

28 November 2006

EPA NT
PO BOX 496
Palmerston NT 0831

Our ref: 31/14369/125317

Attn: Mr Michael Lawton

Dear Sir

Darwin Waterfront Development Proposed Approach for finalising the Audit and Involvement of EPA

1 Introduction

It is the purpose of this document to seek confirmation from EPA regarding the proposed way forward to complete the environmental audits of land and groundwater at the Darwin waterfront development site and, in particular, to allow the auditor to conclude that the land is suitable for its proposed use. In preparing this note we have discussed the requirements with URS and we understand that they are in broad agreement with the approach proposed and its basis.

GHD has been engaged by the NT Government to carryout an environmental audit of the Waterfront site. As specified in the brief for this work and in accordance with the proposal for a draft Environment Protection Objective for management of site contamination in the Northern Territory, GHD is conducting the environmental audit of the Darwin Waterfront site generally in accordance with the Victorian contaminated land audit system, except where NT legislation or the Northern Territory Environment Protection Authority (EPA) specify otherwise. In taking this approach, it is understood that the Victorian audit system or an adaptation of this system is generally precedent in the Northern Territory.

The primary guidance for undertaking such an environmental audit is the Victorian *Guidelines for for Issue of Certificates and Statements of Environmental Audit*, Publication 759b, June 2002. With respect to assessing the requirements for clean up of groundwater and sources of groundwater contamination, important guidance is provided in the Victorian EPA Publication 840 *The Clean Up and Management of Polluted Groundwater*.

2 The Site

The Waterfront site is situated adjacent to Kitchener Bay, and generally consists of a loose fill overlying marine muds which overlie the phyllite (siltstone) bedrock. Fresh (potable) groundwater enters from the escarpment to the north of the site, and gradually becomes saline by the time it reaches the Kitchener Bay shoreline. Increased salinity has been identified in some locations closer to Kitchener Drive, and it appears that this may result from seawater ingress through existing drains or permeable zones although there is uncertainty in this. The groundwater is subject to significant seasonal and tidal influences. Groundwater levels have been measured up to about 4.0 m higher at the end of the wet season, compared to the end of the dry season. Tidal oscillation has been noted within 50 m of the shoreline.



The site contains hydrocarbon contamination of the groundwater, believed to be sourced predominantly from various fuel pipelines which run along Kitchener Drive, but other possible sources include the valve pits associated with the pipelines, historic bombing of fuel storage silos during World War 2, navy fuel storage facilities adjacent the site, activities associated with bitumen plant and fuel transport tunnels situated within the escarpment that were constructed during World War 2, and possibly uncontrolled disposal of oil at some locations.

The hydrocarbon contamination predominantly consists of fuel oil with little or no BTEX detected, and only a small amount of naphthalene has been detected in one area of the site. The contamination is generally present at highest concentrations adjacent Kitchener Drive and while sheens and adsorbed phase have been observed across large areas of the site, the assessment of groundwater quality and inspection of the Kitchener Bay has shown that sheens are not observed in discharges to the Bay, or in the Bay. This can be explained by the processes of natural attenuation in the aquifer and a high level of dilution with seawater as the groundwater approaches the shoreline and is exposed to the large tidal movement of seawater.

Where present, the hydrocarbon contamination is generally seen as a smear zone in the soil around the water table level, with globules of oil that float on the surface of the groundwater. The presence of contamination appears to be highly heterogeneous, with test pits and bores only meters apart with significantly variable concentrations of hydrocarbons present, indicating significant preferential flow pathways and / or residual pockets of a historic fuel source where conditions for attenuation (physical or biological) are more limited. Hydrocarbons as a free phase of greater than 2 mm have been noted only in isolated locations and have not been consistently noted in any given bore, although there are 2-3 bores across the site where free phase has been detected on a number of occasions. It should also be noted that hydrocarbon concentrations are higher when the water table is elevated (when they are mobilised from the soil into the groundwater).

3 Proposed Development

Stage 1 of the proposed site development includes a multi-storey residential apartment block with basement car parks, a multistorey hotel and commercial building with a slab on ground construction with an adjacent multistorey carpark including a basement, a convention centre, restaurant, small utilities buildings, a wave pool and associated plant room and public open space. A sea wall is being constructed across Kitchener Bay which will contain a combined marina and secondary contact recreation lagoon area. Water within the lagoon will be held between 2.5 and 3.0 m AHD, and the shoreline will not be subject to the large tidal movement of water as at present. Water will be pumped from the ocean into the lagoon and turned over at a rate that maintains water quality in the lagoon suitable for secondary contact recreation.

4 Potential for the Contamination to affect Beneficial Uses of the Site

An investigation and assessment of the Waterfront site has been carried out by URS, and this indicates that there is potential for contamination to adversely affect beneficial uses of the land and groundwater at the site. It is an important consideration in this as to whether beneficial uses are relevant, as this can determine whether relevant beneficial uses are affected and therefore whether the auditor can issue a Statement of Environmental Audit that the land is suitable for its proposed use.



With respect to the use of the land at the site, the beneficial uses include human health and aesthetic enjoyment of the site in the context of the proposed development. **We are proceeding on the basis that these beneficial uses need to be protected.**

With respect to groundwater at the site, the beneficial uses that would be protected under Victorian environmental legislation are defined in the *State environment protection policy (SEPP) Groundwaters of Victoria 1997*, with final decisions regarding the relevance of beneficial uses being made by the EPA.

Previous discussions and correspondence with the Darwin Waterfront Corporation and NT EPA have indicated that the beneficial uses of agricultural / irrigation, primary contact recreation, potable and industrial uses are not relevant at the Waterfront site; however, it is required that the aquatic ecosystems and aesthetics of the lagoon be protected. **We are proceeding on the basis that these beneficial uses do not require protection.**

The Victorian SEPP *Groundwater of Victoria* also requires that contaminants should not cause groundwater to become corrosive to structures or building materials. We will consider this.

5 Remediation of the Site

5.1 Overall approach

A remediation plan has been prepared that has the objective of removing contamination that might adversely affect the use of the site as it is proposed to be developed. It has been argued by the Darwin Waterfront Corporation and URS that it is not practical to investigate, identify and remove all sources of contamination across the site, as the location of contamination is uncertain and this would effectively require excavation of the greater portion of the filled area.

Instead, a remediation plan has been formulated that has the objective of identifying contamination that might pose a risk to the development and selectively removing this material, and carrying out other works that protect the Bay noting that the foreshore area will not be exposed to the attenuating effect of large tidal variations, and the water within the marina will be relatively contained and not subject to the very high levels of dilution that presently occur.

The proposed remediation works include the following:

- ▶ Identification and removal of sources of contamination (such as PSH) where possible, and particularly within the footprint of buildings and structures,
- ▶ Removal of disused pipelines and validation of the pipeline corridor.
- ▶ Removal of contamination that might affect the use of the land, such as ore material containing high concentrations of heavy metals.
- ▶ A check of the integrity of remaining infrastructure (such as pipelines) where it cannot be removed because of its on-going use,
- ▶ A check that UXO are not present in areas where subsurface works are proposed and these may intersect UXO.
- ▶ A detailed validation of sensitive areas such as the footprint of buildings to ensure that contamination is not present at concentrations of potential concern to users of the site, as defined by a risk assessment carried out by URS.



- ▶ Construction of a drainage system that will collect contaminated groundwater and avoid contaminated groundwater entering the marina area or migrating under buildings.

In more detail, the proposed works include:

5.2 Removal of sources

Where sources of groundwater contamination are identified, these will be removed. This will include:

- ▶ Removal of pipelines adjacent Stokes Hill Road,
- ▶ Removal of redundant pipelines (particularly along Kitchener Drive) where noted. This work has included the mapping of all pipelines noted on historical maps and encountered during the various excavations. As far as possible these pipelines are being chased out and removed.
- ▶ Where any hydrocarbon contaminated soil is encountered this material will be transferred to the remediation area and the excavation backfilled with soil containing little or no hydrocarbons (Class 1 soil).

5.3 Integrity Testing of Remaining Infrastructure

A single active fuel supply pipeline remaining along Kitchener Drive runs from the Naval fuel infrastructure to supply naval ships docked at Fort Hill wharf. The pipeline is pressure tested above operating pressure before each fuel delivery.

5.4 Validation Program

Test pits and / or bores are being excavated on a 10 m grid beneath the site below where buildings will be located. Where free phase (Class 3 material) is encountered it is being removed. Where hydrocarbon contamination is present that does not form a free phase in water (Class 2 material), it is expected that this may remain if assessment (presently being carried out by URS) shows that it will not pose a risk to the health of persons or give rise to objectionable odours.

5.5 Health Risk Assessment

A quantitative health risk assessment is currently being carried out by URS to assess whether residual Class 2 material might pose an unacceptable risk to human health or give rise to odour. The assessment is considering the proposed construction and use of the building, including the potential for volatiles to migrate into basement and ground floor areas, exposure times, floor slab crack density, proposed drainage holes in the building walls, air exchange rates, depth to contaminated soil and the presence of stairwells / elevator shafts. The preliminary findings indicate that residual hydrocarbons do not contain volatile aromatic compounds at concentrations that could give rise to an unacceptable risk to the users of the site. Note that this work has not been completed, and the outcome is still subject to a satisfactory conclusion of the assessment.



5.6 On-going Remedial System

A drainage system is being constructed that will collect contaminated groundwater and avoid contaminated groundwater entering the marina area, migrating under buildings, or migrating onto adjacent land. This has the particular objective of ensuring that sheens will not be observed in the marina, noting that the high level of tidal dilution will not be available. The system involves a cut-off drain running along Kitchener Drive at an elevation of 2 m AHD where the potential for PSH is highest, together with spur drains running parallel to the buildings at an elevation of 2.5 m AHD. Water entering the drain will be treated via an oil water separator and discharged to sea under licence. This system will intercept rainwater that recharges across the site, and will also allow sea water from the marina to migrate at depth to drain, covering any contamination that remains at depth and reducing the potential for volatiles to migrate into buildings or to the surface of the site.

It is expected that the drainage system will operate until it has been shown that there are no remaining sources of contamination present that could adversely affect the marina or the use of the site. When this is achieved and confirmed by groundwater monitoring, the drainage system may not need to be further operated. URS advise that the site development and design of buildings allows for this to occur, and take into account the increase in groundwater levels that can result. URS advise that the drain has a 50 year design life.

5.7 Natural Attenuation

It is expected that biological degradation of the hydrocarbon contamination will occur over time, and that this will result in the reduction of the residual contamination over time. We are currently reviewing the assessment information provided to confirm this. Preliminary information on this is as follows:

5.7.1 Primary Lines of Evidence

The primary line of evidence that natural attenuation is occurring is where historical data shows that a plume is shrinking or stable. We are currently undertaking an analysis of groundwater data taken since the audit of the site (and hence groundwater monitoring) commenced in 2003. However our current knowledge of the site indicates that this is the case for the following reasons:

- ▶ The site history indicates that hydrocarbon contamination has been occurring for a number of years, from a number of sources and that the quantities are likely to have been significant (particularly spills that occurred when the oil silo's were bombed during World War 2). Site observations indicate that the spread of the plume has been limited, and has not reached the shoreline as would have been expected given the time frame since contamination occurred.
- ▶ Site observations indicate that the hydrocarbons appear to be quite degraded.

5.7.2 Secondary Lines of Evidence

Secondary lines of evidence that natural attenuation is occurring are where a comparison of chemical indicators in and out of the plume indicates that bioremediation is occurring.

Detailed analysis of these indicators is currently being undertaken. However it is noted that:

- ▶ The hydrocarbons present are generally simple molecules that are easy to break down (chlorides, very long hydrocarbon chains or multiple benzene rings are generally less conducive to bio-remediation).



- ▶ Warm Darwin temperatures are conducive to bio-remediation occurring.
- ▶ Electron acceptors are likely to be in plentiful supply, i.e. the high seasonal variation in water table levels (differences of up to 4.0 m have been noted) are likely to re-oxygenate the affected areas, and the sea water intrusion onto the site is likely to be a good source of sulphate (also an electron acceptor).
- ▶ Soils with high concentrations of hydrocarbons excavated and biopiled in the remediation area are showing rapid decline in hydrocarbon concentrations, indicating that a micro-organism population that utilises the hydrocarbons present is likely to already be well established.

6 Non-aqueous phase liquid

Section 18 of the *State environment protection policy (SEPP) Groundwaters of Victoria 1997* states that:

Where non-aqueous phase liquid is present in an aquifer, it must be removed unless the Authority is satisfied that there is no unacceptable risk posed to any beneficial use by the non-aqueous phase liquid.

While NAPL is being removed from the waterfront site where identified, and an intensive (10 m grid) validation program is being undertaken beneath the buildings to identify the presence of NAPL and to remove it where identified, some residual pockets of NAPL are likely to remain on site. URS have outlined a remediation and management program in the RAP to minimise the risks posed to the beneficial uses at the site. This includes the installation of a drainage system and reversal of groundwater flow, and an on-going groundwater monitoring program will provide information about the effectiveness of these measures.

However, as it will not be able to be confirmed that all NAPL has been identified and removed, **we are proceeding on the basis that URS and the auditor will assess the risk associated with the residual NAPL and, assuming this appears to be satisfactory, the auditor will refer this documentation to the EPA so that EPA can confirm that it is in agreement with the proposed course of action.**

7 Potential for soil contamination to affect the beneficial uses of the land

It is important that the residual soil contamination will not adversely affect the future use of the land. URS has assessed this, and has concluded that the soil contamination following clean up will not affect the future use of the land. It is expected that the audit will confirm this conclusion.

8 Potential for groundwater contamination to affect the beneficial uses of the land

It is important that the residual groundwater contamination will not adversely affect the future use of the land, such as may occur through vapours entering buildings. URS is undertaking an analysis of the potential effects of groundwater contamination on the beneficial uses of the land, to ensure that the groundwater contamination will not affect the proposed development.

A risk assessment is being undertaken and, because the groundwater contamination does not include volatile aromatic fractions (such as benzene) or they are only present at low concentrations in limited areas of the site (eg naphthalene), it is expected that this will confirm that the residual contamination will not adversely affect the health of persons at the site in the future. It is also expected that this analysis will show that the residual contamination will not give rise to odours in the buildings.



The assessment will include an analysis of the potential scenarios associated with groundwater movement and groundwater contamination, to confirm that potential impacts resulting from the identified scenarios have been adequately mitigated and controlled. This analysis will include scenarios such as whether groundwater may rise in the future, and whether odorous or oily groundwater could enter the buildings (eg through proposed weep holes).

The auditor has had discussions regarding this and has received a draft of the risk assessment. Initial considerations suggest that the audit will be able to confirm the conclusions of URS that the groundwater contamination should not adversely affect the future use of the land through vapours and groundwater rise, assuming that certain conditions apply regarding the design and construction of buildings at the site, and that the validation confirms that the residual contamination complies with the acceptance criteria.

9 Potential for groundwater contamination to affect the beneficial uses of the groundwater

In terms of assessing the risks of the residual groundwater contamination on beneficial uses of the groundwater, it is necessary to determine which groundwater beneficial uses require protection. This has been discussed in Section 4.

It is assumed that maintenance of aquatic ecosystems is a beneficial use that is to be protected. In this respect, the drainage system has the purpose of avoiding groundwater flow from the site to the marine environment, and would be expected to protect this beneficial use. However this will need to be demonstrated via site observations, and the monitoring program, which will be implemented once the lagoon and other infrastructure affecting groundwater flow are in place. The site management plans will outline a contingency plan to be implemented in the event that the drainage system is inadequate.

While the beneficial use of protection of buildings and structures may be affected by the saline nature of the groundwater, it is understood that the design specification for all buildings and structures is to withstand such conditions, and this is unrelated to the existing soil and groundwater contamination at the site.

With respect to other possible beneficial uses, particularly irrigation, primary recreation and potable use, as stated in Section 4, we have been advised that these do not require protection at this site and we are proceeding on this basis. We also note that there will be an increase in the area over which salt water is present across the site, which may in any case preclude these beneficial uses.

It has been an issue of considerable discussion between the auditor, URS and informally with the Victorian EPA as to whether this situation would require a determination from the EPA that the clean up has been carried out to the extent practicable (CUTEP). The Victorian EPA suggests that in Victoria it probably would, on the basis that groundwater contamination exists and will be controlled by a drainage system, and is not being fully cleaned up. These requirements are discussed in the Victorian EPA Publication 840 *The Clean Up and Management of Polluted Groundwater* which states that:

Groundwater should be cleaned up such that the protection of beneficial uses (existing and potential) is restored. In some cases this will not be possible or feasible, however, in all cases polluted groundwater must be cleaned up to the extent practicable.

And;

The evaluation of practicability should be clearly documented against each of the criteriafor consideration by EPA.



Determining whether clean up has been carried out to the extent practicable must take into account technical, logistical and financial considerations, as defined in Victorian EPA Publication 840. This is documented and provided to EPA, for EPA's decision. If EPA is satisfied that clean up to the extent practicable has occurred, then the audit can be completed (assuming that all other audit requirements have been met), and the auditor is not precluded from proceeding to issue a statement that the site is suitable for the proposed use. Information on the CUTEP process is provided below.

Because these considerations lead to the conclusion that the Victorian EPA would probably require a determination of whether clean up has been carried out to the extent practicable, **we are proceeding on the assumption that this will also be required by the NT EPA.**

Irrespective of whether a CUTEP submission is required by EPA, we expect to assess the basis for the remediation using these principles and include this reasoning in the audit report.

10 Preliminary considerations regarding whether CUTEP would be likely to be supported for the site

We understand that the technical, logistical and financial considerations that support the conclusion that clean up will have been carried out to the extent practicable is currently being prepared by URS. The following points listed below provide preliminary considerations relevant to this. These have been based on preliminary advice from URS, and are subject to our final detailed review of the information provided by URS. Note that discussions have been carried out with a variety of organisations and agencies during the course of the development of a remedial action plan, and there is general support for the proposed approach to remediation.

Irrespective of whether a CUTEP submission is made, we expect to include this information in the audit report as support for the remediation.

The information being compiled by URS is expected to support the conclusion that the clean up undertaken is commensurate with the significance of the pollution and the timeframe for clean up and the reasonableness of this time frame. Information provided by URS will consider, for example, the cost of carrying out a more complete clean up involving excavation of all of the site and the identification and treatment or off-site disposal of all materials that might give rise to groundwater contamination.

The assessment will take into account technical, logistical and financial considerations in accordance with Victorian guidelines. We understand from our discussions with URS that the main elements of the argument in support of CUTEP will be:

- ▶ Technical: the identification of all remaining sources of contamination (such as smeared zone material) across the site would require extensive works and excavation of large quantities of soil from considerable depth across a significant portion of the site, and treatment or off site disposal of the material. Because of the uncontrolled nature of the fill and its variability, it would be difficult to obtain surety regarding the absence of residual contamination at all locations without such works, and even if such works are undertaken, it would be difficult to achieve a high level of certainty that all sources on a local scale have been identified and dealt with to a level that will allow future use of the groundwater (eg for potable purposes). Because of this, there is uncertainty as to whether such more extensive excavation works will result in a fully reliable solution to ensure a sensitive use of groundwater such as potable use.



- ▶ Logistics, the extensive excavation works can be expected to take a considerable time, and to be difficult in terms of the large quantities of material requiring stockpiling, storage and off site disposal.
- ▶ Financial: extensive works of this nature would involve a large cost.
- ▶ Reduction in level of risk: more extensive works will reduce the level of risk associated with residual contamination to users of the site, and to beneficial uses of groundwater and land. However, because the risk posed by the residual contamination if such works were not carried out is expected to be low, it can be concluded that the net benefit achieved by carrying out further remediation works will be small.

11 Conditions pertaining to the site and groundwater monitoring

It is understood that the contamination status of the site will be recorded on the title of the site, probably by attaching the Statement of Environmental Audit to the title. The preferred mechanism for this needs to be confirmed. This could be removed when the beneficial uses of the groundwater have been restored, and would require a submission to EPA outlining the evidence that this had occurred.

It is expected that because sources of groundwater contamination will remain in place following remediation, ongoing groundwater monitoring will be required until it has been confirmed that the contamination is reducing and does not pose an unacceptable risk. The requirements for monitoring will be detailed in a Groundwater Monitoring Plan. This Plan could require, for example, groundwater sampling and analysis to be carried out quarterly until groundwater trends stabilise under the new flow regime, and then reduced to a lesser frequency (eg biannually - wet and dry season). When beneficial uses have been restored (i.e. there is no groundwater pollution) or it can be assured that the residual contamination does not present a risk, a submission can be made to EPA to obtain agreement that monitoring may cease.

We will be pleased if you will confirm that this course of action is consistent with your requirements.

If you have any queries, or require further clarification regarding this matter please call.

Yours faithfully
GHD Pty Ltd

A handwritten signature in black ink, appearing to read 'Peter Nadebaum', written in a cursive style.

Peter Nadebaum
Environmental Auditor
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