

REASSESSING THE VALUATION OF CONTAMINATED LAND IN AUSTRALIA

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ABSTRACT

The issue of the valuation of contaminated land was explored 10 years ago by the author. Since then, there have been new developments in the technology of decontamination and changes in people's risk perception over time. Due to the shortage of land supply, more rural land and former industrial sites are converted to commercial and residential uses than before. There is a need to carry out new research to see how contaminated land is valued in Australia today. The survey reveals a number of findings including that the use of the unaffected valuation approach is still dominant in Australia.

Keywords: Contaminated land, valuation methods, risk perception, stigma issues.

INTRODUCTION

Australia is the only country in the world that occupies a whole continent. It has a land area of about 7.7 million square kilometres and a population of around 20 million. It is easy for one to form the opinion that land is plentiful in Australia and the people have the largest share of land per capita. In fact, habitable land in Australia is limited and the geographical features force the majority of the people to settle in several big cities around the country.

The expansion of population has seen vacant development land in urban areas getting scarce. Conversion of rural land and former industrial sites for higher value use has become an important means to increase land supply. For example, in Sydney, the state government has designated growth centres in the north-west and south-west to release rural land for 160,000 dwellings over the next 25 to 30 years (Sartor, 2005).

As for the redevelopment of former industrial sites, the list below provides some recent examples in Sydney:

1. The former Defence Naval Stores site (19.62 ha) on the northern shores of Parramatta River at Ermington. In November 2006, consent was granted for residential redevelopment of the site by stages. Site remediation is required to remediate various types of heavy metal and hydrocarbon contaminants (NSW DoP, 2008a).

2. The former Carlton & United Brewery site (5.8-hectare) on the western edge of the Sydney CBD. The redevelopment concept plan was approved in February 2007 to provide office space, apartments and a 5,400 square metre community park. Certain parts of the site were affected by petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAHs). Remediation work is required for the redevelopment (NSW DoP, 2008b).
3. Residential development at Precinct C (6,795m²), Rhodes Peninsula. The site comprised reclaimed land formed by filling materials supplied by the former chemical manufacturer Union Carbide Australia. The backfill materials are very toxic and remediation must be completed before any construction certificate is released. The redevelopment project was approved in April 2008 (NSW DoP, 2008c).

Rural land or former industrial sites might be contaminated by previous uses. A contaminated site is defined by the Australian National Health and Medical Research Centre (NHMRC, 1999) as “a site where toxic chemicals that have the potential to be harmful to human health or to the environment are present at levels higher than those normally found in the area”. The document goes further to explain that land contamination “may occur following use of the land for industrial, agricultural or commercial activities. Contamination can also occur after waste disposal, spills or storage of raw materials, or from neighbouring properties following movement of the chemical (for example by wind, movement through the soil, or in ground or surface water). Chemicals that could be found at a contaminated site include metals (like lead or arsenic), oil, tar, explosive gases, solvents, or other poisonous or hazardous wastes”.

Before development or redevelopment, the market value of the subject contaminated land has to be assessed. Valuation of contaminated land is not a simple task. It is a cross-disciplinary practice that requires knowledge in economics, environmental impact assessment and planning, property management, human health risk, identification and remediation of contaminated land and valuation (Chan, 2003). Valuation methods have to be suitably adapted and specific valuation assumptions have to be made.

A survey of Australian valuers was conducted 1998 to find out how they valued contaminated land (Chan, 2000). Since then, there have been new developments in the technology of decontamination and changes in people’s risk perception over time; see more discussion below. In order to find out if Australian valuers have changed their approaches to value contaminated land, a survey was conducted in August 2008. This paper is based on the findings from the current survey.

PROGRESS IN REMEDIATION TECHNOLOGY AND CHANGE OF RISK PERCEPTION

There has been progress in remediation technology over the years. Some methods are

innovative and some are cost effective, such as the removal of atrazine (a chemical commonly found in herbicides) by supercritical extraction method¹ (Castelo-Grande & Barbosa, 2003) and the removal of zinc from industrial effluent by sand (Aslam, Hassan & Malik, 2004). The World Intellectual Property Organisation's database has recorded 27 new patents of soil decontamination methods since 1998 (WIPO, 2009).

In Australia, innovative and reliable methods are used to remediate contaminated sites. For example, in the redevelopment of the former ICI Dulux paint factory site in Cabarita, Sydney, the developer used on-site contaminated soil excavation and advanced soil washing method to make the site "cleaner than clean" (i.e. cleaner than background level) (Chan, 1999). This helped reduce the risk perception and eventually the whole project was sold without stigma impact.

Another example is the Botany Industrial Park, commonly known as the Orica site. It is a 74ha site at 11km south of the Sydney CBD. Over the years, the industrial activities had contaminated the groundwater with 1, 2-Dichloroethane (EDC) and other toxic chemicals. The toxic groundwater plume has spread 2 km² covering the area under the homes of about 1000 residents (Skelsey, 2004). The remediation method chosen is air stripping plus recuperative thermal oxidiser. Construction works for the groundwater treatment plant were approved in February 2005, and Orica needs to work non-stop for 30 years to clean up the toxic groundwater (Peatling, 2004). This remediation technology claims to have a destruction efficiency of greater than 99.99% (URS, 2004).

There is also change of risk perception. Risk perception is defined as "the subjective judgment that people make about the characteristics and severity of a risk" (Wikipedia, 2009). Since contaminated land may cause health and environmental problems, the risk perception can significantly affect the market value of the land.

Residential use is a sensitive land use. It is a general belief that resident properties built on a widely publicised former contaminated site may cause concerns of buyers. This belief, however, is not always supported by market evidence. Given that risk perception is psychologically based, it may change over time and vary according to the people's knowledge about the contaminated land and the condition of the property market. For example, due to the transparent communication with the local council and the public, and the use of advanced remediation method, the market inflicted no stigma value deduction on the residential redevelopment of the Cabarita ICI site mentioned above when sales began in around 2000.

In a recent study of home buyers' risk perception of residential development built on former contaminated land, Petersen (2008) investigated the sales of residential units built on the former Union Carbide site (a notorious contaminated site at Homebush Bay in

¹The supercritical extraction method makes use of a supercritical fluid (i.e. any substance when used above its critical pressure and temperature forms a good solvent) to extract solutes from solid matrices.

Sydney) in the Rhodes Peninsula. He finds that the “stigma effect is not getting much attention” as expected. Neither the real estate agents nor home purchasers he came across expressed that they had concern about the stigma issue.

THE PREVIOUS SURVEY

The previous survey was carried out in April 1998. Due to resource constraints, only valuers in New South Wales, Queensland and Victoria were surveyed. These three states were the most populous states in Australia and about 70% of the valuers worked there. Opinion from valuers in these three states was believed to be sufficiently representative of all Australian valuers. Questionnaires were sent to 500 valuers in the three states. The address of valuers was supplied by the divisional office of the Australian Property Institute (API) in the three states. The NSW office supplied 1368 addresses, the Queensland office 28 and the Victoria office 19. Since the number of addresses from Queensland and Victoria was relatively small, they were all taken. The remaining 453 addresses were randomly selected from the New South Wales list. There was also a follow-up interview of 40 participating valuers – 22 in New South Wales, 11 in Queensland and 7 in Victoria. Altogether 107 valuers responded to the survey. The response rate was 21%.

THE CURRENT SURVEY

In the current survey, the same questionnaire, except with some minor updates, was posted to valuers in New South Wales, Queensland and Victoria. Due to resource constraints, a total of only 300 valuers were surveyed this time; 100 valuers were randomly picked from each of the states. For Victoria, the divisional office of the API supplied an address list of 126 valuers, 100 valuers were randomly chosen from the list. The address of valuers in New South Wales was randomly picked from the Certified Practicing Valuers booklet published by the New South Wales divisional office. For Queensland, the address of valuers was randomly selected from the Queensland Valuers Registration Board web site. The resource constraints did not allow a follow-up interview this time. In this survey, a total of 83 valuers returned feedbacks, giving a response rate of 28%.

ANALYSIS OF SURVEY RESULTS

In the previous survey, for the purpose of data analysis, valuers who had valued 6 or less contaminated property were regarded as being less-experienced and those who valued more than 6 were regarded as being more-experienced. This grouping method is also used to analyse the feedback for the current survey. It should be noted that the grouping is for the purpose of data analysis in this study only; it does not mean that valuers in the less-experienced group are inexperienced valuers.

Response rate analysis

The questionnaire was mailed to the valuers and two reminders were sent to them. The response rates are shown in the table below:

Table 1: Response rate analysis

Action	New South Wales		Queensland		Victoria		Total	
	2008	1998	2008	1998	2008	1998	2008	1998
No. of questionnaire sent	100	453	100	28	100	19	300	500
No. replied	29	90	25	11	29	7	83	107
Response rate (%)	29	20	25	37	29	39	28	21
Valuers with experience in valuing contaminated land	5	45	3	11	7	7	15	63
No. of contaminated land valuation done by individual valuer	3 – 6	1 – 100	5 – 10	1 – 50	3 – 50	2 – 30	n/a	n/a

The response rates for the current survey (total 28%) are higher than those in 1998 (total 21%). However, the number of valuers with experience in valuing contaminated land has dropped significantly. In addition, the number of contaminated land valuations done by an individual valuer is less than the previous survey (3-50 in 2008 vs. 1-100 in 1998). This could be due to the smaller scale of the current survey and the small number of responses from valuers. In the current survey, 60% of the experienced valuers are in the more-experienced group and 40% in the less-experienced group.

Similar surveys were carried out in the UK (cited in Kinnard, Worzala, Bond & Kennedy, 1999), New Zealand (Bond, 1998) and the USA (Kinnard, Worzala, Bond & Kennedy, 1999). The response rate of both surveys in Table 1 is lower than that in the UK, New Zealand and the US (54%, 47% & 46% respectively). The higher overseas response rate could be due to the valuers surveyed in those studies were all preselected and some of them had replied to a call for participation. The overseas surveys did not group respondents into more-experienced and less-experienced groups.

Opinion on contaminated land guidance note

Valuation of contaminated land in Australia is governed by documents published by the valuation professional body. The first Contaminated Land Practice Standard was published by the Australian Institute of Valuers and Land Economists (now the Australian Property Institute) in 1994. The document was replaced by a Practice Guidance Note in the subsequent years. In 2006, the Australian Property Institute and the New Zealand Property Institute (PINZ) jointly published a guidance note – Consideration of Hazardous and Toxic Substance in Valuation, and ARPGN1 Land Contamination Issues. In 2008, the two institutes joined force again to revise the two documents in the latest issue of practice guidance document – Valuation and Property Standards. The following table shows the participating valuers’ opinion on the documents.

Table 2: Opinion on contaminated land guidance note

Questions	Less-experienced group		More-experienced group	
	(%)(Yes)		(%)(Yes)	
	2008	1998	2008	1998
Are you aware of the valuation Guidance Note “Consideration of Hazardous and Toxic Substances in Valuation” or the previous documents?	89	90	100	91
Do you refer to the Guidance Notes when valuing contaminated land?	78	68	83	72
Do you follow the valuation approaches outlined in the documents?	67	65	67	78
Do you think the valuation approaches reflect real life practice?	56	45	83	59
Do you find the contents of this document helpful/practical?	78	77	83	78

It can be seen that valuers in the less-experienced group were marginally less aware of the Guidance Note (89% in 2008 vs. 90% in 1998); but overall there was more reference to the documents than the previous survey. In contrast to the 1998 survey figures, more valuers in both groups said that the Guidance Note reflects real life practice. It could be inferred that the contents of the current Guidance Note are more helpful than the previous versions.

The overseas surveys mentioned above did not include this item, so there is no comparison.

Valuation approach analysis

Contaminated land may be valued by the unimpaired or impaired approach. The unimpaired approach, otherwise known as the unaffected valuation approach, requires the valuer to assess the contaminated property as if it were clean. This assumption is explicitly made in the valuation report and the client is warned about the likely value impacts due to the land being contaminated. No doubt a valuation done in this manner is not very helpful and the value assessed does not reflect the actual condition of the property.

In contrast, the impaired approach, otherwise known as the affected valuation approach, requires the valuer to take into consideration that the property is contaminated. The first step is for the valuer to value the property as if it were clean. The valuer then makes a deduction for the operational loss due to land contamination, cost of investigation and remediation, and any value reduction due to stigma impact.

These two approaches are documented in the Guidance Note. The survey results regarding the application of the approaches are summarised in the table below.

Table 3: Contaminated land valuation approach adopted

Suggested valuation basis	Less-experienced Group (%)		More-experienced Group (%)	
	2008	1998	2008	1998
Unimpaired approach	67	55	83	81
Impaired approach	89	52	33	56

Unlike the previous survey results, there were more valuers in both groups using the unimpaired approach (67% & 83% in 2008 vs. 55% & 81% in 1998). The reasons given by the valuers for using this approach include “depends upon our instructions”, “depends on information available”, “if costs unknown” and “if client wants that”. It should be noted that, by instructing a valuer to use this valuation approach, it does not mean the client is not concerned about environmental issues or the stigma impact on the property value; see survey results in Table 5 below.

As for the use of the impaired approach, the reasons given by the valuers in the current survey include “if sufficient comparable sales evidence was available”, “depending on information provided”, “depends upon our instructions”, “depends on information available”, “if costs are known”, and “depends on expert, if more information is known”.

The survey figures also show that more valuers in the less-experienced group (89%) than the more-experienced group (33%) used the impaired approach. The discrepancy could be due to the smaller scale of the current survey, with the small number of responses.

In the US, 54% of the respondents claim to use the unaffected (unimpaired) approach. This question was not included in the UK and New Zealand surveys; therefore no comparison can be made.

Analysis of valuation method used in practice

The table below shows the valuation methods used by the responding valuers for contaminated land valuation in practice.

Table 4: Valuation methods used in practice

Valuation Methods	Less-experienced Group (%)		More-experienced Group (%)	
	2008	1998	2008	1998
Comparison method	78	81	100	78
Capitalisation method	11	52	67	56
Cost approach	44	71	33	59
Hypothetical development method	56	42	67	52
Accounts method	0	16	0	6
DCF method	22	32	50	16
Environmental balance sheet approach	11	3	17	13

It should be noted that the valuation methods listed in the table are the same methods used to value clean properties. The difference is, in contaminated land valuation, the valuer needs to make further adjustment for remediation cost, other financial losses and stigma factor, etc. if the impaired valuation approach is adopted.

The survey results show that the comparison method remains the most popular method in both previous (81% & 78%) and current surveys (78% & 100%). In contrast, 80%, 0% and 29% of the respondents in the US, UK and New Zealand respectively use this method.

In the previous survey, the cost approach was the second most popular valuation method. It is ranked third in the current survey while the hypothetical development method moved up to the second position. These two methods were not covered in the relevant overseas survey, so there is no comparison.

The capitalisation method used to be the third most popular method; it remained popular this time only among valuers in the more-experienced group (67%). In comparison, 80%, 100% and 100% of the respondents in the US, UK and New Zealand respectively use this method.

There was no change to the ranking of the DCF method. In the current survey, there are more valuers in the more-experienced group (50%) and less valuers in the less-experienced group (22%) using this method. In comparison, 64%, 7% and 29% of the respondents in the US, UK and New Zealand respectively use this method. It shows that Australian valuers are more open to using this method than their counterparts in the UK.

The environmental balance sheet approach was only sparingly used and no valuer in the current survey used the accounts method. The overseas surveys did not cover these two methods, so there is no comparison.

Stigma issue analysis

Stigma “arises from the effect of present or past contamination upon the market’s perception of the property and represents a discount, beyond the direct and indirect costs likely to be incurred, required to compensate for the risks associated with contaminated or previously contaminated property including the risk of achieving the planned remediation” (API & PINZ, 2008). The following table shows the attitude of clients and valuers in stigma issues.

Table 5: Attitude of clients and valuers

Questions	Less-experienced Group (%)		More-experienced Group (%)	
	2008	1998	2008	1998
Clients concern for stigma impact (Yes)	78	48	83	56
Allowance for stigma impact in valuation	89	58	75	72

In the current survey, more valuers in both groups, 78% and 83% respectively, said that their clients were concerned about stigma impacts on the land value. This is an increase from the previous survey results (48% and 56%). It reflects that clients are more concerned about the impact of stigma on property value than 10 years ago. The increase may be due to increasing environmental awareness as well as legal liability considerations. The overseas surveys did not cover this area so there is no basis for comparison.

It should be noted that the client’s concern for stigma impact does not mean that the client cannot instruct the valuer to use the unimpaired approach to value the property. In certain

circumstances, such as for book value or existing use purposes, despite knowing that the property is contaminated, a client may only want to know the value for the property on clean land basis.

In the earlier section on change of risk perception, there was evidence to suggest that purchasers were getting less concerned about stigma issues. The finding does not mean that valuers can altogether forget about making allowance for stigma impacts. The instructing party's requirements and the issue of professional liability would urge valuers to consider likely stigma impacts in contaminated land valuation. These possible reasons may help explain the apparently contradicting figures in Table 5 that there are more valuers in the current survey made allowance for stigma impacts in their valuation.

Adjustment for stigma impacts can be done by different methods. The table below summarises the current survey results of stigma adjustment methods.

Table 6: Stigma adjustment approaches

Questions	Less-experienced Group (%)		More-experienced Group (%)	
	2008	1998	2008	1998
Arbitrary discount rate	33	16	33	22
Percentage adjustment	89	29	67	28
Lump sum adjustment	44	3	33	6
Other methods	0	3	0	13

The table shows that in the current survey, the number of valuers in both groups using all three adjustment methods has increased. There was a big increase in the application of the percentage adjustment method. In comparison, 66%, 80% and 83% of the respondents in the US, UK and New Zealand respectively use increased discount rate for adjustment.

None of the valuers in either group used other methods. This is a sharp contrast to the previous survey results that valuers used other methods such as zero adjustment, arbitrary adjustment, higher profit and risk factor, using comparable evidence and lower loan-to-value ratio method (Chan, 2000). The UK and New Zealand respondents only used reduced rental income as alternative method for adjustment. In a separate survey, Richards (1997) finds that valuers in the UK mainly use upward adjustment to all-risk-yields or discount rate and percentage end deductions to value to account for stigma. In contrast, Australian valuers use more stigma adjustment methods than their overseas counterparts even though no other methods are used as per previous survey.

Analysis of the Australian valuation methods

The advances in soil decontamination technology and the change of risk perception can influence the choice of valuation methods. Do valuers really know about the progress in soil decontamination methods? In the current survey, valuers were asked if they worked with an environmental auditor/consultant for each contaminated land valuation. The responses are summarised in Table 7 below. As the changes in soil decontamination techniques and risk perception were not studied in the previous survey, Table 7 only lists the responses from the current survey.

Table 7: Working with environmental experts

Valuers	Yes (%)
Less-experienced group	67
More-experienced group	67

The figures show that 67% of valuers from both groups worked with environmental experts for each contaminated land valuation. Those who did not work with an environmental expert might have been instructed by the client to use the unimpaired approach or that working with an environmental expert was not necessary for the individual valuation task. Thus it can be inferred that the valuers were indirectly aware of the progress in soil decontaminated technology through contact with environmental experts and they chose the appropriate valuation method accordingly.

The impact of risk perception on contaminated land value is reflected by the stigma adjustment process. The figures in Table 6 show that only the arbitrary discount rate, percentage adjustment and lump sum method were used for stigma adjustment. The valuers must have chosen the appropriate stigma adjustment method with regard to the prevailing risk perception in the property market and the actual site conditions.

Against the background of new developments in soil decontamination methods and the change of risk perception, the current survey results show that the comparison method is still the preferred valuation method among Australian valuers. This method is the best valuation method if comparables are available. It was used in the study of contaminated land valuation by a number of researchers, such as Patchin (1994), Mundy (1992), Wilson (1994), Simm (1997), Fisher, Lentz and Tse (1992) and others. Nevertheless, the transaction of contaminated land is infrequent and it is difficult to get good comparables. The comparison method is more appropriate for valuing clean land. Table 3 shows that there are more valuers using the unimpaired approach. Since the unimpaired approach assumes the land is clean, it helps explain why the comparison method remains the preferred method.

The current survey shows that the hypothetical development method is the second preferred method. This method is generally used for estimating the market value of land

with development or redevelopment potential. The fact that it is ranked second supports the earlier statement that more rural land and industrial sites are being converted for higher value use.

Regarding the capitalisation method or income approach, valuers in the more-experienced group give it the same ranking as the hypothetical development method. There is an increase in the application of the capitalisation method by the more-experienced valuers (67% in 2008 vs. 56% in 1998). However, the use of this method by valuers in the less-experienced group has dropped significantly (11% in 2008 vs. 52% in 1998). The sharp contrast may be due to the smaller scale of this survey and the small number of survey responses received. The same reason also explains the difference in the previous and current survey results regarding the cost approach, DCF method and the environmental balance sheet approach.

None of the valuers from either group in the current survey applies the accounts method. The accounts method is generally used to value special properties such as hotels, licensed premises and nursing homes, etc. The fact that it was not used by the valuers might be due to valuers did not come across contaminated properties in this category. Alternatively, the anomaly could be explained by the same reasons that the current survey has a smaller scale and there is less response to the survey.

In this round of survey, no valuer used other methods to value contaminated land. It appears that the progress in soil decontamination technology and the change of risk perception did not persuade the valuers to use other valuation methods. Over the years, researchers have suggested different alternative methods for valuing contaminated land, such as survey method (Greenberg & Huges, 1993; McLean & Mundy, 1998), multiple regression analysis (Dotzour, 1997; Reichert, 1997), option pricing approach (Lentz & Tse, 1995), mortgage-equity analysis approach (Chalmers & Jackson, 1996), Monte Carlo simulation method (Gain, 1990; Weber, 1997), expected utility model (Whiltshaw, 1996), conjoint analysis (Bond, 2001), multi-criteria decision-making approach (Chan, 2002) etc.

The finding that the valuers did not use other valuation methods might be due to a number of possible reasons such as the existing methods are applicable for the valuation, they are not aware of the existence of these methods or they do not have the necessary skills to apply the methods. If the last two reasons are the case, it is not a healthy sign. In a highly competitive business environment, the lack of knowledge in the latest development in valuation methodology may make valuers look conservative.

CONCLUSION

Since the previous survey, there have been new developments in the technology of soil decontamination and changes in people's risk perception over time. The current survey

shows that there is an increase in the awareness of the contaminated land Guidance Note published by the API and PINZ. There is also an increase in the number of valuers who found the contents of the guidance note helpful and practical. Regarding the valuation approach, the unimpaired approach is still most popular.

Despite the evidence that purchasers are getting less concerned about stigma impacts, the current survey finds that clients are now more concerned about the environmental issues of the land, and there are more valuers making allowance for stigma impacts on land value. The anomaly could be due to the legal liability concern of the clients and valuers.

The analysis above infers that Australian valuers are aware of new developments in soil decontamination technology and the change of risk perception in the property market. The current survey finds that the new developments in soil decontamination technology and the change of risk perception have little impact on the choice of valuation methods. The valuers still prefer to use the unimpaired approach and the comparison method to value contaminated land. The current survey also finds that apart from some changes in the ranking of preferred methods, Australian valuers only use the valuation methods listed in Table 4. They do not use other valuation methods. One possible reason is that the valuers are not aware of the alternative methods.

Valuers, like other professionals, need to enhance their knowledge. It will be more effective if the API can organise seminars to broaden the valuers' knowledge in the alternative methods. In addition, the API may update the next issue of the contaminated land Guidance Note by incorporating the alternative methods in the document.

REFERENCES

Aslam, M.M., Hassan, I. & Malik, M., 2004, Sand As Adsorbent For Removal Of Zinc From Industrial Effluents, *Electrontronic Journal of Environmental, Agricultural and Food Chemistry*, Vol. 3, No. 6, pp. 792–798.

API and PINZ, 2006, *Professional Practice*, 5th edition.

API and PINZ, 2008, *Valuation and Property Standards*, 6th edition.

Bond, S.G., 1998, *The Appraisal of Contaminated Land in New Zealand*, paper presented at the 14th American Real Estate Society Conference in conjunction with the International Real Estate Society Meeting, Monterey, California, April 15 – 18.

Bond, S., 2001, The Use of Conjoint Analysis to Assess the Impact of Environmental Stigma, *Pacific Rim Property Research Journal*, Vol. 7, No. 3, pp. 182-191.

Chalmers, J.A. & Jackson T.O., 1996, Risk Factors in the Appraisal of Contaminated Property, *The Appraisal Journal*, LXIV (1), pp. 44 – 58.

Castelo-Grande, T. & Barbosa, D., 2003, Soil Decontamination By Supercritical Extraction, *Electrontronic Journal of Environmental, Agricultural and Food Chemistry*, Vol. 2, No. 2, pp. 331–336.

Chan, N., 1999, The Impact of Environmental Planning on the Value of Contaminated Land, *Australian Land Economics Review*, Vol.5, No. 1, pp. 8 – 20.

Chan, N., 2000, How Australian Appraisers Assess Contaminated Land, *The Appraisal Journal*, Vol. LXVIII, No. 4, pp. 432 – 440.

Chan, N., 2002, Stigma Assessment – A Multi-criteria Decision-making Approach, *Pacific Rim Property Research Journal*, Vol. 8, No. 1, pp. 29 – 47.

Chan, N., 2003, Contaminated Land Valuation Methods – The Current Status, *Australian Property Journal*, Vol. 37, No. 8, pp. 567 – 572.

Dotzour, M., 1997, Groundwater Contamination and Residential Property Values, *The Appraisal Journal*, LXV (3), pp. 279 – 285.

Fisher, J.D., Lentz, G.H. and Tse, K.S.M., 1992, , Valuation of Commercial Properties Contaminated With Asbestos, *Journal of Real Estate Research*, 7, pp. 331 – 350.

Gain, K.J., 1990, Appraising by Probability Analysis, *The Appraisal Journal*, LVIII (1), pp. 119 – 126.

Greenberg, M. & Huges J., 1993, Impact of Hazardous Wastes Sites on Property Value and Land Use: Tax Assessors' Appraisal, *The Appraisal Journal*, LXI, (1), pp. 42 – 51.

Kinnard, W.N., Worzala, E.M., Bond, S. & Kennedy, P., 1999, *Comparative Studies of United States, United Kingdom and New Zealand Appraisal Practice: Valuing Contaminated Property*, paper presented at the 15th American Real Estate Society Annual Meeting in Tampa, Florida, April 7 – 10.

Lentz, G.H. and Tse, K.S.M., 1995, An Option Pricing Approach to the Valuation of Real Estate Contaminated with Hazardous Materials, *Journal of Real Estate Finance and Economics*, Vol. 10, No. 2, pp. 121 – 144.

Patchin, P.J., 1994, Contaminated Properties and the Sales Comparison Approach, *The*

Appraisal Journal, LXII (3), pp. 402 – 409.

McLean, D.G. & Mundy B., 1998, The Addition of Contingent Valuation and Conjoint Analysis to The Required Body of Knowledge for the Estimation of Environmental Damages, *Journal of Real Estate Practice and Education*, Vol. 1 (1), pp.1 – 19.

Mundy, B., 1992, The Impact of Hazardous Materials on Property Value, *The Appraisal Journal*, LX (2), pp. 155 – 162.

National Health and Medical Research Council (NHMRC), 1999, *Toxicity Assessment Of Carcinogenic Soil Contaminants*, p. xi.

New South Wals Department of Planning (NSW DoP), 2008a, Former Naval Stores Site at Ermington – Phases 6 and 8 residential development (MP 06_0289)
http://www.planning.nsw.gov.au/asp/06_0289.asp, accessed 22 October 2008.

New South Wals Department of Planning (NSW DoP), 2008b, CUB site,
<http://www.planning.nsw.gov.au/plansforaction/cub.asp>, accessed 22 October 2008.

New South Wals Department of Planning (NSW DoP), 2008c, Project: Two Residential Flat Buildings, Lot 104, 42 Walker Street, Rhodes (MP 05_0043),
http://www.planning.nsw.gov.au/asp/05_0043.asp, accessed 22 October 2008.

Peatling, S., 2004, Contested bay clean-up may take 30 years, *Sydney Morning Herald*, Wednesday 17 November, p. 3.

Petersen, B., 2008, *Rhodes foreshore and the Stigma Effect*, coursework for Sustainable Development and Urban Development program, University of New South Wales, 19 April.

Reichert, A.K., 1997, Impact of a Toxic Waste Superfund Site on Property Values, *The Appraisal Journal*, LXV (4), pp. 381 – 392.

Richards T., 1997, Beware the Contamination Factor in Valuation, *Chartered Surveyor Monthly*, May Issue, pp. 28 – 29.

Sartor, F., 2005, Media Release - *Planning for Sydney's Growth*, 22 September,
http://www.metrostrategy.nsw.gov.au/dev/digitalAssets/1339_1127710794914_050922%20MR%20sustainable%20land%20release.pdf

Simm, G., (1992) Problems for the valuation surveyor, paper presented at *Seminar on 'Environmental Assessment'*, Sheffield City Polytechnic, 5 March 1992.

Skelsey, M., 2004, \$320 The only penalty paid by Orica for nation's worst chemical spill, *The Daily Telegraph*, Thursday 2 September, p. 23.

Starr, C., 1969, Social Benefits versus Technological Risks, *Science*, Vol. 165, No. 3899, pp. 1232 – 1238.

URS, 2004, *Botany Groundwater Cleanup Project – Environmental Impact Statement*.

Weber, B.R., 1997, The Valuation of Contaminated Land, *Journal of Real Estate Research*, Vol. 14, pp. 379 – 398.

Wikipedia, circa 2009, *Risk Perception*, http://en.wikipedia.org/wiki/Risk_perception, accessed 4 January, 2009.

Wilson, A.R., 1994, The Environmental Opinion: Basis for an Impaired Value Opinion, *The Appraisal Journal*, LXII (3), pp. 410 – 423.

Wiltshaw, D.G., 1996, An Economic Analysis of Contaminated Land, Remediation and Liability, *Journal of Property Research*, Vol. 13, pp.131 – 141.

World Intellectual Property Organization (WIPO), circa 2009, Patent Search, <http://www.wipo.int/pctdb/cgi/guest/irange5>, assessed 4 January, 2009.

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