BEST PRACTICE GUIDELINES FOR THE USE OF ALTERNATIVE MATERIALS AND PROCESSES IN ROAD CONSTRUCTION WITH RESPECT TO ENVIRONMENTAL ISSUES

Final Report

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EXECUTIVE SUMMARY

This document presents a series of best practice environmental guidelines for the use of alternative materials and associated processes in road construction.

In general, the main environmental consideration is to ensure that runoff or leachate water that has been in contact with alternative materials is not able to discharge to ground water or adjacent water courses. Discharges to the atmosphere are also important but are not the main focus of the guidelines.

For most alternative materials, this means that appropriate processing, stockpiling and transportation procedures must be observed, and in general, the materials should be located above the water table. Encapsulation and/or sealing of the materials is also desirable, as is provision of appropriate drainage systems.

For most alternative construction processes, the main focus is on establishment of appropriate plans and contingency measures to divert water around the site and to contain any water that is collected on the site as a result of heavy rain or a construction mishap such as rupturing a water main. Adequate monitoring must be carried out to ensure that the water collected at the site is fit for discharge either during the construction operation, or at a suitable juncture following an emergency situation. If discharge is not appropriate the collected water should be removed by vacuum equipment and disposed of appropriately.

It is important to recognize that sound environmental management is required for construction activities in general, not only for those involving alternative materials or processes. In many instances the environmental credentials of traditional materials may be more questionable than those of alternative materials, especially considering that a major source of contaminants is deposition by vehicles, a process that occurs irrespective of the composition of the pavement surface.

1 INTRODUCTION

1.1 General

In the past, road pavements in New Zealand have typically comprised flexible structures incorporating unbound aggregate subbase and basecourse layers with a chip seal or thin bituminous surface course. This type of pavement structure has generally served the traveling public well, given the relatively low levels of axle loadings and traffic volumes. In addition, there has been an abundance of high quality aggregate in most parts of the country.

However in recent times, the availability of premium quality road construction aggregate has diminished as existing resources become depleted and the regulatory consent requirements for extended or new quarry operations become increasingly more demanding. There is also a heightened awareness of environmental issues associated with quarrying and road construction in general. This has resulted in pressures to, not only conserve existing aggregate resources, but also to recycle construction and industrial by-products wherever possible. The use of recycled materials has a win-win effect in that there is reduced demand for quarried aggregates and a reduced volume of material being dumped in landfills. The use of recycled materials also has the benefit of reduced transportation costs as the recycled material is often located at, or close to, the site where it is being re-used.

Increasing axle loads and traffic volumes, combined with heightened environmental considerations, dictates that innovative materials and construction practices need to be established to provide cost-effective and high performing pavement construction and rehabilitation solutions.

1.2 Objective

The objective of this project is to develop a best practice guidelines document for the use of alternative materials in road construction. In particular, the focus of the guidelines is minimization of the risk of environmental contamination. This includes considerations regarding, not only the mechanical and chemical properties of the materials, but also their processing, storage, transportation, handling and potential for re-use.

1.3 Definitions

In this report, *alternative materials* are defined as being either:

- non-traditional road building materials; or,
- materials that are derived from recycling or industrial by-products.

2 ENVIRONMENTAL CONSIDERATIONS

2.1 General

Auckland Regional Council (ARC) is responsible for management of the environmental well-being of the Auckland region. To achieve its objectives, the ARC establishes, monitors and enforces environmental criteria under the framework of the Resource Management Act (1991).

While there are many aspects of the environment that are susceptible to contamination, water resources are of primary concern. Water has a dual role in that it can act as both a medium for contamination and a receptor. In the medium role, storm water can act as a leachant or as a transporting medium. As a receptor, water can take the form of ground water, overland flow, streams, rivers, harbours and the open sea.

It is vital that contaminant levels are kept to an accepted level to be able to support the very sensitive flora and fauna that inhabit the water environment. The environmental well-being of the coast is also important in terms of recreational activities, tourism and conservation of natural formations.

2.2 Environmental Controls

The ARC has developed a set of environmental response criteria designed to maintain environmental well-being in relation to storm water and waste water discharges. These criteria are presented in the ARC report entitled *"Blueprint for monitoring receiving environments"* (ARC 2004).

The environmental response criteria focus on sediment quality, benthic ecology and human health risk as the main factors in assessing the potential impact of storm water and waste water discharges. These criteria must be adhered to in any road construction activities, in particular those that utilise alternative materials and/or processes that may have a higher risk of contamination. Special consideration should also be given to materials and/or processes that have a reduced track record in terms of environmental soundness compared with traditional road construction materials.

While storm water and waste water are the primary focus of the ARC environmental response criteria, due consideration must also be given to atmospheric discharges, mainly in the form of the generation of dust. Wind-blown dust has the potential to contaminate water courses as well as being a respiratory threat to road workers and members of the public. Dust can also coat pasture and crops on properties adjacent to the construction with obvious detrimental effects.

It is important to note that employers are responsible for the health and safety of their employees under the Health and Safety in Employment Act (1992). The Act also states that employees must be made aware of any environmental implications involved in their activities.

3 ALTERNATIVE MATERIALS & ASSOCIATED PROCESSES

This guideline document focuses on alternative materials that are currently used in road construction and the processes associated with their use. While a number of alternative materials are used overseas, there is a relatively small number that are routinely used in New Zealand.

A list of alternative materials that are used in New Zealand is presented in Table 1. A list of recycling and associated processes is presented in Table 2.

Table 1 Alternative materials used in road construction in New Zealand.

Application	Material
Base / subbase aggregate	Asphalt millings
	Recycled concrete
	Meltor slag (ex NZ Steel)
	Glass cullet
Asphalt additives	Asphalt millings
	Steel slag (ex NZ Steel)
Fill	Asphalt millings
	Scrap tyres
Chip sealing	Meltor slag (ex NZ Steel)
	Steel slag (ex NZ Steel)

Table 2 Recycling and associated processes used in road construction in New Zealand.

Process	Material
In situ stabilisation	Lime
	Cement
	KOBM
	Bitumen (foamed)
Milling and saw cutting	Asphalt fines
	Concrete fines
Surface washing / cutting	Surface wash water

Other recycled materials or alternative processes may be identified in the future as a result of further research or advances in recycling techniques. Such materials will require an evaluation process to determine their environmental soundness before they can be used in the field.

Opus International Consultants (2006) sets out a process by which new or alternative materials can be evaluated. Briefly, the evaluation process involves:

- An initial assessment that examines all existing information regarding the composition, history and performance of the material in road construction.

- Screening tests to determine if the material contains leachable contaminants with respect to environmental impact.

- Development of a comprehensive Environmental Impact Assessment that exposes the material to more robust leaching and aquatic ecotoxicity testing using parameters that are specifically applicable to the site conditions and receiving environment.

4 CONTRACTOR'S ENVIRONMENTAL MANAGEMENT SYSTEM

4.1 General

All road construction organizations should have a formally documented Environmental Management System (EMS). A strong commitment to the EMS must be made from the company management down.

All employees involved in activities that could have an impact on the environment must be fully conversant with the EMS and company management must ensure that the EMS is strictly followed and that appropriate staff training and maintenance of the document is provided.

The EMS should include detailed accounts of the following:

- the management's policy with respect to environmental issues;
- responsibilities for implementing the EMS;
- potential environmental risks;
- operational procedures to minimize the risk of contamination;
- actions in the event of non-compliance;
- records that demonstrate environmental compliance;

Discussion of potential environmental risks and operational procedures to minimize the risk of contamination is presented in Sections 5 and 6 of this document.

4.2 Pre-start Planning

Adequate pre-start planning is the key to ensuring the environmental security of any construction activity. One of the most important aspects of the procedures included in the EMS is to inspect the site in question to identify features that may be significant to the construction operation and its potential affect on the environment. The site inspection should note:

- surface drainage provisions;
- overland flow paths;
- presence of water courses;
- location of low points;
- location of cesspits and manholes;
- watermain shut-off valves;

All of the considerations listed above should be documented by the member of staff identified in the EMS as being responsible for the management of the project. The relevant information must then be communicated to the on-site staff before work commences.

4.3 Implementation of the EMS

The project manager must ensure that the requirements of the EMS are implemented on site.

4.4 Environmental Incidents

An important component of the EMS, which must be fully understood by all project managers and site supervisors, is the process that must be followed if there is an incident that may have environmental consequences. It is a legal requirement to develop an Emergency Spill Response Plan if an organization stores, transports or uses environmentally hazardous substances.

ARC advises that a Spill Response Plan should generally comprise:

- Be safe
    - Is specialist safety equipment required?
- Stop the source
    - Discontinue application of the offending material, plug the leak, shut off water supplies, etc.
- Protect stormwater
    - Confine the contaminant.
    - Block off access to stormwater grates, drain covers, etc.
- Notify
    - Inform company management.
    - Inform regional council (Pollution Hotline).
- Clean-up
    - Neutralise hazardous substances.
    - Pump or sweep the contaminant into suitable containers.
    - Clean up residues.
- Dispose of spill material
    - Dispose of hazardous substances using appropriate means.
- Review
    - Assess causes of incident.
    - Update EMS.
    - Provide additional staff training.

5 ALTERNATIVE MATERIALS

5.1 Alternative Materials as Aggregate Replacement Products

5.1.1 General

The majority of alternative materials in road construction activities involve the replacement of conventional aggregates in fill, subbase or basecourse applications. In New Zealand, these products include:

- asphalt millings;
- recycled crushed concrete;
- meltor slag (ex NZ Steel);
- steel slag (ex NZ Steel); and,
- glass cullet.

All of the above materials have the potential to release fine particles and associated constituents either in terms of fugitive dust or in runoff. There may also have the potential to leach toxic compounds if they are in contact with water for a sufficient period of time.

Table 3 provides a summary of the various sources for contamination and mitigation measures. Details that are specific to each material are presented in the following paragraphs.

Table 3 Basic environmental considerations for aggregate replacement materials.

Phase	Release Mechanism	Transfer Medium	Mitigation Measures
Processing	Fugitive dust	Air	Keep material moist
Storage stockpiling	Fugitive dust	Air	Keep material moist
	Leachate	Ground water	Seal stockpile area
		Storm water	Divert clean water away from stockpiles, collect runoff in silt ponds
Transportation	Fugitive dust	Air	Cover trays of trucks & trailers
Site stockpiling	Fugitive dust	Air	Locate in sheltered area, keep material moist
	Leachate	Ground water	Seal stockpile area, truck in as required
	Runoff	Storm water	Install silt fences, hay bales, vegetation strips adjacent to water courses
Construction	Fugitive dust	Air	Keep material moist
	Leachate	Ground water	Do not allow layer to be exposed to heavy rain
	Runoff	Storm water	Install silt fences, hay bales, vegetation strips adjacent to water courses, block cesspits or manholes if necessary
	Runoff	Stormwater	Seal pavement surface

5.1.2 Asphalt Millings

Description
Asphalt millings, also known as recycled asphalt pavement (RAP), is the term given to the material that is generated when asphalt layers are removed from an existing pavement to permit reconstruction and/or resurfacing. Asphalt millings comprise high quality mineral aggregate combined with oxidized bituminous binder.

The material is received from the recycled road pavement generally processed using screening and crushing plant before it is re-used. The end result is a well-graded, high quality aggregate with a residual bitumen content generally in the range 4.5 to 6%.

The most cost-effective application for millings is recycling back into asphalt. This takes advantage of the material's inherent binder content. Alternatively, millings can be used as general fill, subbase aggregate or as basecourse aggregate in low traffic road applications.

Specific Environmental Considerations
Table 3 presents potential sources, release mechanisms, transfer media and mitigation measures for asphalt millings when used in general fill, subbase or basecourse applications. It shows that dust, leachate and runoff are the primary release mechanisms for potential contaminants. However, the majority of the millings material is likely to have a very low risk of liberating significant quantities of contaminants.

Compounds of specific interest are associated with the residual bitumen that coats the aggregate or is separated from the aggregate particles during the milling or processing operations. This could be expected to provide a source of polynuclear aromatic hydrocarbons (PAH) and other potential contaminants. However, Townsend and Brantley (1998) concluded that leaching of heavy metals and PAHs was not an issue either in the stockpiling or in-service phases of the millings implementation.

The most significant potential for contamination is likely to be release of heavy metals that would have been deposited on the surface of the original road prior to the asphalt being milled. These compounds would have originated from vehicle exhaust emissions, brake pad dust, oil drips, etc.

In summary, appropriate environmental management of applications using asphalt millings should comprise:

- Observe the basic mitigation measures described in Table 2;
- Designers should ensure that when in service the millings materials are located above the water table by installing appropriate drainage measures. This will minimise the contact with ground water;
- Designers should ensure that the pavement surface is sealed so that exposure to storm water is minimized.

5.1.3 Recycled Concrete

Description

Recycled concrete consists of high quality crush rock aggregate and hardened, cementitious paste. The raw concrete is processed at a central facility, or on-site using a mobile plant. The processing involves crushing, screening and ferrous metal reinforcement removal.

If properly processed, recycled concrete can perform extremely well in pavement base and subbase applications. This is as a result of the high degree of angularity of the aggregate particles and a tendency for the residual cement to be re-activated. Both these factors contribute to the material achieving a relatively high shear strength. Recycled concrete can also be used as bulk fill, however its premium mechanical properties are not efficiently utilized in a bulk fill application.

Specific Environmental Considerations

Recycled concrete has the potential to produce high pH leachate and runoff if the cement fines are released from the aggregate or the cementitious paste. pH values of up to 11 are noted in the literature (FHWA, undated). Transit New Zealand M/4 Notes (2006) reports that recycled concrete aggregates should be washed to remove dust from the coarse particles. The wash water would need to be collected and treated appropriately to neutralize the pH prior to discharge.

Melton and Weymouth (2005) state that recycled concrete aggregate layers should be located above the water table to minimize the contact with ground water.

Transit M/4 Notes also reports issues with respect to the formation of tufa-like precipitates in some recycled concrete aggregates. The precipitate originates from the reaction of carbon dioxide with calcium oxide in the cement. The material can block drains and cause saturation of the aggregate layer.

In summary, appropriate environmental management of applications using recycled concrete should comprise:

- Observe the basic mitigation measures described in Table 2;
- Designers should ensure that when in service the recycled concrete aggregate is located above the water table by installing appropriate drainage measures. This will minimise the contact with ground water;
- Drains should be designed to avoid blocking if tufa forms;
- Designers should ensure that the pavement surface is sealed so that exposure to storm water is minimized.

5.1.4 Meltor Slag (ex NZ Steel)

Description
Meltor slag is a byproduct of the iron making process at New Zealand Steel, Glenbrook. Its main constituents are titanium oxide, aluminium oxide, calcium oxide, magnesium oxide and silica oxide (Transit New Zealand, 2006).

Meltor slag has been used with success as a subbase and basecourse aggregate as well as a sealing chip. It has also been used in drainage applications. The aggregate has very good shape, high strength and a strong resistance to polishing, i.e. all very desirable properties for a roading material.

Specific Environmental Considerations
The chemical make-up of meltor slag is closely related to the somewhat unique steel making process that is used at NZ Steel. This process is very consistent, and correspondingly, the composition of the slag is also very consistent. Irrespective of this, the meltor slag suppliers (Steelserv Ltd) maintain a stringent quality assurance testing programme to ensure that the constituents remain within accepted ranges. The QA programme also includes "weathering" of the raw material in stockpiles for at least six months.

Thorough environmental testing carried out by Steelserv Ltd has confirmed that the use of meltor slag in road construction does not present a significant risk to the environment. Auckland Regional Council has accepted the use of meltor slag subject to compliance with the Steelserv QA programme.

The leachate from meltor slag has been shown to be mildly alkaline and therefore it should be used above the water table, in conjunction with an appropriate drainage system and away galvanized or aluminium pipes that could corrode (Transit New Zealand, 2006).

In summary, appropriate environmental management of applications using meltor slag should comprise:

- Observe the basic mitigation measures described in Table 2;
- Designers should ensure that when in service the slag aggregate is located above the water table by installing appropriate drainage measures. This will minimise the contact with ground water;
- Stockpiles should be maintained close to optimum water content to minimize the need to add water during construction;
- Designers should ensure that the pavement surface is sealed so that exposure to storm water is minimized.

5.1.5 Glass Cullet

Description
Glass cullet is collected glass that is not suitable for, or is surplus to, the supply of glass that is recycled into new glass products.

Transit New Zealand allows up to 5% glass cullet to be used in basecourse and subbase applications. The cullet must achieve a defined particle size distribution and must have less than 5% contamination by mass. Note that contamination generally comprises paper, metal, plastic and cork.

Specific Environmental Considerations
Glass cullet is generally deemed to be environmentally sound if it is processed appropriately. For example crushing to a 10 mm down grading removes sharp edges and renders the material safe to handle. While there is generally no specific requirement to wash the cullet, producers must ensure that objectionable odours do not occur.

The majority of the glass cullet is derived from bottles and packaging, although ceramics and window glass may be included. Glass from cathode ray tubes and other applications that present a risk of environmental contamination are not permitted.

The low cullet dosage allowed by Transit New Zealand (2006), i.e. 5% means that the quantity of cullet is not significant and therefore environmental risk is kept to a minimum.

In summary, appropriate environmental management of applications using glass cullet should comprise:

- Observe the basic mitigation measures described in Table 2;
- Restrict cullet proportion to 5% by mass;
- Ensure that cullet is not derived from cathode ray tubes or other applications that could present an environmental contamination risk;
- Wash cullet if it presents an odour issue;
- The cullet must be crushed to a 10 mm down grading to remove sharp edges.

5.2 Alternative Materials as Asphalt Additives

Byproducts that are commonly used as asphalt additives in New Zealand are:

- Recycled asphalt pavement (RAP); and,
- Steel slag (ex NZ Steel).

These products replace a proportion of the mineral aggregate component of the mix. In the case of RAP, the additive also provides a proportion of binder into the new mix.

Granulated scrap rubber is used in some overseas markets, however it is unlikely that the economics of this process will make it viable in New Zealand, at least in the short to medium term.

The nature of hot mix asphalt is such that its aggregate component is largely encapsulated by a coating of bituminous binder. Therefore water does not come into contact with the aggregate except at the pavement surface. As a result, runoff water is the only environmental concern during the service life of the layer, however contaminants deposited by vehicles are likely to far outweigh any contaminants associated with the RAP or slag contained in the mix.

Handling of the RAP or steel slag prior to producing the mix, and the production itself, present a higher risk environmental contamination.

Both the RAP and steel slag should be stockpiled and managed according to the guidelines outlined in Section 5.1.4 (as per meltor slag in the case of steel slag). Asphalt producers must also follow plant manufacturer's procedures to ensure that emissions from the asphalt plant are kept to acceptable levels during mix production.

5.3 Alternative Materials as General Fill

Byproducts that are occasionally used as general fill in New Zealand are:

- Recycled asphalt pavement (RAP); and,
- Used tyres.

When RAP is used as general fill it will generally be in an unprocessed form. This means that its particle size distribution may not be ideal and it is likely to include a significant proportion of basecourse or subbase aggregate. It could also include a proportion of soil, depending on the composition of the original pavement that was recycled.

Used tyres contain a relatively high proportion of zinc and PAHs. However, the literature is inconclusive regarding the environmental credentials of used tyres. Kim (2003) states that used tyres break down in the presence of oxygen and liberate contaminants that are easily leached by storm or ground water. On the other hand, Claus (undated) reported that leachate from waste tyres was only toxic to trout fly and that the toxicity reduced significantly with natural dilution, decreasing rubber surface area and increasing time in contact with water.

Irrespective of the literature, it would be prudent to restrict the use of waste tyres to fill applications that are above the ground water table and sealed from contact with storm water. This is especially significant where the applications are in close proximity to water courses.

5.4 Alternative Materials in Chip Sealing

Byproducts that are occasionally used as sealing chip in New Zealand are:

- Meltor slag; and,
- Steel slag – both ex NZ Steel.

Both forms of slag that originate from the NZ Steel operation at Glenbrook are considered to be effectively benign in an environmental sense as long as they are weathered adequately and handled appropriately in stockpiling and transporting (see Section 5.1.4). Slag products also have a relatively low tendency to polish under repeated traffic loading, which promotes favourable skid resistance properties.

Contaminants contained within runoff are significantly more likely to originate from vehicle and tyre emissions that are deposited on the road surface than from the slag sealing chips.

6 RECYCLING & ALTERNATIVE PROCESSES

6.1 In Situ Stabilisation

Description
In situ stabilization is the process whereby chemical additives are mixed with the in situ soil and/or aggregate materials to improve the layer properties. This improvement generally takes the form of mitigating swelling clay minerals in the fine fraction, binding the aggregate particles or simply providing a drying action.

The additive that is chosen will be dependent upon the nature and reactivity of the material that is being treated, the objective of the designer in carrying out the treatment and economics of the various treatment options.

There are a large number of additives, however in general, four are commonly used in New Zealand, i.e.

- Cement;
- Lime;
- KOBM; and,
- Foamed bitumen.

These additives can be used singularly, however it is common practice to use a combination of products to achieve multiple benefits.

Specific Environmental Considerations
The stabilization process is arguably the most scrutinised aspect of pavement recycling in terms of environmental compliance because of the potential impact that a construction mishap can have on adjacent water courses. Moreover, most stabilizing jobs involve a large area of exposure so the potential for environmental damage is relatively high.

The hydraulic binders listed above, i.e. cement, lime and KOBM can all generate caustic dust and runoff water can be highly alkaline. Bitumen contains toxic compounds that must never be allowed to discharge to water courses.

One of the highest risks of environmental contamination involves stabilization additives being washed off the road surface during construction either by heavy rain or damage to water pipes.

Environmental management considerations when planning stabilization activities should include:

Before construction the contractor should:

- Carry out an inspection of the site noting:
    - Surface drainage flow paths.
    - Location of low points.
    - Location of cesspits and manholes.
    - Proximity of adjacent water courses.
    - Possible water diversion routes.
- Search site plans to establish:

    - Stormwater drainage provisions.
    - Sewer system provisions.
    - Location of water mains and valves.
- Arrange for additional labour to be on standby in case of an emergency.
- Arrange for pumps and suction trucks to be on standby in case of an emergency.
- Obtain permission to pump water into the sewer system in case of an emergency.
- Conduct a pre-construction briefing to ensure that all staff on-site are aware of the construction process and the emergency plans.
- Keep a close watch on weather conditions to ensure that construction is not carried out if there is a chance of rain or heavy showers. High winds could also be an issue with powdered additives such as cement and hydrated lime.

During construction the contractor should:

- Keep a close watch on weather and stop work if rain or heavy showers are immanent.
- Pre-hoe the site without additive on the ground to ensure that any conflict with services does not result in wash-off of additive (urban areas).
- Use universal testing paper to monitor the pH of water in cesspits. If the pH exceeds 9 the water should be diverted to ground or removed using sucker trucks.
- Ensure that additive spreaders or other related plant are not washed down on site.
- Endeavour to cover or seal the stabilized layer as soon as practicable after construction.

In the event that a mishap occurs or there is heavy rain during construction the contractor should:

- Contain the site by:
    - Diverting water way from the site using bunds.
    - Blocking cesspits and manholes.
- Shut off water main if it is damaged.
- Monitor pH in cesspits and at nearby stormwater outfalls.
- Pump water into sewer system if allowed by regional authority.
- Divert water until cesspits are clear and pH is less than 9.
- Remove water from blocked cesspits and manholes using suction trucks and dispose of appropriately.

In addition to the above considerations, all plant must be in appropriate working condition, in particular, additive spreaders should be accurately calibrated, bitumen tankers and hoses functioning properly and emergency shut-off valves (for foamed bitumen) checked regularly.

Where possible, plant that is capable of carrying out dustless processes should be used. This not only minimizes the amount of dust that is generated by the process, but it also reduces the risk of additive runoff in the event of heavy rain or a burst water main.

6.2 Milling and Saw Cutting

Asphalt milling and saw cutting of asphalt or concrete are common practices in road maintenance and rehabilitation. Both processes can present significant environmental risks, mainly in terms of fine particles of asphalt or cement which can be liberated as fugitive dust or they can be washed off the road to adjacent water courses in heavy rainfall events or discharge of water used in the saw cutting process.

The contaminants of concern are suspended solids, heavy metals, PAHs and highly alkaline runoff. A proportion of the contaminants originate from the fines produces by the process while the remainder originates from deposition from vehicles.

Asphalt milling of significant areas should be carried out in such a fashion that the availability of fines for entrainment in runoff water is minimized. This includes sweeping the finished surface and disposing of the fines in an approved fashion.

Saw cutting can be carried out using one of three processes, i.e:

- dry;
- semi-wet; and,
- wet.

Environmental measures will be dependent on the size of the job, the proximity of water courses and the process that is used. Dry or semi-wet cutting would be appropriate for small jobs whereas larger jobs would generally require semi-wet or wet processes to be used.

In most instances the use of wet vacuum equipment should be sufficient to collect the fines and wash water that is used in the saw cutting process. On relatively large jobs a similar set of environmental considerations as those presented for in situ stabilization should be used (Section 6.1). This includes thorough planning for containment of the site in the event of heavy rain or a mishap such as a ruptured water main.

Another environmental consideration associated with milling and saw cutting is noise, however this issue is not pursued further in this document.

6.3 Surface Washing / Cutting

High pressure washing and/or cutting of the road surface to restore skid resistance is a technique that is used relatively frequently in New Zealand. It is a cost-effective alternative to resealing in most instances.

The process involves application of water at very high pressure to cut excess bitumen from the surface. The equipment includes powerful suction heads that remove the cutting water and the detritus that is obtained. The equipment can collect up to 3 m^3 of solids and 40,000 l of water per day (AAPA, 2004). These materials must be disposed of in an approved manner to avoid contamination of the environment.

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For most alternative materials, this means that appropriate processing, stockpiling and transportation procedures must be observed, and in general, the materials should be located above the water table. Encapsulation and/or sealing of the materials is also desirable, as is provision of appropriate drainage systems.

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It is important to recognize that sound environmental management is required for construction activities in general, not only for those involving alternative materials or processes. In many instances the environmental credentials of traditional materials may be more questionable than those of alternative materials, especially considering that a major source of contaminants is deposition by vehicles, a process that occurs irrespective of the composition of the pavement surface.

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