. The adverse impact on the local environment can therefore be minimised though again it should be noted that odour emissions from vehicles arriving at and departing from the Refuse Transfer Station may be significant. The buffer zone required will depend on design of the plant and the treatment facilities provided to control and odour emissions. The distance should be determined when detailed information on the proposed plants and their location are available. However, there is considered to be no difference between the RODP and Option South.

4.2.9 In both options, land use allocated to industrial development is limited to the area of the Port, together with the China Merchants operations and PCWA operations. This separation of the potential pollution producing industries/operations from sensitive uses should minimise potential environmental impacts.

4.3 Vehicle Related Pollution

4.3.1 Prediction of the air quality impact of vehicle emissions is based on several factors - traffic flow characteristics (traffic volume, vehicle type mix and emission rates of the pollutants) and the dispersion characteristics (wind speed, the constraints to dispersion caused by building/street canyon effects, turbulence due to vehicle movement, etc). These factors have been discussed in Technical Paper 22 which describes the Caline 4 Air Quality prediction method. This model has been used to examine the effects of traffic pollution on air quality for the RODP.

4.3.2 The major parameters for development of the road system were set out in TP12. The Guidelines given in the HKPS and G for the reduction of air pollution from road vehicles were supplemented by further recommendations on the provision of ventilation corridors and other features to enhance natural ventilation (TP22). These factors have been considered in the overall design of the reclamation and where possible dispersion patterns have been promoted by the adoption of the breezeway concept and the avoidance of canyon developments.

4.3.3 Traffic information used for the predictions was based on the forecast AM and PM Peak Hour Traffic Flows for the RODP in the Design year 2011 (Figure 5.3 in TP16).

4.3.4 The emission factors of CO, NO_x and HC for the traffic mix were derived from the US EPA 'Compilation of Air Pollution Factors' AP-42 document, taking into account the local fleet mix. This methodology was discussed in TP22. Emission factors were derived for the design speeds of the various roads. The emission factor for lead (Pb) was based on that determined by the Netherlands Ministry of Health and Environmental Protection and verified using the UK Department of Transport Assessment methods.

4.3.5 A wind speed of 3m/s was used in conjunction with a range of Pasquill Stability categories and wind directions to establish the worst case peak hour traffic generated pollutant concentrations. The predicted levels of pollutants have been assessed in relation to the air quality standards of the HK Air Pollution Control Ordinance (Table 4.1).

Table 4.1

AIR QUALITY STANDARDS

(HK AIR POLLUTION CONTROL ORDINANCE)

Pollutant	Concentration in Micrograms per Cubic Metre (i) Averaging Time				
	1 Hour (ii)	8 Hours (iii)	24 Hours (iii)	3 Months (iv)	1 Year (iv)
Total Suspended Particulates			260		80
Respirable (V) Suspended			180		55
Carbon Monoxide	30,000	10,000			
Lead				1.5	
Nitrogen Dioxide		300	150		80

(i) Measured at 298°K (25°C) and 101.325 kPa (one atmosphere).

(ii) Not to be exceeded more than three times per year.

(iii) Not to be exceeded more than once per year.

(iv) Arithmetic means.

(v) Respirable suspended particulates means suspended particles in air with a nominal aerodynamic diameter of 10 micrometres and smaller.

4.3.6 Predictions have been made for the RODP, Option North only. Traffic flow forecasts have not been provided for Option South and detailed calculations of air quality impact are not possible. Road cases were selected to cover the range of road types looking primarily at the areas expected to result in the heaviest pollution potential. An assessment has been included of the cut and cover underpass as the main distributor road to give a indication of potential air quality around the portals. This has been based on assumptions regarding the design of the portal, the slip roads and the tunnel section and the results should be regarded as indicative only. A detailed study should be carried out at the design stage.

Carbon Monoxide

4.3.7 The predicted levels of carbon monoxide remain safely below the 1 hour air quality standard of 30,000$\mu g/m_2$ as can be seen from Table 1 in Appendix 1.

Oxides of Nitrogen

4.3.8 Predictions were initially made of the NO_x concentrations resulting from the vehicle emissions of NO_x. Subsequently, estimates were made of the likely concentrations of NO_2 a component of NO_x in order to allow direct comparison with the Air Quality Objective of $300\mu g/m^2$ of NO_2. The UK Transport and Road Research Laboratory (TRRL) assume an approximate NO_2 content of 20% in NO_x. The Caline 4 model can also be used to predict the conversion of NO to NO_2 based on various factors including the background concentrations and the reaction kinetics. This has been used as a further check on the likely NO_2 concentrations.

4.3.9 From the results in Table 2 in Appendix 1, it can be seen that the levels of NO_x are predicted to be high. The estimates of NO_2 concentrations indicate that the 1 hour standard is likely to be exceeded in three areas - the Green Island link approach roads, the Distributor underpass portals and Route 7 along Belcher Bay where the distributor road runs directly beneath. If a background NO_2 concentration of 50-60$\mu g/m^3$ is assumed for these areas, the total NO_2 is very likely to exceed the standard.

4.3.10 These concentrations will decrease with distance from the road, rapidly dropping to within the AQO concentration. The predicted dispersions indicate that AQO should not be exceeded beyond 25m from the roadside. The sliproads alongside the underpass approaches will provide buffer separation.

4.3.11 Some measures can be adopted to mitigate this impact:

i) improve natural or forced ventilation to maintain good dispersion.

ii) avoid excessive high speed which would result in high emission rates

iii) provide suitable separation distances between roadway and receptors particularly those for sensitive uses

iv) reduce traffic flows - fewer vehicles, less pollution

v) impose controls on vehicle exhausts e.g. catalytic converters with unleaded petrol

Points i) and iii) are the main measures which can generally be considered. Measures iv) and particularly v) are generally considered to be the long term solutions to pollution in cities. Measure v) is a policy decision which is now being implemented and should eventually realise reductions in the levels estimated in this paper.

Lead

4.3.11 Estimates of long-term average lead concentrations have been made for the locations giving most concern relating to vehicular pollution. From Table 3 in Appendix 1 it can be seen that the predicted concentrations are relatively low, with the maximum prediction being $0.69\mu g/m^2$.

4.4 Tunnel Ventilation

4.4.1 The enclosed nature of tunnels prevents the natural dispersion of pollutants emitted by the vehicles travelling through the tunnel. Ventilation systems within the tunnels are designed to maintain pollutant concentrations within the guidelines set down by EPD. The discharge to the atmosphere of this ventilation air can cause concern relating to adverse environmental impact.

4.4.2 Recommendations were given in early technical papers (TP12, WP2 - Options Report) regarding the need for careful consideration in the siting of tunnel ventilation outlets. These should not be located within areas of sensitive land use; buffer Zones should be provided e.g. near to schools, residential areas and hospitals. Advice was also given in the reports on the potential to maximise dispersion by careful siting.

4.4.3 The tunnel ventilation stack has been located on the north west perimeter of the reclamation, north of Green Island. (See Fig 2) The stack is on the edge of a high-rise residential area, with buildings proposed to be of a height up to 90m. A local road routed approximately east-west across the reclamation in line with the ventilation stack, provides a ventilation corridor, which will aid dispersion.

4.4.4 With the tunnel vent stack at this proposed location, the impact of the exhaust emissions on the reclamation area will be limited. For most of the year, the prevailing winds will blow the plume away from land - for 70% of the year winds are from the East. It is with winds from the quadrant West to North that there is likely to be a potential impact on the reclamation. From the long-term wind roses these winds could occur for approximately 10-15% of the year, with the westerly winds occurring primarily in the summer months. This location will minimise the potential effects on the reclamation.

4.4.5 At this stage in the development, there is insufficient information available to prepare accurate predictions of pollution due to the ventilation emissions. However, an assessment has been made, based on certain assumptions, in order to provide an indication of the likely pollution concentrations. A more detailed study should be carried out when a detailed design of the ventilation and exhaust stack is available.

Design issues which should be considered include:

- height of release
- velocity and orientation of release
- ventilation engineering in the tunnel itself
- landscape and visual appearance of the shaft

4.4.6 The calculations have been based on emissions from a 20m high stack, using a Gaussian plume model for an elevated point source. The pollutant emissions rates and ventilation flow are based on the predicted peak hour traffic flow and mix for the Design Year 2011.

4.4.7 For worst case conditions of dispersion, the maximum ground level pollutant concentrations on an hourly basis would be approximately:-

CO 500 $\mu g/m^3$

NO_x 500 $\mu g/m^3$

Lead 0.5 $\mu g/m^3$

These would be experienced at about 300m from the stack. The CO and lead levels would not be expected to cause air pollution concern. On a long-term average basis the lead concentration would be well within the AQO. The NO_x emission could result in contribution of approximately $100\mu g/m_3$ NO_2 to the ambient levels. The predicted levels of NO_2 from the local roads in the surrounding area are generally low, less than $100\mu g/m^3$. This analysis indicates that the total NO^2 concentrations in this area, taking into account the local roads and the tunnel vent emissions should not exceed the AQO.

4.4.8 This analysis, does indicate that the ventilation stack should not give rise to unacceptable levels of pollution in the surrounding area. However, the tunnel exhaust emission should be assessed fully in the final detail design to ensure that sensitive use sites do not suffer adverse impact.

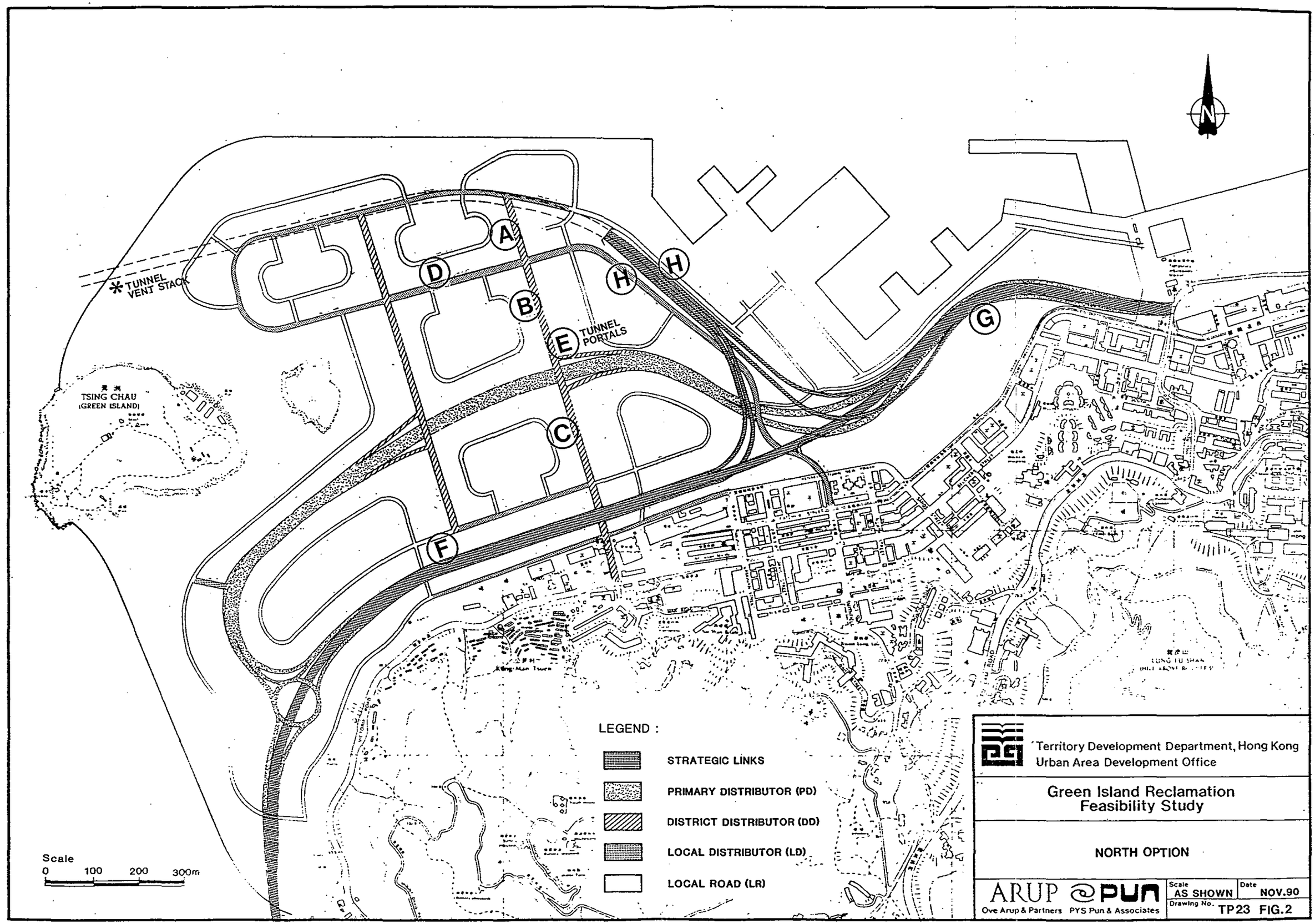
4.5 Option South

4.5.1 As traffic forecasts were not provided for Option South it is not possible to give detailed comments on this road network impact. However, in general terms the main conclusions from the RODP assessment would apply to the Option South.

4.5.2 In general, the traffic flows on the road network should not give rise to unacceptable pollution levels. The main areas where vehicular pollution would give rise to concern are the approach roads to the Green Island Link tunnel portal and Route 7 along Belcher Bay.

4.5.3 The south link option will involve an interchange between the Green Island link approaches and Route 7. The combined effect of these road traffic flows may result in significant pollutant emissions which may adversely affect areas of Kennedy Town and the adjoining reclamation.

4.5.4 The location of the Green Island Link stack would require careful consideration. It is likely that winds from the south through to north may result in an impact on the reclamation development, i.e. more frequently than at the northern option location.



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Green Island Reclamation Feasibility Study

NORTH OPTION

ARUP @ PUN
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Scale AS SHOWN | Date NOV.90

Drawing No. TP23 FIG.2

5.0 CONCLUSIONS

5.1 The study brief requires that Green Island be zoned largely for housing. There is also a requirement for two major strategic links to be included within the reclamation in addition to the Primary Distributor links required for the reclamation itself.

5.2 Attention has been given throughout the development of the RODP to guidelines for minimising the impact of pollution (from vehicular and industrial sources) on the local air quality. However acceptable levels of vehicular pollution may not be possible at all locations given the planning brief for the two strategic links.

5.3 Estimates of the likely levels of pollution from traffic flows indicate that some areas close to strategic links may be adversely affected by vehicle pollution. Precise determination of the effects of traffic pollution cannot be made at this stage as detailed design of certain areas such as the Green Island Link approaches, the distributor underpass and the Green Island Link vent stack are not available.

5.4 Some measures are likely to be required and it is recommended that sensitive land uses should not be located in close proximity to areas where air pollutant concentrations approach or exceed guide-line values. (e.g. Sports hall etc). Non sensitive buildings should be used where possible to screen sensitive areas. Where residential accommodation is zoned in areas adjacent to the major strategic links adequate separation distances should be allowed. Good internal planning of sensitive areas within the developments or the use of well sealed glazing and air conditioning in the lower floors would need to be considered.

5.5 The principle of ventilation corridors should be preserved in the development of the RODP to maximise natural ventilation. Street canyon type development should be avoided.

5.6 With underpasses, consideration should be given at the design stage to maximising the ventilation effects produced by the traffic flow: e.g. septum walls in the tunnel; splitter walls at the portal to separate the traffic flows; and design of the portals and approaches so that the induced ventilation and natural ventilation are not inhibited. The need for buffer separation to sensitive users should be clarified by detailed assessment at the design stage.

The function of the splitter walls is to minimise the recirculation of air from the outflowing tunnel portal to the inflowing portal.

The recirculation flow system is complex depending on the exposure of the portals, their physical separation, the tunnel ventilation system and the inlet and outlet velocities achieved at the portals. Recirculation is also affected by the type of traffic flow in terms of the different turbulence regimes given by cars and HGVs.

5.0 CONCLUSIONS

5.1 The study brief requires that Green Island be zoned largely for housing. There is also a requirement for two major strategic links to be included within the reclamation in addition to the Primary Distributor links required for the reclamation itself.

5.2 Attention has been given throughout the development of the RODP to guidelines for minimising the impact of pollution (from vehicular and industrial sources) on the local air quality. However acceptable levels of vehicular pollution may not be possible at all locations given the planning brief for the two strategic links.

5.3 Estimates of the likely levels of pollution from traffic flows indicate that some areas close to strategic links may be adversely affected by vehicle pollution. Precise determination of the effects of traffic pollution cannot be made at this stage as detailed design of certain areas such as the Green Island Link approaches, the distributor underpass and the Green Island Link vent stack are not available.

5.4 Some measures are likely to be required and it is recommended that sensitive land uses should not be located in close proximity to areas where air pollutant concentrations approach or exceed guide-line values. (e.g. Sports hall etc). Non sensitive buildings should be used where possible to screen sensitive areas. Where residential accommodation is zoned in areas adjacent to the major strategic links adequate separation distances should be allowed. Good internal planning of sensitive areas within the developments or the use of well sealed glazing and air conditioning in the lower floors would need to be considered.

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The function of the septum wall would be similar to that of the splitter wall. Air flows from counter moving traffic streams are not continuous but are broken up by the passage of the trailing vortices spread out laterally. The presence of a low height septum wall between carriageways would minimise interaction due to low level turbulence in the external roadways.

5.7 In the ventilation of the Green Island Link, the design of the surface outlet stack will require special design consideration. With the North Link option, the emergence close to the industrial and port areas, together with the local feeder roads in this are, provides a useful buffer between the industrial and the residential areas.

5.8 The road networks should be designed to encourage smooth traffic flows and reduce congestion. Congested traffic with very low traffic speeds will result in adverse impact in terms of vehicle exhaust emissions.

5.9 Detailed air pollution assessments should be made for the Green Island Link ventilation and portal emissions when more detailed information is available on the designs.

Appendix 1

Table 1

Maximum Predicted 1 Hour CO Concentrations ($\mu g/m^3$)

Location	Roadside Concentration
A	900
B	1,600
C	2,100
D	660
E	2,000
F	350
G	2,000
H	1,700

For Location see Figure 2.

Table 2

Maximum Predicted 1 Hour NO_x and NO_2 Concentrations ($\mu g/m^3$)

Location	Roadside	NO_2 Caline	TRRL
A	400	70	80
B	420	100	84
C	660	160	132
D	250	40	62
E	1,600	NA	320
F	350	20	70
G	1,300	150	260
H	1,660	140	332

NA - Not available.

For Location see Figure 2.

Table 3

Maximum Estimated 24 Hour Average Lead Concentrations

Location	Lead Concentration ($\mu g/m^3$)
C	0.43
G	0.60
H	0.69

For Location see Figure 2.

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