MUNICIPAL ENGINEERING FOUNDATION
2007 STUDY TOUR

Planning for: the Redevelopment of Former Landfill Sites and the Establishment of Alternative Waste Facilities

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1.0 - Introduction

One of the key challenges for municipalities throughout the world is managing the collection and disposal of household waste. There is a growing expectation that local governments will provide environmentally sustainable waste systems that achieve high levels of recycling and ensure the safe disposal of residual waste.

Many municipalities in metropolitan Melbourne have introduced multi bin collection systems to encourage householders to separate recyclables and green waste from the residual waste stream. Regional resource recovery centers separate plastics, paper, steel, aluminum and glass from domestic recycling bins. Composting facilities have been established to process green waste, residual waste is land filled at a number of former quarry sites.

Some of Melbourne's municipal authorities are currently achieving waste diversion rates in excess of 50%. The Victorian State Government has adopted a diversion target of 65% by 2014; it is very unlikely that the current waste systems can be refined to achieve this target. Alternative waste processing facilities will need to be progressively introduced to achieve higher waste diversion rates.

If Melbourne is to achieve its waste diversion goals by establishing alternate waste processing facilities there will need to be close cooperation between State and Local Government Authorities. The process will involve the adoption of strategic plans, and the identification of potential sites for the construction of facilities to serve large sections of the metropolitan area.

For many years the Melbourne community has enjoyed a plentiful supply of landfills and by world standards, very cheap disposal costs. Traditionally landfills have been redeveloped as major recreational reserves. In Melbourne, environmental regulators require modern landfills to be capped and domed, rendering the sites useless for most types of active sports. In the future enhanced environmental standards may preclude the filling of some former quarry sites.

In recognition of the need to ensure that an effective planning framework is in place for the management of alternative waste treatment facilities, closed landfills and former extractive industry sites, the Victorian Municipal Engineering Foundation, as part of its 2007 program has funded a study tour to allow me to attend the 2007 ISWA conference and review the manner authorities in Europe, the United Kingdom and Hong Kong have addressed similar challenges. The following report addresses the objectives of the study tour.

2.0 - Acknowledgements

It would not have been possible to conduct this tour without the goodwill and support of a number of parties. In particular, I would like to thank the Victorian Municipal Engineering Foundation for its visionary programs aimed at developing the Local Government Engineering sector and for providing a financial contribution towards the costs of the study tour. I would also like to acknowledge the support provided by the Councillors, CEO and staff at the City of Kingston for encouraging me to participate in the program and managing my day to day responsibilities during my absence.

It would not have been possible to conduct this study tour without the generous support of a number of organisations and individuals who went out of their way to make themselves available and coordinate site visits. In particular I would like to thank, Phillip Lee, Environmental Protection Department, Hong Kong; Rene Beijnen, Province of North Brabant, Holland; Angiolina Hargreaves, Forestry Commission, UK; John Dinsdale, Oldham Metropolitan Borough Council, UK; the staff at the City of Glasgow, Scotland; Tom Cowan, City of Belfast, Northern Ireland; and Ken Hobden Quarry Products Association London.

Landfill restored to soccer ground, Oldham, UK

3.0 - Objectives

The principal purpose of this report is to outline the findings of a study tour conducted to gain a better understanding of the processes that have been adopted in Europe, the United Kingdom and Hong Kong to guide the redevelopment of former landfill sites and plan for the establishment of alternative waste facilities. The following sections of the report will explore in more depth the following specific objectives:

Objective 1 - Strategic Planning

To gain an understanding of the challenges associated with preparing strategic plans for the siting and development of alternative waste facilities.

Objective 2 - Alternative Uses

To gain an understanding of alternative after uses that have been established on former landfill sites.

Objective 3 - Environmental Challenges

To gain an understanding of the environmental challenges associated with the redevelopment of former landfill sites.

Objective 4 - Forestry and Agriculture

To gain an understanding of issues associated with the utilisation of former landfills for forestry and agriculture.

Objective 5 - Restoring Extractive Industry Sites

To gain an understanding of innovative practices adopted for the restoration of former extractive Industry sites.

4.0 Waste Management in Europe and the United Kingdom

Over the last years the cliché "cradle to grave" has been commonly used to express the notion that it is desirable to gain the full potential from our natural resources. However the concept of "cradle to grave" is based on the premise that a resource has a finite life and that one day it will require disposal. The Dutch are now basing their environmental sustainability policies on the concept of "cradle to cradle" on the basis that any given resource should not have a finite life and that products should be designed in such a manner so that, when a product reaches the end of its useful life, each of the components that make up that product can be salvaged and reused in the production of alternative products.

4.1 - The Management of Waste in the European Union (EU)

Whilst the EU has adopted legislation that discourage its member states from landfilling waste, the actual performance standards achieved varies significantly within the Union. The EU directives for the disposal of waste to landfills are considered by some of its member states as a minimum standard, other countries such as Holland and Germany have adopted significantly more stringent standards. EU targets for the amount of municipal waste to landfill are based on a reduction of the volume of waste generated in 1995, the targets are; a 25% reduction by 2010, a 50% reduction by 2013 and 65% reduction by 2020. Data produced by Ffact Management Consultants (2007) indicates that in 2004 the overall average volume of waste disposed to landfill within the EU was approximately 48% of the waste stream, a figure comparable to the results achieved by leading Local Government Authorities in metropolitan Melbourne. Whilst Holland's 22 landfills still have significant landfill capacity there is a moratorium on the establishment of new landfill sites. In 2004 only 3% of waste produced in Holland was disposed to landfill, 63% of waste was recycled and 34% incinerated. Waste disposal costs in the Netherlands are approximately A$200 per tonne.

In Germany landfilling has been totally banned. At the other end of the scale Poland, Latvia and Greece landfill more than 95% of all waste generated. Many European countries are investing in incineration capacity in order to recover the energy contained in waste products as an alternative to landfilling.

In Holland all three tiers of government: National, Provincial and Local, play a role in waste management. Local Authorities are responsible for the collection of household waste; the collection of industrial waste is left to the private sector. Unlike Australia, the Dutch National Government is actively involved in the planning of waste on behalf of its 16 million people. A new 9-year waste management plan is prepared every 6 years. The current National Plan was adopted in 2003 and preparation of the 2009 plan has already commenced. The Plan is binding on Holland's 12 provinces and 458 municipalities and has been a key driver in managing the 60 million tonnes of waste generated each year. The Plan focuses on increasing resource recovery rates and a reduction in the volume of material that is disposed to landfill. The current Plan places sustainability at the start of the production chain and has a strong emphasis on increasing incineration rates for combustible waste as well as recognising the potential for the Dutch to incinerate waste from neighbouring countries.

Provinces in Holland are responsible for preparing regional waste management plans and the licensing of waste facilities. The Province of North Brabant services a population of approximately 2.2 million people who live in 70 municipalities. The Province of North Brabant has played a key role in the management of landfills in the region. The preferred method of waste disposal in Holland is the thermal treatment of waste for energy recovery, as thermal treatment plants require a huge capital investment and treat significant volumes of waste the Province of North Brabant has joined with two other provinces to establish a regional incinerator that processes 600,000 tonnes of domestic waste per annum. To put this figure in perspective, the total volume of residual domestic waste disposed to landfill by the 30 municipalities in metropolitan Melbourne in 2005/06 was 716,000 tonnes.

Ffact Management Consultants (2007) suggests that whilst the private sector is continuing to play a key role in the provision of waste services in Europe, there appears to be a reduction in the number of players as larger companies are expanding their product share through acquisitions and by offering a full range of waste services ie collection, treatment, disposal and consultancy services. Recent developments in the waste sector in Australia would suggest a similar trend.

4.2 - The Management of Waste in the United Kingdom (UK)

Approximately 400 million tonnes of waste is produced in England and Wales each year with landfilling being the traditional form of waste disposal. Like Australia, landfills have generally been sited on former extractive industry sites. Historically Local Waste Disposal Authorities have operated sites for municipal waste with industries either managing their own landfills or using private sector operators. The majority of waste management sites in the UK today are managed by the private sector.

The UK government has introduced landfill targets for all local authorities as a measure to achieve EU directives. If a municipality exceeds its allocation it will be required to pay a penalty of £150 per tonne or alternatively purchase capacity from another municipality that has introduced measures to reduce waste, and will not exceed its allocated target. Another key driver for reform is a proposal to increase landfill taxes from £24 to £48 per tonne by 2010.

The Oldham Metropolitan Borough Council, a municipality in the Greater Manchester area, has a population of 230,000. Oldham's current rate of diversion of domestic waste is approximately 18%, the major challenges in lifting this rate is considered to be the high levels of tenanted multi-unit accommodation and the significant number of ethnic residents. Under the national program the Oldham Metropolitan Borough Council must achieve a waste diversion rate of 40% by 2011; the overall national target is 35%. If diversion rates remain the same the penalty for the city in 2011 will be in the order of £20 million. The city has purchased landfill offsets from other municipalities at a rate of £45 per tonne to meet interim targets. The City is currently implementing a range of initiatives utilising funding provided by the National Government, in an attempt to meet its targets. These initiatives include a dedicated food waste collection service, the material collected is processed by an in vessel composter. The city has considered a combined green waste/food waste collection but it was determined that the combined processing costs would be cost prohibitive.

The Scottish Government has initiated and provides the funding for the development of a National Waste Plan. The plan requires Scotland's 11 regions to prepare waste plans for the next 10 to 15 years; 6 authorities in the Glasgow region have joined to form one of the eleven regions. The Government has initiated discretionary landfill targets; landfill allowances are set to rise from £50 to £150 per tonne if targets are not achieved. In Scotland, the landfill tax is currently £20 per tonne, it is proposed that this will increase to £30 per tonne. In order to comply with EU landfill directives no new landfills will be approved in Scotland post 2011. The key challenge for Scottish municipalities is identifying and gaining approval for alternative facilities to treat waste.

Waste planners believe that the major obstacle associated with introducing alternative waste technologies in Scotland is a concern that many people will recall the highly polluting incinerators that were used to process waste up until the 1970's and will not give serious consideration to high technology energy recovery facilities that involve the thermal treatment of waste. Another key challenge will be the introduction of alternative collection systems in a community where approximately 70% of the population lives in tenements or public housing.

5.0 - Response to Specific Objectives

The following sections of the report will address in more detail each of the specific objectives of the study tour. Each section will include: background information outlining why the objective is relevant to the planning for alternative waste disposal facilities and the redevelopment of former landfill sites; relevant information on how the objective is being addressed in areas visited as part of the study tour; and case studies, where relevant.

Recreation Reserve (former landfill), Amsterdam

5.1 - Objective 1 - Strategic Planning

To gain an understanding of the challenges associated with preparing strategic plans for the siting and development of alternative waste facilities.

5.1.1 Background

The four former Regional Waste Management Groups that were responsible for the planning of waste in metropolitan Melbourne have recently been consolidated into a single Authority. One of the key challenges for the new Authority will be the preparation of a Waste Management Plan for Melbourne. The plan will need to establish a direction for the future of landfilling and the possible introduction of alternative waste facilities.

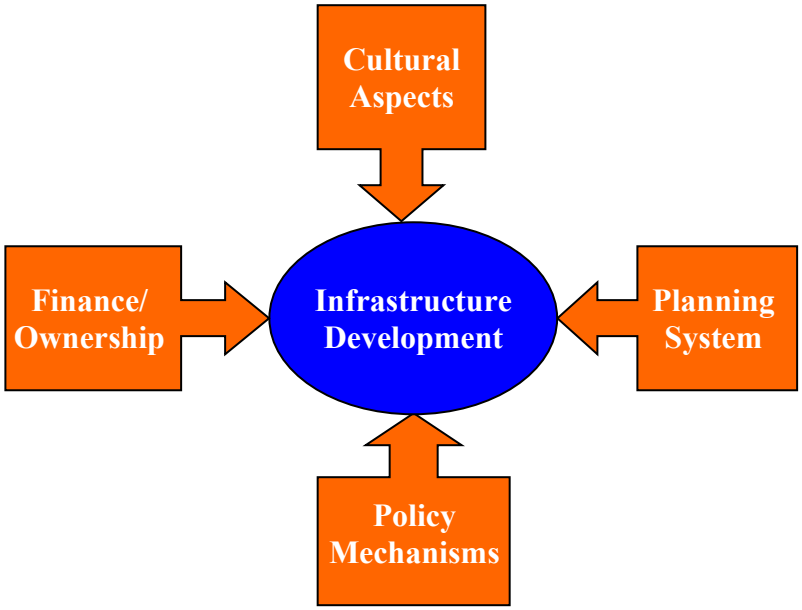
In the past the cost of land filling in Melbourne has been relatively cheap, this is mainly due to an abundant supply. Landfill costs have not in themselves been an incentive to consider the construction of alternative facilities to treat waste. Legislative targets may however drive the progressive introduction of alternative facilities to process waste. Planning systems in Victoria have lagged a long way behind technological developments in the waste industry and will need to be reviewed to recognise alternatives to landfill.

5.1.2 Strategic Planning in Europe and the UK

It is estimated that there are up to 150,000 closed landfills in the EU, many of these sites have the potential to be utilised for office developments, golf courses, parkland, farming and the cultivation of forests (DeWit, Kers amd Ritsema, 2007) . In Europe there is a long tradition of using technology to treat waste as an alternative to landfill. The EU Landfill Directive requires that most wastes should be treated before landfilling and sets targets for the reduction of biodegradable waste sent to landfill using 1995 as the base year, the targets are a 25% reduction by 2010, a 50% reduction by 2013 and a 65% reduction by 2020.

The UK is a long way behind the leading EU states in developing infrastructure to reduce its reliance on landfills. In 2005 a report prepared by SLR Consulting Limited, entitled; "*Delivering Key Waste Management Infrastructure: Lessons Learned from Europe",* recognised that the UK was up to 15 years behind key states such as Germany, Austria, Denmark, Holland and Denmark who have already achieved biodegradable waste diversion targets. The report analysed the various cultural factors, financing initiatives, planning systems and policy mechanisms that have contributed to the achievement of these goals.

The study suggests that cultural factors such as a lack of natural resources like fossil fuels or a high demand for heating in winter are just as important as the legislative controls in convincing a community that incineration is more desirable than landfilling. The report further suggests that any country wishing to change attitudes towards waste disposal should consider the integration of waste and energy policies in order to improve a community's perceptions of waste as a resource.



Criteria for Waste Infrastructure Development
(Source – SLR Consulting Ltd)

The SLR Consulting report concludes that common themes exist in countries where alternative waste technologies have been successfully implemented, these themes are:

- **A Regime of Certainty:**
  - A clear forward plan for future waste capacity needs.
  - A ban on landfilling.
  - Strict regulation and leadership at a national level for the operation of waste treatment facilities.
  - Security of waste supply.

- **A Partnership between the tiers of Government:**
  - Clear policy direction by National Government.
  - Forward planning by Regional Government.
  - Implementation by Local Government.
  - Effective liaison between all tiers.

- **Transparency and public trust:**
  - Strict adherence to waste regulations.
  - Separate waste charging.
  - Compensation for communities where waste treatment facilities plants are sited.

- **An integrated approach across waste streams:**
  - Costs reductions through integration of waste streams and waste facilities.

The report further suggests that States that have not been successful in introducing alternative waste technologies are charaterised by the following common features; a lack of certainty, poor strategic planning, no local ownership and inconsistent political messages which contradict the waste hierarchy.
Factors that facilitate the successful introduction of alternative waste facilities include:

- A clear Plan for the longer-term provision of facilities to meet the demands of their communities;
- A clear mandate for Regional Planning Authorities;
- Access to alternative systems of financing;
- A clear distinction between the roles of Waste Planning Authorities and Environmental Agencies ;
- A transparent system to compensate local communities where treatment facilities are constructed;
- The construction of facilities as close as possible to the area in which the waste is generated; and
- Long term contracts with a guaranteed supply of material.

The SLR consulting report concludes that it is unlikely that the UK will achieve the targets it has set for the diversion of waste from landfill, this can be attributed to; time delays and the expense of gaining planning approval, the lack of proactive planning to identify sites for future facilities and contractual difficulties associated with the construction of new waste facilities.

It is clear from European and UK experience that it is not possible for a single authority to successfully address longer term waste management challenges. In many communities regional groupings have been established to facilitate the provision of regional infrastructure. In the UK, planning for waste is the responsibility of Counties or Unitary Authorities, in urban areas. Plans are generally developed for a 15 year period and make provision for waste management facilities to treat all forms of waste. The statutory processes associated with the adoption of Waste Plans can take several years particularly if the landowners of sites earmarked for waste disposal facilities are keen to pursue other forms of development for their land. Political intervention in the planning processes can also lead to the refusal of planning applications for facilities identified in a waste plan. In response to the long delays in the provision of alternative waste facilities, the UK Government has introduced legislation allowing compulsory acquisition of sites identified for future waste facilities.

In the Greater Manchester area a voluntary arrangement has been put in place to establish The Greater Manchester Waste Disposal Authority. The Authority is managed by a Chief Officers Group, has a Board made up of elected representatives and is in the process of entering into an arrangement with the private sector, known as a PFI (Private Funding Initiative), for a 25 year waste disposal contract for recycling and residual waste facilities. In Northern Ireland waste planning is also initiated by central government and voluntary regions have been formed between councils to tackle waste challenges.

5.2 Objective 2 - Alternative Uses

To gain an understanding of alternative after uses that have been established on former landfill sites.

5.2.1 Background

In Victoria the State Government through the Victoria Planning Provisions regulates development in Metropolitan Melbourne, Local Councils generally administer these controls.

In the past landfills have been operated by Municipal Councils with the sites subsequently being redeveloped for active or passive recreation. In more recent years landfills have been owned and operated by the private sector. Once sites have been filled the private sector will be expecting to gain a return on their landholding.

As the Local Planning Authority, the City of Kingston is preparing a Structure Plan to guide the future development of a number of former landfill sites. One of the key challenges associated with this project is to identify land uses that can be accommodated on former landfill sites and to specify environmental controls to regulate the manner that former landfills can be redeveloped.

The redevelopment of a former landfill site, enables a community to make use of degraded land, and in doing so, preserve other more valuable land parcels for higher value land uses. In urban areas, the redevelopment of former landfill sites may allow a community to designate land for uses that cannot normally be achieved within a fully developed area. The sustainable redevelopment of a former landfill site, initially involves an assessment of the characteristics of the site once this is completed alternative land uses can then be evaluated and the preferred development option pursued.

A feasibility study of the development potential of a former landfill sites should take into consideration the environmental and geotechnical constraints of the site, community attitudes and the commercial potential of development options. In certain circumstances, governments may need to provide environmental indemnities or financial assistance to promote the redevelopment of a site, particularly if the risks or financial costs adversely impact on the viability of the preferred development outcome. Conversely if the cost of redeveloping a former landfill site is less than the land value of a comparable land parcel developers will be keen to access and utilise the site without the needs for incentives. In such circumstances it may also be possible to pursue improved environmental outcomes as part of the development approval process.

Options for the reuse of landfill sites are dependent on a number of factors such as, the location of the site, the extent that that the landfill will have adverse impacts on the environment and human health and the potential level of exposure to risks associated with a particular land use. Van Vossen (2005) suggests that following graduation of potential reuses, ranked from low risk to high risk:

- Parking Area
- Industrial Area
- Shopping Mall
- Office Building
- Nature Reserve
- Sporting Reserve
- Residential

5.2.2 After Use of Landfill Sites – Hong Kong

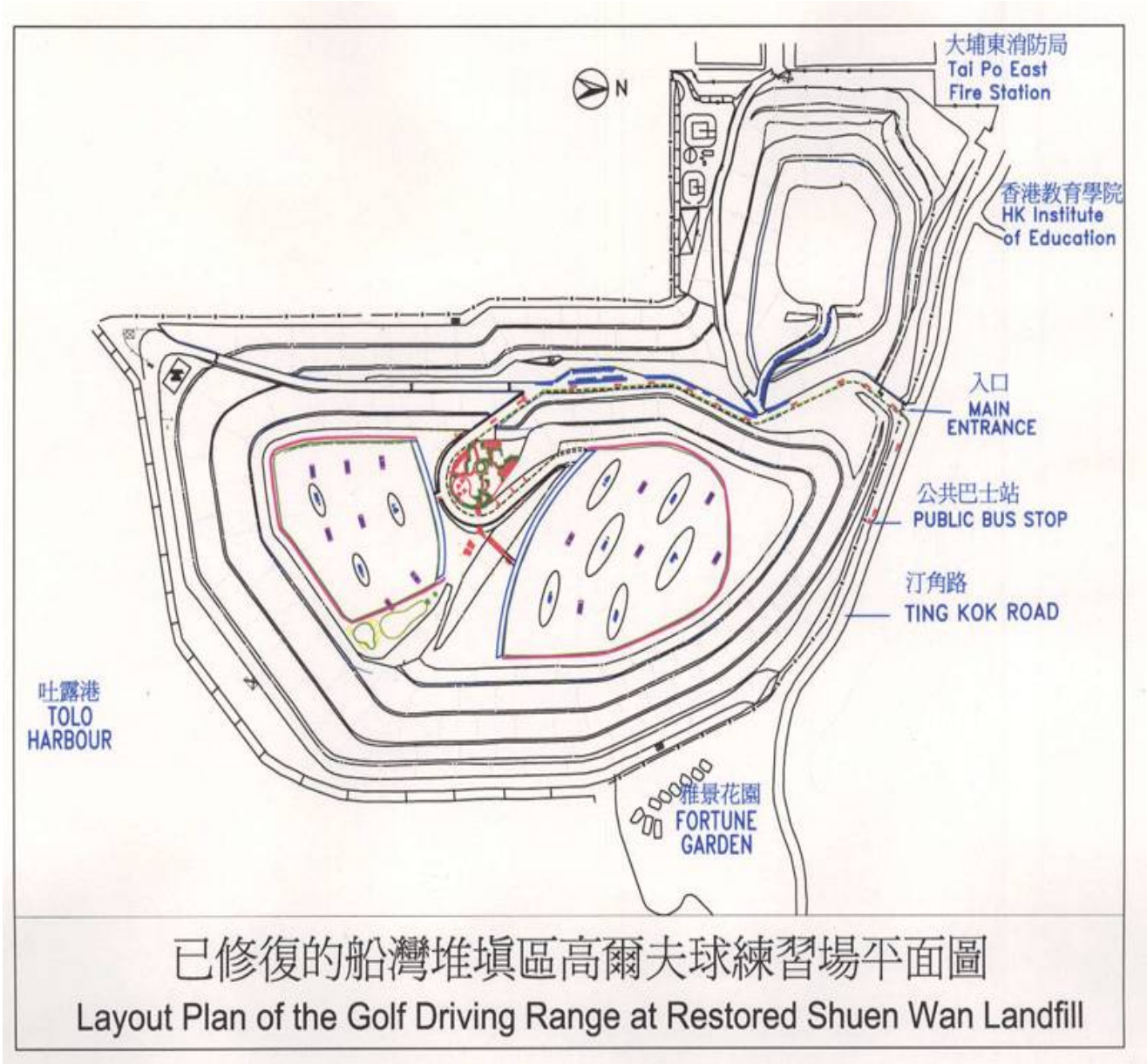
In Hong Kong the Environmental Protection Department (EPD) manages landfilling and the redevelopment and aftercare of landfill sites. As Hong Kong has a high population density former landfill sites provide an opportunity for the provision of key recreational assets. The EPD manages a restoration and development program for 13 closed landfills in Hong Kong. The objective of the program is to reduce the environmental and health risks associated with closed landfills and to provide green zones within urban areas so that the community can enjoy a healthier living environment.

5.2.2.1 Shuen Wan Landfill

The Shuen Wan landfill is a 50 hectare site that commenced operation in 1973 and closed in 1995; the site has subsequently been restored and is progressively being developed as a golf facility. The restoration works involved the construction of a landfill cap, which included a final 1.3 m deep soil layer, leachate extraction system and landfill gas plant. The restoration costs were in the order of A$25M, aftercare costs are estimated at A$800,000 per annum.

The site has been finished as a number of 'tabletops' ie relatively steep slopes with flat platforms. The slopes are well vegetated and the platforms are progressively being developed as a golf facility. Two driving ranges with a total of 145 bays are currently in operation and plans are underway to establish a 9 hole golf course on the site.

Shuen Wan Landfill (Source: Hong Kong EDP website)



(Source: Hong Kong EDP website)

Vegetated Slopes Shuen Wan landfill

Driving Range Suen Wan Landfill

5.2.2.2 Sai Tso Wan Recreation Ground

The Sai Tso Wan landfill is situated on a three hectare site and operated for a 3-year period from 1978, approximately 1.6 million tonnes of domestic and commercial waste has been placed on the site to a maximum depth of 65m.

The site is located in a high density residential area, two hectares of the site has been restored to provide a high quality grass baseball/soccer pitch, children's playground, a rubber jogging track and a waste education centre.

The park is a demonstration project and incorporates a number of environmental initiatives including a wind turbine, solar panels, stormwater recycling system and the use of recycled materials to provide a rubber base for the children's playground and the jogging track. A product known as 'Rubber Soil', a porous construction material, which is made from waste tyres, has been used as the sub base material for the block paved areas on the site.

Sai Tso Wan Recreation Reserve (source Hong Kong EDP website)

Sporting field Sai Tso Wan Recreation Ground

Playground and jogging track, Sai Tso Wan Recreation Ground

5.2.3 After Use of Landfill Sites - North Brabant Holland

The Province of North Brabant has been a leader in facilitating projects that enable former landfills to be redeveloped for alternative uses. The Province is the lead agency for the SUFALNET (Sustainable Use of Former and Abandoned Landfills Network) program. The program is partially funded by the EU and has a number of partner agencies throughout the European Union.

The overall objective of SUFALNET is, "*to reduce environmental risks and to stimulate reuse of closed landfills through exchange and dissemination of policies, projects and instruments."*

Examples of restoration projects within the Province of North Brabant include:

5.2.3.1 Gulbergen landfill

The Gulbergen landfill site is situated near Eindhoven and served the needs of approximately 300,000 people. A regional group representing 21 municipalities purchased the 500 hectare site of which only 50 hectares was ultimately developed as a landfill.

Filling commenced in 1958 and concluded in 2005, approximately 10,000,000 cubic metres of material was deposited on the site. The maximum finished level is about 40m above the natural ground level. The long term plan for the site involves the establishment of a series of industrial and recreational uses. The portion of the site that has been filled is currently being developed as a mountain bike track and a 36 hole golf course operated by a private club. In the long term it is proposed to add bicycle and walking trails, climbing facilities, a bob run, a festival area and an indoor ski facility.

Landfilling ceased on the site prior to the introduction of stringent aftercare and environmental controls, however a private energy company owned by the Province is funding the construction of a fully engineered cap for the site. The cost to provide the final cap is in the order of A$600,000 per hectare.

Capping Works – Gulbergen landfill

5.2.3.2 Eindhoven Waste Precinct

In North Acht on the outskirts of Eindoven, a former landfill site is currently being developed as a waste precinct, the first stage, involving the construction of a waste transfer station which compacts waste which is then railed to a thermal treatment facility, has been completed. The site, which was filled in the 1960s and 1970s, is not subject to the stringent remediation requirements that apply to current day landfill sites. Until recently opportunities to redevelop the site, were limited to the cultivation of maize to feed cattle. A recent policy initiative by the Province of North Brabant will enable this strategically located site to be redeveloped as a waste precinct to serve a number of waste related industries. The province has granted approval on the proviso that the site remains in a single ownership and the owner commits to a range of environmental initiatives. Rather than subdivide the land, the owners will continue to maintain an interest in the site and is responsible for site monitoring and future remediation works. In order to facilitate development, the owner has entered into lease arrangements that make the surface of the site available to third parties. As the waste layer is relatively thin, approximately 4m in depth, the transfer station is constructed on 1600 piers.

Waste transfer station on former landfill, Eindhoven

Maize crop on former landfill, Eindhoven

5.2.3.3 The Fold (Office Complex) Assendelft

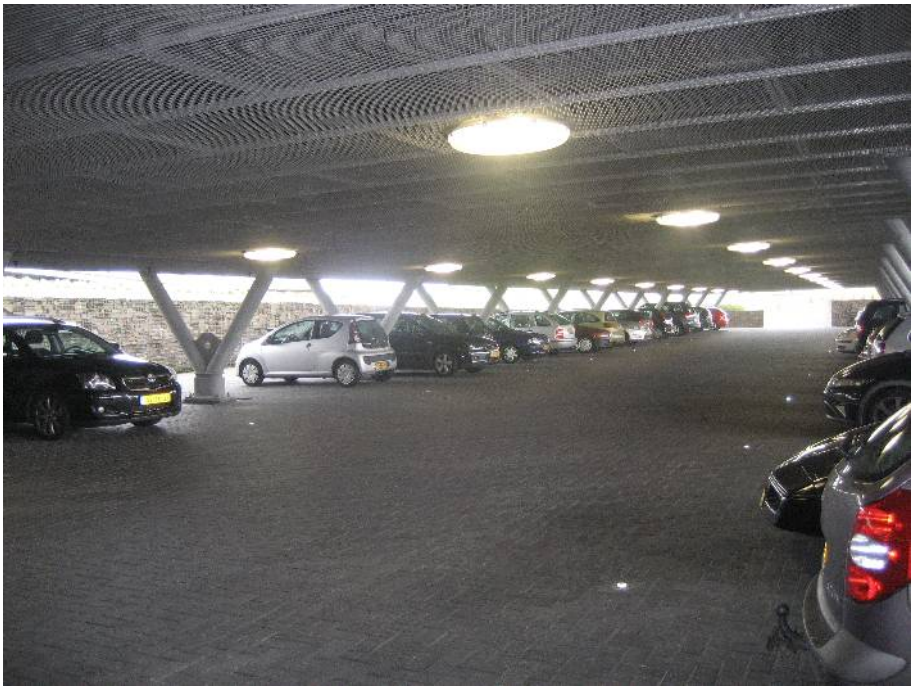
The Dutch waste firm Afvalzorg (Wastecare) has constructed its headquarters on one of its landfill sites. The building overlooks a major shipping channel connecting Amsterdam to the North Sea and incorporates a range of impressive environmental and architectural features.

The design constraints prohibited the use of piles, as piling would compromise the landfills bottom liner. The solution was to site the building into the landfill. The weight of the material removed was roughly equivalent to the weight of the building therefore minimising future settlement. The building was constructed on a concrete raft slab, and rests on a series of hydraulic jacks that can be used to adjust the building level if the slab sinks at some time in the future. The sides of the underground car park are open to minimise the risk of methane collecting beneath the building. The 100m long building incorporates a green roof to blend into the surrounding landscape and improve its environmental performance.

The company uses monitoring equipment within the building to remotely monitor the operation of each of its landfills and make adjustments if necessary. Each of the capping systems installed by Afvalzorg includes electrical sensors that will alert controllers of any breach or failure of the landfill cap.

The Fold - Assendelft

Green Roof



Car Park

Adjustable hydraulic jack

5.2.4 After Use of Landfill Sites - United Kingdom

The most common uses of former landfills in the UK are agriculture in rural areas and recreation in urban areas. The quality of the agricultural land constructed on a former landfill site is often compromised by the poor quality of soils used in restoration, settlement and the impact of landfill gases.

Programs to redevelop former landfill sites appear to be initiated by either a local authority or a government agency rather than coordinated by regional government as is the case in Holland. Examples include;

5.2.4.1 Cross Lane Landfill - Wirral, Liverpool, UK

The Cross Lane landfill site is located near Birkenhead across the Mersey River from Liverpool. The landfill was operated by the local Municipal Authority from the 1960s and was closed in the 1980s, prior to the introduction of legislative changes that required landfills to be licensed. Since that time the site has been left as a wasteland with no environmental protection measures.

Under the Newlands program the Metropolitan Borough of Wirral entered into an arrangement with the UK Forestry Commission to redevelop the site as parkland. The first stage of the rehabilitation program involved a detailed site analysis to determine the extent of pollutants present on the site and any potential impacts. The risk assessment approach adopted by the Forestry Commission is based on the **SOURCE-PATHWAY-RECEPTOR** model, ie the identification of all potential sources of pollution or risk, assessing the manner that any potential pollutant source may be transmitted off site and identifying activities or sites that have the potential to be impacted by a pollutant emanating from the landfill. The application of this model has enabled the development of a remediation strategy that limits the capping of the site to those areas that are identified as high risk. One of the key challenges associated with the restoration of the Cross Lane landfill was the establishment of a final profile that enabled effective drainage without disturbing the fill material; this has been achieved by constructing aggregate trenches to manage surface water. Planting on the site has been limited to specially constructed beds. The species selected are relatively small and have been carefully chosen with the aim of maximising tree stability and limiting root infiltration.

Cross Lane landfill

Tree beds, Cross Lane landfill

5.2.4.2 Mostenvale Landfill, Manchester, UK

The former Mostenvale landfill is located in the Manchester urban area; the site is adjacent to a residential community, which over many years has experienced significant social problems. Since its completion the former landfill has become a wasteland, an area considered by the local community as very unsafe.

The Mostenvale landfill was not capped, has a top cover of 250mm of soil, and is being rehabilitated under the Newlands program by the UK Forestry Commission. The first stage of the rehabilitation program involved soil testing, the results identified a number of "hotspots". Strategies to minimise the risk of exposure at these locations included the placement of additional fill material or vegetation barriers planted to limit access to certain sections of the site.

Monstenvale landfill

Monstenvale landfill

5.2.4.3 Kenmuir Site, Glasgow, Scotland

The Kenmuir site in downtown Glasgow, Scotland is an example of a landfill located in a former quarry site. The site was originally filled with ash; in more recent times the landfill accepted conventional municipal waste. The former landfill has now been redeveloped as an office complex. Prior to its redevelopment, the site was rehabilitated to comply with Scottish Contaminated Land Regulations at a cost of £6M. The works included the removal of the top 5m of waste and perimeter monitoring systems to minimise the migration of landfill gasses into adjoining properties.

Office complex, Kenmuir site

Rehabilitation works, Kenmuir site

5.2.4.4 Summerston Landfill Glasgow, Scotland

The Summerston landfill, a former quarry, is located within a Green Belt on the rural outskirts of Glasgow. The site is similar to many Australian landfills, in that the environmental standards at the site have progressively been strengthened over time, the site is now operating as a fully engineered landfill. It was originally proposed to restore the site to enable the planting of oats and the creation of an urban woodland. In order to enable the site to be redeveloped in this manner the following design parameters were adopted; a capping layer consisting of 1m of clay below a 1m layer of topsoil, a minimum grade for the finished surface of 1 in 100 and no planting within 5m of landfill gas collection pipelines

The Glasgow Council sought funding to enable the project to proceed; however, the application was not successful as the environmental regulator opposed any development that would allow public access to a former landfill site. The UK Forestry Commission is currently considering becoming involved with the project. It is hoped that the project will commence in 2009.

5.2.4.5 Giants Park North Foreshore, Belfast, UK

Giants Park is located 3 km from the Centre of Belfast. The site operated as a landfill from the early 1970s, covers an area of approximately 130 hectares and has recently been closed.

Recently approved masterplans for the site feature 80 hectares of Parkland and a 50 hectare Waste/Recycling precinct. It is estimated that the total cost to redevelop the site will be in the order of £70M. Once completed the parkland will be a major recreational feature for the entire city incorporating sporting fields, a festival area, an amphitheatre, a trail network and natural habitat precincts. The waste precinct designates an area for the future provision of a range of alternative waste treatment facilities and will enable Belfast Council to achieve its waste reduction targets.

The finished profile of the site has been contoured but the adopted landform will not compromise the proposed end uses. Strategic locations within the site have been filled with ‘hardfill’ to facilitate the construction of buildings on the site. The capping consists of 0.5m of clay and a 2m depth of top/sub soil. Tree species that are known to survive on landfill sites have been selected and will be planted in tree boxes that have been constructed into the landfill. The capping system in the area to be used for the waste precinct incorporates a plastic membrane to minimise the risk of explosion resulting from a build up of methane in an enclosed space. Waste processing facilities will be funded and operated by the private sector on behalf of 11 Local Authorities. Options under consideration include an incinerator and an in vessel aerobic digester. Belfast Council proposes to install and operate a power station on the site to be fuelled by landfill gas and is currently considering options to use the surplus heat generated to heat council buildings in the vicinity.

Capping works, Giants Park

North Foreshore, Belfast

North Foreshore, Belfast

5.2.5 After Use of Landfill Sites - Italy

A paper prepared by SUFALNET (2007) provide examples of how Italian authorities have redeveloped landfills for recreation and industrial uses; one outstanding example is San Guiliano Urban Park in Venice.

5.2.5.1 San Guiliano Urban Park, Venice

The San Guiliano area is located close to the road and rail bridges that link the Italian mainland to the city of Venice. The site was Venice's major landfill, for both industrial and residential waste between 1945 and 1968.

Today the former landfill is the major recreational park for the Venetian community. The site occupies an area of area of 68 hectares and has been redeveloped at a cost of €50 million with funds being provided by the EU, local and regional governments. The site is used by thousands of people each week end and features a 15km path network, 10,000m2 of squares and public places, sporting fields, a skating track, a large car parking area and bars and restaurants to serve those visiting the site. SUFALNET (2007).

Whilst sections of the parkland are elevated the former landfill has been shaped to provide large level areas so that the site can be effectively managed as Venice's key recreational space.

San Guiliano Urban Park

5.3 Objective 3 – Environmental Challenges

To gain an understanding of the environmental challenges associated with the redevelopment of former landfill sites.

5.3.1 Background

Traditionally former landfills in the Melbourne Metropolitan area were not subject to any environmental controls and redeveloped as passive open space or sporting fields. Whilst the initial levels of maintenance of a sporting field built on a former landfill may be onerous, in the longer term many of these sites have become major community facilities.

Over the last twenty years more stringent environmental standards have been adopted for the management and aftercare of landfill sites. As many current landfill sites are now owned by the private sector it is envisaged that regulatory authorities will be asked to consider a range of alternative land uses for former landfill sites. The future redevelopment of some former landfill sites may be limited by the extent of measure in place to manage leachate and landfill gas. Another challenge will be developing sites that have been finished to comply with guidelines that encourage landfill operators to shape sites so that the post settlement slope of a landfill is not less than 5%.

5.3.2 Risks Associated with Former Landfill Sites

The challenges associated with managing former landfill sites are not unique to Australia. There are approximately 150,000 former and abandoned landfills in Europe which do not meet current rehabilitation standards (van Vossen 2005).

The risks associated with a former landfill can be categorised as follows:

Landfill Gas - the potential of exposure for humans, livestock and vegetation as well as its contributing factor as a greenhouse gas. Landfill gas can result in an explosion if allowed to build up in a confined space.

Surface Waste - the potential to pollute surrounding water bodies that may be used for drinking water, farming or recreational purposes.

Ground Water - the potential for pollutants to contaminate ground water that may be used for beneficial purposes.

Direct Exposure to Waste - if waste is not adequately covered or at some time in the future is disturbed, there may be a risk to human health either by direct exposure or the consumption of products generated from the former landfill site ie crops or livestock.

Impact on Building Material - prior to allowing construction works to take place on a former landfill site an assessment should be undertaken to determine if the former landfill will have an impact on building construction materials used in foundations.

The potential risks from a landfill site can be mitigated by incorporating engineering controls such as gas and leachate collection systems designed to minimise discharges to the environment and lining systems to minimise the infiltration of surface water and protect groundwater.

In recent years many developed countries have progressively adopted stringent controls for the development, operation and aftercare of landfill sites. Many communities are also funding measures aimed at reducing the risks associated with former unregulated landfill sites. Specific examples in Holland and the UK are outlined in the following sections.

5.3.3 Landfill Regulatory Controls - Holland

- In Holland the specification for the construction of a top cover for landfills is far more stringent than the standards we have adopted in Australia. However, the actual construction of the final cap is often deferred for many years to enable settlement to take place. In Melbourne it is common practice to construct a cap shortly after filling is completed. In such circumstances the cap can be compromised during the initial settlement phase. A typical final cap in Holland consists of 500mm of topsoil, 300mm drainage layer (sand), a HPDE liner, 250mm of a sand/bentonite mix and 300mm of sand. The total depth of the cap being in the order of 1.35m. Landfill base liners are typically up to 4m in depth.

- Van Vossen (2005a) suggests that current regulatory philosophy based on containing waste by providing liners and caps is basically flawed, as this practice does not actually address longer term environmental issues and the potential for pollution always remains. Van Vossen proposes an alternative approach based on natural attenuation whereby compounds that have the potential to cause pollution can, over time, be broken down by biological degradation and chemical precipitation and will therefore be eliminated. Van Vossen proposes natural attention as a viable alternative to containment on the basis that natural processes to eliminate waste pollutants take place both inside and outside of the landfill and the landfill will therefore not be a long term liability.

- The total cost of aftercare of old and abandoned landfills in the EU is estimated to be €50 billion. If the concept of natural attenuation is accepted aftercare costs will decrease significantly and former landfill sites in urban areas can be redeveloped for housing, commercial or industrial purposes (Van Vossen (2005a).

- Dutch authorities have introduced the concept of "**eternal aftercare**" for landfills where filling commenced after 1996. In practice what this means is, that once a site has been rehabilitated in accordance with the license conditions stipulated by the licensing authority (the Province), the operator is required to make a financial contribution to meet the costs for any future for aftercare to the Province. The funds are tied to the site and the Province has the ability to invest the funds to ensure that they are not eroded over time. At this stage the Province of North Brabant has in excess of €100 million in trust accounts.

- Landfills operating prior to 1996 are exempt from the stringent aftercare requirements, however should a pre 1996 site be proposed for redevelopment, the Planning Authority could impose conditions aimed at achieving environmental improvements on the site. In some cases Provinces have provided funding for the rehabilitation of former landfill sites.

5.3.4 Landfill Regulatory Controls – Oldham, UK

The Oldham Metropolitan Borough Council is a local government authority located in the Greater Manchester area. One of the challenges for the municipality is managing the large number of relatively small former landfill sites that are scattered throughout the urban area. In the UK, landfills that were completed prior to 1974 were not required to be licensed, even though many of these sites have been closed for more than 40 years. Many are still generating sufficient quantities of methane to potentially be a source of explosion if allowed to migrate into adjoining properties. The Oldham Metropolitan Borough Council has been able to access low interest loan funds from the National Government to retrospectively install capping systems, consisting of a geotextile membrane and approximately 1m of topsoil at a number of higher risk sites. Control systems to intercept and vent off landfill gas along the perimeter of the sites have also been constructed. Examples include:

- The Chapell Rd playing fields are located on a former landfill that accepted domestic waste until the 1960s. The site is currently used as a training facility for the Oldham Athletic Soccer Club. Rehabilitation works at the site included the installation of a perimeter venting system consisting of wells placed at 30m intervals, each well is fitted with a stack and cowl. A limestone trench wrapped in a membrane connects the wells. The level of investment to manage former sites is very significant, for example it is estimated that the cost of the remediation works conducted at the Chapell Rd playing fields would be in excess of A$6 million if the works were completed today.

Vent - Chapel Road Playing Fields

- In 1989 the Oldham Metropolitan Borough Council was forced to relocate 1,000 secondary school students from the Counthill School due to elevated levels of methane detected in sub floors and classrooms. The methane gas had migrated from two adjoining former landfill sites. Rectification works included the demolition of some classrooms, the installation of membranes, flare stacks, gas monitoring systems and the sealing of all service entry points.

- The Oldham Metropolitan Borough Council has now identified 400 former landfill sites and implemented a monitoring program that involves measuring barometric pressure, CO_2, CH_4 and O_2 levels at former landfill sites.

Chapel Road Playing Fields

5.3.5 Finished Surface Profiles

One of the key challenges in exploring development options for recently completed landfill sites in metropolitan Melbourne is determining end uses that are compatible with the finished surface profiles. EPA guidelines encourage landfill operators to achieve a minimum post settlement slope of at least 1 in 25, rather than finishing the site to match in with the surrounding topography. This guideline is based on the premise that a sloped surface can accommodate future settlement without compromising its ability to shed stormwater. Landfill operators are very supportive of such an approach as it maximises the volume of airspace and therefore increases revenues.

There are no guidelines that stipulate landfill slopes in the UK and Europe; rather the focus is designing a capping system that will ensure effective drainage. This may involve delaying the construction of the final cap until after initial settlement has taken place. The provision of an artificial liner and ensuring an ongoing maintenance regime is in place; such an approach is far more flexible and enables sites to be designed to accommodate a greater range of end uses as has been illustrated in previous section of this report.

In Hong Kong landfills are constructed with steep slopes and relatively flat platforms allowing the finished site to be used for a range of recreational activities.

Sporting field on former landfill site, Hong Kong

5.4 Objective 4 - Forestry and Agriculture

To gain an understanding of issues associated with the utilisation of former landfills for forestry and agriculture.

5.4.1 Background

Many former landfills in metropolitan Melbourne have been successfully redeveloped as parkland. There has, however, been a reluctance to undertake forestry works on former landfills due to concerns that tree roots may compromise the landfill cap. Planning controls that regulate the development of former landfills provide the opportunity for sites to be restored for agricultural purposes.

5.4.2 Forestry on landfill sites - the UK experience

Simmons (1999) suggests that there are considerable benefits in restoring landfills for the purposes of increasing ecological diversity, restorations that provide bland open green space do not always positively respond to the local areas and are often considered as wastelands. Simmons further suggests that areas restored with wildflowers, shrubs and trees present a far more attractive landscape.

Simmons identifies a number of techniques for the natural regeneration of landfill sites including:

- **Non intervention techniques**, where natural regeneration is allowed to occur without any human intervention. This approach will not be suitable for the majority of landfills as it is dependant on the close proximity of seed stock to enable natural propagation on the landfill site.

- **Techniques that involve the creation of a natural habitat** by seeding or planting to establish grasslands, wildflowers, tree and shrub areas, woodlands or wetlands. Simmons acknowledges that landfill restoration guidelines generally discourage tree planting in order to limit the risk of tree roots penetrating a landfill cap but suggests that recent research indicates that trees do not have an adverse impact on well constructed caps and do not damage artificial lining systems such as a HDPE liner, as the majority of roots are contained in the top 1m of soil.

In 2000 the British Government Department for Communities and Local Government published a paper entitled, "Woodland *establishment on landfill sites: site monitoring"*. The report acknowledges that past practice discouraged the planting of trees on landfill sites and that this position was based on little scientific evidence. Authorities have been reluctant to allow planting on former landfills due to concerns that; root systems may penetrate landfill caps, landfill material will impact on the health of a tree and shallow rooted trees may be unstable and blow over. The paper was based on ten years of research and concludes that it is feasible to establish trees on landfill sites, providing certain standards are met. The report concludes that:

- Tree planting on former landfill sites should not be considered where an engineered cap is not provided, where there is less that 1.5m of loosely placed topsoil (1m if a synthetic liner is constructed), or if slopes are less than 1 in 10 without natural drainage.
- As trees are generally shallow rooted it is feasible to plant trees without comprising the integrity of a compacted landfill cap.
- A properly constructed capping system is required to protect trees from leachate and landfill gas.
- Trees with a rooting system of more that one meter are generally stable.

- Tree roots will not draw water from the clay material that forms a landfill cap and will therefore not contribute to the cap cracking.
- Tree planting should be delayed if settlement rates are high.
- Tree species should be matched to site conditions and a high standard of tree maintenance should be provided.
- Species such as Poplar, Alder, Cherry, Oak and Ash are best suited for planting on former landfill sites.

The EPD in Hong Kong utilises extensive tree planting on the slopes of its 'tabletop' landfills. In the United States a number of landfills are currently being restored as urban woodlands, however, Dutch authorities discourage intense tree planting on former landfill sites.

5.4.2.1 Patersons Landfill Glasgow, Scotland

Glasgow City Council has recently approved a proposal to establish the UK's largest urban forest on the Patersons landfill; the site is located adjacent to one of the City's key entry points. The project is aimed at eliminating an eyesore and will involve the planting of more than 1 million trees, the establishment of grass meadows and fields of wildflowers over a 92 hectare site. The project will span over a 5-year period and is scheduled for completion by 2012. The estimated cost of the project is £1.5M to be funded from a landfill tax scheme.

Patersons landfill, Glasgow

5.4.3 Agriculture on landfill sites - the UK experience

Simmons (1999) suggests that it is difficult to establish viable agricultural crops on landfills that are impacted by landfill gas or where it is necessary to maintain gas infrastructure. A study conducted by Reeve *et al* (2000) entitled "*Evaluation of mineral sites restored to agriculture"* provides a comprehensive analysis of the factors that influence the quality of land restored to agriculture after mineral extraction and landfilling. The report concludes that:

- High quality restoration can only be expected if the character of the soil has been analysed prior to extraction and a soil handling and restoration strategy prepared;
- Topsoil should be carefully stripped to avoid contamination with other soil layers;
- Soil stored in stockpiles is at risk of compaction and the degradation of the soil structure;
- The success of a restoration program is dependent on the quality of the works, ie accurate placing to achieve the desired profile; and
- Loose tipping is the preferred method of restoration as it reduces the risk of compaction and therefore provides better soil permeability.

The report concludes that it is possible to successfully restore a landfill for a future agricultural use providing a project plan is prepared and the site supervisor is able to understand the key requirements of the plan.

5.5 Objective 5 - Restoring Extractive Industry Sites

To gain an understanding of innovative practices adopted for the restoration of former extractive Industry sites.

5.5.1 Background

In metropolitan Melbourne there are a number of sites that been extracted for sand. Many of the resultant holes have been used for landfilling. In the future some former extractive sites may not be suitable for landfilling. If this is the case, how can such sites be redeveloped to ensure that they can make a productive contribution to the area?

5.5.2 Restoration of Extractive Industry Sites - the UK experience

Planning approvals for the excavation of sand and gravel in the UK include strict controls to ensure that sites are rehabilitated to a high standard. Many of the sites are located in agricultural green belt areas and restored by solid inert filling to re-establish farmland. Some sites have also been restored for recreational purposes such as sporting fields, passive open space, nature reserves, fishing lakes and wetland areas.

In the UK, the Quarry Products Association recognises that quarrying is a temporary land use and that restoration is an integral part of the quarrying process. The Association promotes sound environmental practices by making annual awards to recognise those sites that have been rehabilitated to a high standard. One of the key challenges for quarry companies in the UK is being able to access solid inert material to restore sites, as they are forced to compete with unregulated construction projects such as golf course developments. This is particularly difficult when competitors are not subject to the same strict controls, for the acquisition and placement of solid inert fill material. Until recently, the use of inert material to restore quarry sites in the UK was considered as a reuse of waste, rather than disposal, and therefore afforded a higher status in the waste hierarchy than landfill. Recent regulatory changes have adopted a different position with material used for restoration being considered as part of the waste stream and therefore included in the calculations for waste reduction targets. As the availability of suitable rehabilitation material is impacting on the ability to gain approval for extraction in the UK, the Quarry Products Association is actively lobbying for a review of the regulations that govern inert filling in an effort to ensure that sufficient material is made available to restore extraction sites.

The definition for solid inert waste in the UK differs to that in Victoria and sits somewhere between our solid inert waste and clean fill definition. In the UK, material that can be accepted at solid inert landfill sites is separated into two categories.

Category A - Single source material that can be accepted without testing:

- Concrete.
- Bricks.
- Tiles and ceramics.
- Glass.
- Soil and stones.

Category B- Material accepted with Pre-testing:

- Waste from mineral excavation.
- Tailings.
- Waste gravel and crushed rock.
- Waste sands and clay.
- Ballast.
- Dredging spoil.
- Mixed construction and demolition waste (concrete, bricks, tiles, ceramics, glass, soil, and stone).

As the majority of extractive industry sites in the UK are located in agricultural areas, planning policy seeks to protect sites from irreversible damage by requiring a level of restoration and aftercare to protect the long term agricultural potential of the land. In 2000, Reeve *et al* concluded a five year project to assess the success of planning controls in achieving this objective over 41 sites.

Whilst the report concluded that that the majority of sites were restored at a lower level than the original ground conditions, there was no discernable difference between sites that were landfilled when compared to those that did not involve landfilling.

The major factor that impacted on the quality of the restoration was the manner that the soil was handled during the removal, stockpiling and replacement stages. Stockpiling and the use of heavy earthmoving equipment such as scrapers increased the risk of topsoil compaction. If soil is excavated and transported with trucks the risk of compaction is lower. Any increase in density adversely impacts on the quality of the soil structure, soil permeability and the root depth of planted crops.

5.5.2.1 Brett Aggregates Shepperton Site

The Brett Aggregates Shepperaton sand and gravel quarry is located on the outskirts of London in an agricultural area. Approvals for the site limit the area of the site that can be worked at any one time. The quarrying process involved the removal and storage of topsoil material prior to the excavation of sand and gravel to a depth of 12 metres. Once the extraction is completed a one metre thick impermeable barrier is placed in the quarry hole. Solid inert material is then sourced for the site; tipping fees are £7 per tonne, which is significantly cheaper than other forms of landfill, no levies apply. The quality of the fill material is tested on a regular basis. Once filling is completed the final surface profile is established which consists of 700mm of subsoil and 300mm of topsoil. Care is taken to ensure that construction equipment is not allowed to travel over the final surface to prevent compaction, this requires the site to be rehabilitated in 6m wide strips, and agricultural drains are placed at 12 m intervals to ensure effective drainage. The surface profiles have slopes of about 1 in 100 and are carefully profiled to prevent flooding and to enable the site to blend into the surrounding countryside.

5.5.2.2 Hanson site - Reigate

The Reigate site, operated by the Hanson group, has been mined for silica sands since the 1920s. In the early years of operation the sandpits were filled and restored as agricultural grazing land. In more recent times sandpits have been restored as high quality recreational areas incorporating lakes stocked with salmon and trout for recreational fishing.

Former extraction sites restored for fishing lakes, Reigate

6.0 Conclusions and Recommendations

When measured against best practice overseas, the systems in place for recycling and waste collection in metropolitan Melbourne are generally superior to those evident in Europe and the UK. European Union legislation is the key driver for the progressive reduction of landfilling, as the principal means of waste disposal for its member states. The level of compliance with the EU's landfill targets varies significantly across the Union. Those countries that have embraced energy recovery as an alternative to landfilling have clearly articulated national policy frameworks. However, the motives do not appear to be based solely on improving environmental outcomes as there is a complimentary goal based on security of energy supply. It is important to recognise, that the circumstances in metropolitan Melbourne, where there is an abundance of potential landfill space, is clearly different to those in Europe and Hong Kong. There are, however, a number of key lessons to be learnt in terms of strategic planning for waste disposal and the monitoring and after use of landfill sites. The conclusions and recommendations of the study tour assessed against each of the tours objectives are set out below.

Objective 1 - Strategic Planning

To gain an understanding of the challenges associated with preparing strategic plans for the siting and development of alternative waste facilities.

There are a number of common themes in those countries where alternative waste technologies have been successfully implemented. Common factors include a waste policy framework that is clearly articulated and has the support of all tiers of government, strategic waste plans that identify potential sites and facilitate the establishment of alternative waste treatment facilities and enforceable targets to reduce the reliance on landfills or legislation that requires the progressive phasing out of landfills. Alternative waste facilities are capital intensive and generally involve a partnership between several local authorities and the private sector. Such an arrangement will only be successful if the contracts are structured for an extended period ie for up to 20 years and provide for a guaranteed waste supply.

The four Waste Regions that operated in metropolitan Melbourne have recently been consolidated into a single authority. One of the major benefits of the restructure is that the State Government has been actively involved in the preparation of waste policy, waste plans and the statutory planning framework for alternative waste facilities. Experience in the UK and Europe would suggest that for the process to be successful it is imperative that the State Government forms a view on the future role of landfills. Given the abundance of potential landfill space on the outskirts of metropolitan Melbourne clear policy direction needs to be established for the future role of landfills as a method of waste disposal

Recommendation: That Local Government advocate that the State Government provides a clear policy direction for the future role of landfilling prior to the finalisation of the Melbourne Waste Management Plan and that the plan identify the location of alternative waste facilities.

Objective 2 -Alternative Uses

To gain an understanding of alternative after uses that have been established on former landfill sites.

The redevelopment of a former landfill site enables a community to make use of degraded land, and in doing so, preserve other more valuable land parcels for higher value land uses. In urban areas, the redevelopment of former landfill sites may allow a community to designate land for uses that cannot normally be achieved within a fully developed area. Options for the reuse of landfill sites are dependent on a number of factors such as; the location of the site, the extent that that the landfill will have adverse impacts on the environment and human health and the potential level of exposure to risks. Potential uses include parking areas, industrial complexes, retail and offices developments, sporting fields and passive recreational uses. Residential development will only be appropriate if strict environmental controls are adopted

A feasibility study to determine the development potential of a former landfill site should take into consideration the environmental and geotechnical constraints of the site, community attitudes and the commercial potential of development options. In certain circumstances, governments may need to provide environmental indemnities or financial assistance to promote the redevelopment of a site, particularly if the risks or financial costs adversely impact on the viability of the preferred development outcome. Conversely if the cost of redeveloping a former landfill site is less than the land value of a comparable land parcel, developers will be keen to access and utilise the site without the needs for incentives. In such circumstances it may also be possible to pursue improved environmental outcomes as part of the development approval process.

The after use of a landfill site should be a key consideration when a landfill proposal is initially under consideration so that a potential landfill site can be designed and developed for a designated end use. This is particularly relevant if the site is owned by the private sector. Finished landfill sites should be retained in a single ownership so that long term environmental responsibility is not fragmented, subdivision of a former landfill site should be discouraged.

Recommendation: That the Victoria Planning Provisions be modified to require planning applications for the establishment of a landfill to demonstrate a viable end use once filling is completed, and that the subdivision of former landfill sites be prohibited.

Objective 3 – Environmental Challenges

To gain an understanding of the environmental challenges associated with the redevelopment of former landfill sites.

The risks associated with a former landfill site includes the impacts of landfill gas on humans, livestock, vegetation and the environment, the potential for surface water and groundwater to pollute surrounding water bodies that may be used for drinking water, farming or recreational purposes, the risk of direct exposure to waste and the impact of waste on building materials.

The potential risks from a landfill site can be mitigated by incorporating engineering controls such as gas and leachate collection systems designed to minimise discharges to the environment and lining systems to minimise the infiltration of surface water and protect groundwater.

In recent years many governments have progressively adopted stringent controls for the development, operation and aftercare of landfill sites. Many communities are also funding measures aimed at reducing the risks associated with former unregulated landfill sites.

The environmental measures in place for developing and operating a landfill in Australia are comparable to best practice overseas; however, it is apparent that the extent of monitoring and management of completed landfills in Europe, the UK and Hong Kong are significantly advanced when compared to aftercare measures adopted in Australia. The aftercare of a landfill requires a significant investment, in Victoria landfill sites are now required to provide financial assurances as a mechanism to address future environmental challenges, the greatest potential risk lies with former landfill sites that were developed without any environmental controls.

In Europe, Hong Kong and the UK programmes funded by national and regional governments are in place to actively monitor former landfill sites to determine if there is a risk to surrounding communities. Monitoring programmes have been established for some sites that were filled more that 50 years ago.

In Melbourne, environmental regulators require modern landfills to be capped and domed, rendering the sites useless for most types of active sports. This practice is not common overseas, with many sites that are subject to stringent environmental controls being developed to create relatively level finished profiles that are ideally suited for sporting grounds. Rather than stipulating a finished surface profile, regulators overseas focus on the provision of an effective drainage system. In Europe the establishment of a final cap is sometimes delayed until initial settlement has taken place.

Recommendation: That Local Government Authorities establish a register of former landfill sites and progressively introduce a program to monitor potential impacts on surrounding land uses with the highest priority being monitoring for the off site impacts of landfill gas.

Recommendation: That Local Government Authorities make representation to environmental regulators to review the current practice that requires the finished surface profile of landfills to be domed and therefore limits the number of potential after uses for landfill sites.

Objective 4 - Forestry and Agriculture

To gain an understanding of issues associated with the utilisation of former landfills for forestry and agriculture.

There are considerable benefits in increasing ecological diversity when restoring a former landfill site. There has, however, been a reluctance to consider tree planting as an option due to concerns that trees will be either unstable or the tree roots will compromise the landfill capping system. Studies conducted in the UK suggest that this position was based on little scientific evidence and that tree planting on a former landfill can be a viable alternative if specific conditions are met

The EPD in Hong Kong utilises extensive tree planting on the slopes of its 'tabletop' landfills. In the United States a number of landfills are currently being restored as urban woodlands, however Dutch authorities discourage intense tree planting on former landfill sites.

It is difficult to establish viable agricultural crops on landfills that are impacted by landfill gas or where it is necessary to maintain gas infrastructure. However, it is possible to successfully restore a landfill for a future agricultural use providing a project plan is prepared and the site supervisor is able to understand the key requirements of the plan.

Capping systems constructed on landfills in metropolitan Melbourne are generally designed to ensure that the cap will prevent the ingress of water; the depths of topsoil over the capping material are generally inadequate to support and promote a diversity of vegetation. The re-establishment of natural vegetation on closed landfills should be considered as an alternative to planting grasslands.

Recommendation: That Local Government Authorities make representation to environmental regulators to review guidelines for landfill capping systems with the view of increasing the depth of topsoil, to a minimum depth of one meter, to enable a greater diversity of vegetation to be established on former landfill sites.

Objective 5 - Restoring Extractive Industry Sites

To gain an understanding of innovative practices adopted for the restoration of former extractive Industry sites.

Planning Approvals for the excavation of sand and gravel in the UK include strict controls to ensure that sites are rehabilitated to a high standard. Many of the sites are located in agricultural green belt areas and restored by solid inert filling to re-establish farmland. Some sites have also been restored for recreational purposes such as sporting fields, passive open space, nature reserves, fishing lakes and wetland areas.

The definition for solid inert waste in the UK differs to that in Victoria and sits somewhere between our solid inert waste and clean fill definition. The UK definition for clean fill includes concrete, bricks, tiles, glass, soil and stones. If the definitions of clean fill were reviewed to adopt a standard similar to that in operation in the UK there would be a greater incentive to restore former extractive sites that may not be viable for a solid inert landfill. Clean filling to restore an extractive industry site to a beneficial use should be considered as a reuse of waste and not be subject to waste levies.

Recommendation: That Local Government Authorities make representation to environmental regulators to review the definition of clean fill with the view of adopting a similar definition to that in operation in the UK to encourage the rehabilitation of former extractive sites.

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