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Full Length Research Paper

Identifying water and air pollution stresses in Macarthur region: Australia to analyse ecologically sustainable development

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ABSTRACT

The suburb of Minto is located within the global coordinate system of 34.0265°S and 150.8507°S and is located in Campbelltown City Council. The area is originated over Hawkesbury Sandstone juxtaposition by Wianamatta Shale and enjoys deep ravine topography. An examination of soils at outcrop has confirmed that the project site is situated on the foundation of Wianamatta Shale. Environmental processes are actively under surveillance round the clock in Australia and Macarthur region is not an exception. The entire country has developed modern setup of environmental protection procedures in protecting every single Water Source and carving gaseous emanation from industries. Greater Sydney is one of the few locations in the world where tap water is superb and aquatic ecosystem is good (>75%). Sydney drinking waters are aesthetically excellent, ecologically well balanced and taste is magnificent. Water management companies such as Sydney water has to go through stringent water quality test at Sydney state-of-the-art laboratory to satisfy water experts before they are allowed to supply tap water for residential consumption. Air pollution industries have been monitored round the clock to restrict air pollution beyond the admissible limit. Air pollution in the Macarthur region ranges from 34-36 RAQI which is good and safe comparing with international standard. The research shows effect of particulate matter PM10 exposure can cause deaths up to 40 days after the exposure. In the baseline model using PM10 it is found the overall PM10 effect (per 10 micro g/m 3) was 0.74% for respiratory deaths and 0.69% for cardiovascular deaths. In unrestricted distributed lag models, the effect estimates increased to 4.2% for respiratory deaths to 1.97% for cardiovascular deaths. PAH air pollutants contributes to slower processing speed, attention-deficit/hyperactivity activity disorder symptoms, externalizing problems in urban youth by chemicals exposure arch Carbon Monoxide (CO); Nitrogen Dioxide (NO_2); Ozone (O_3); Sulphur Dioxide (SO_2); Lead (Pb); Volatile Organic Carbon (VOC's) are far below the desired level. Old service stations plays dominant role in polluting surrounding environment of Campbelltown are replaced with the robust greener technology that render service to lot more vehicles in one out-let, transforming them from pollution producing to generation of fun loving environment while refuelling their vehicle. The improved management practice efficiently reducing number of service stations establishing at strategic location convenient for consumers. Older service station that is more damaging for the environment is progressively replaced with more environment friendly services and no damage for the environment such as child care centres. Above all it is a matter of great pride that environmental and water resources management and techniques of emission control is one of the best in the world.

Keywords: Soil, Formation, Geochemical, Waterways, Emission, Pollution, Effluent, Biodiversity

INTRODUCTION

The world's development towards better living better with a better quality of life is inherent and Australia is always one step ahead among the rest of world. Australia is working very hard to protect the environment processes to achieve Ecologically Sustainable Development (ESD to match with the economic development (Environmental Planning and Assessment Act, 1979; Environmental Planning and Assessment Regulation, 2000). The damage that was

inflicted during worldwar-1 and worldwar-2 the country is steadily replacing the old industrial setup with the most advanced environment friendly production line that improve productivity enormously while the it becomes very kind to mother nature. For example the Hawkesbury river precinct that was once levelled as the most polluted industrial site in Australia which has been hygienically cleaned and is now one of the world popular Olympic venue for the world. Similarly every single old industry in the Macarthur region has been has either redeveloped; replaced or commissioned new industry has been setup with ESD principle. The massive unplanned growth of industries during the western industrial revolution has inflicted great damages to the local as well as global environment. Although the world community is now aware of these damages but experiencing great difficulty to reduce or rapidly winding up pollution emission. Since the introduction of UN sponsored "Triple Bottom line Principle (Slaper et al., 2011)", nations around the world are increasingly putting in place stringent regulatory requirements to deter environmental pollution but lot more efforts are still needed to achieve visible progress. The phenomenon of Global Warming, Green House Gas Emission, Sea Level Rise, Salinity Increase, Change of Weather pattern (too much and too little rain fall, untimely rainfall, rise of temperature etc), an increase in Natural disasters (Cyclone, Tornadoes, Floods, Hail Storm, Severe Bushfire and others) are no longer a myth but are the harsh reality (Protection of the Environment, 2012; The Protection of the Environment Administration Act, 1991). The purpose is to identify the existing state of environmental and functional problems and stresses in relation with of water and air pollution in the Macarthur region. The scope of the project is also to Identify as far as possible, the potential capabilities, constraints and opportunities of those stresses in regards to future use. The proposed land use change will bring multi-directional benefit to the society and the environment. The primary aim is to identify the effective control measures and how they can best be applied to protect the environment from further degradation. Formulate short term and long term action plan. The short term goal is to put a halt to those pollution mechanisms and promote environmentally land use change. The long term goal is to transform existing land use change to more environmentally friendly enterprises. Develop, initiate and put in practice environmental management scheme that will not only improve Australian environment but will also contribute to achieve long term global ecologically sustainable development.

PROJECT AREA

The suburb of Minto (Figure 1a and 1b,) located within the Global Coordinate System (latitude and longitude) of 34.0265°S and 150.8507°S. The suburb of Minto (post code 2565) is a part of Campbelltown City Council (Environmental Planning and Assessment Act, 1979; Environmental Planning and Assessment Regulation, 2000), which is part of Cumberland State Districts of Macarthur region.

The Minto area is somewhat naturally defined by Bow Bowing Creek in north-eastern boundary and Myrtle Creek in the south-eastern boundary Map. In terms of district boundary, Minto is bounded by Ingleburn in the north, Minto heights in the East, Leumeah in the South and by St. Andrews in the east. The actual site in Figure 2, is a small land located on Ben Lomond Road at the intersection of Minto Mall boundary and Ben Lomond Road. The site is currently occupied by a Service Station which is going through the process of decommissioning. Prior to that the land was traditionally used for agricultural purposes.

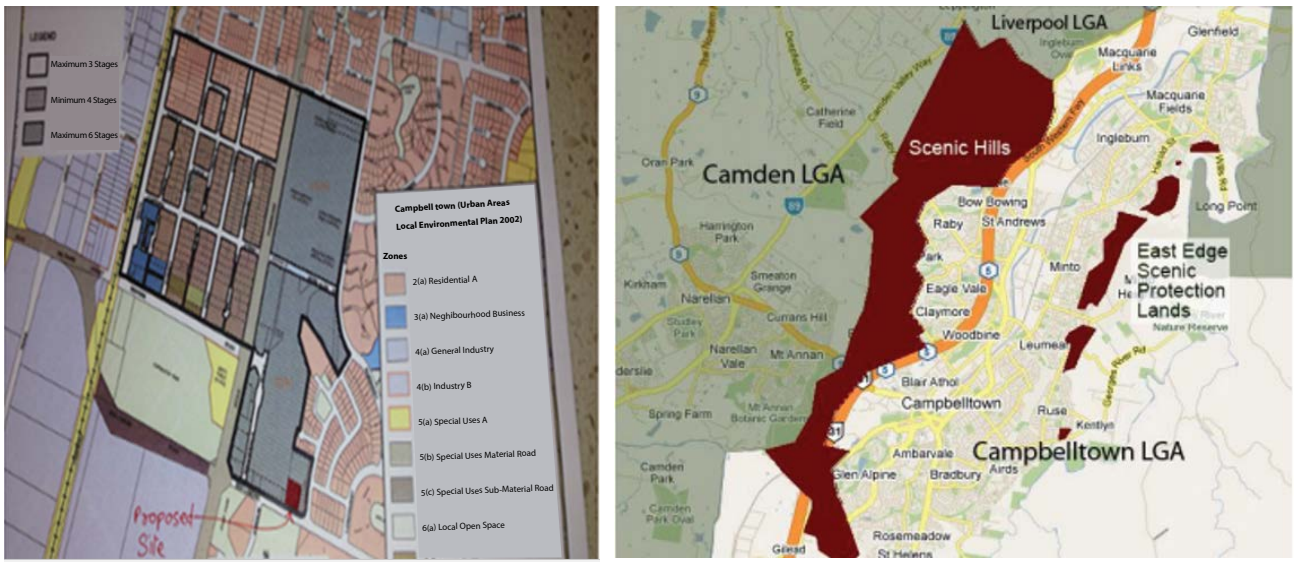

Figure 1(a) and 1(b). Location Map of Minto project area in Campbelltown District.

Figure 2. Frontal view of the service station that is to be decommissioned.

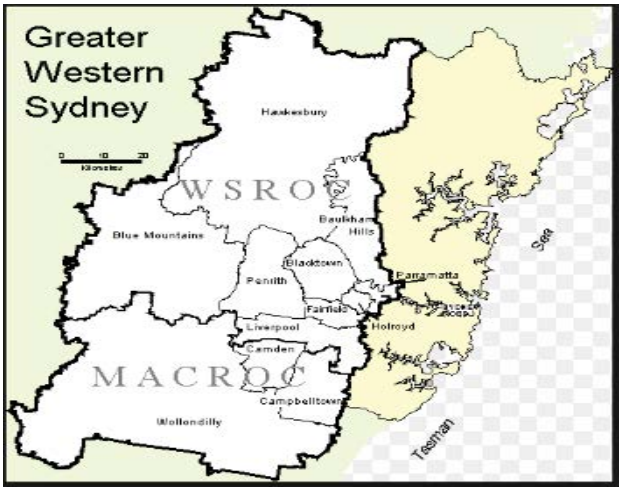

Figure 3. Physiographic Map of Greater Campbelltown Districts (Council Development Report, 1979).

PHYSIOGRAPHIC SETTINGS

The greater Campbelltown Catchment is characterised by two distinct physiographic (Council Development Report, 1979), regions shown in Figure 3. In the south and east, the Georges river and its right bank tributaries flowing northwards from relatively high elevation (300 to > 400 meters) which was formed by up-warping of Hawkesbury Sandstone, resulting in the typical plateau and deep ravine topography (Council Development Report, 1979). The second physiographic region is found north and west of the main channel. To the west, the Wianamatta Shale series overlie the sandstone and form the gently sloping, well rounded topography. The elevation of these region is generally well below 100 meters. Their floors are occupied by wide flood plains, and the valley sides are gentler than those found in the sandstone regions.

SOIL CLASSIFICATION

The soil of Campbelltown district has been mapped by

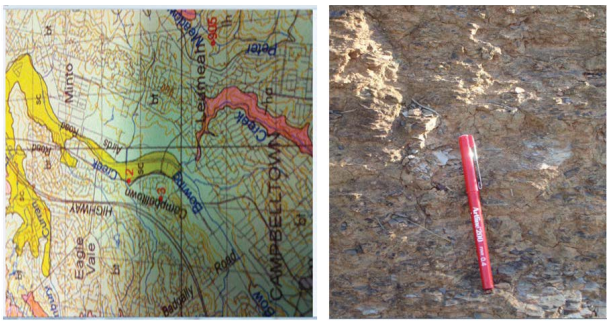

Figure 4. Wollongong-Port Hacking Soil Landscaping Series-Sheet 9026-9126.

(Walker, 1980). He found that parent rock played the most important role in distribution of soils. In order of importance in the main soil associations are: (1). Hawkesbury Associations (on Hawkesbury Sandstone); (2). Hammondville Association (on Passage Beds); (3). Cumberland Association (on Wianamatta Shales); (4). Elderslie Association (on Old River Terraces); and (5). Nepean Association (on Young alluvium).

A field work has been completed. An examination of soils at outcrop shown in Figure 4 has confirmed that the project site is situated on the foundation of Wianamatta Shale. The soil characteristics range from Hammondville Associations to Cumberland Association as properties of both Associations has been observed in the exposed soil at the outcrop. The detailed Soil Landscape Mapping (Wollongong-Port Hacking, soil Landscape Series Sheet 9026-9129), edition 1 reprint classified soils of Greater Campbelltown Area as follows shown in Figure 4: (1) Blacktown Soil (bt) Assemblages (bt) belongs to Residual Landscape association; (2) South Creek (sc) Assemblages belonging to Alluvial Landscape Association; and (3) Lucas Heights (lh) Assemblages belonging to Colluvial Landscape Associations. The project area lies on the Blacktown Soil (bt) Assemblages shown in Figure 4.

ENVIRONMENTAL STRESSES

Water Pollution

When water is polluted the DO content of water begins to decrease and when DO is dangerously low it affects all living creatures including human (NSW WRC, 1992; Sydney Water Act, 1994; Sydney Water Catchment Management Act, 1993). The entire environment is dependent on water. It is therefore absolutely vital to safe guard our precious water resources. Principal Sources and the associated resultant pollution of water regime shown in Figure 5. Human health requires the most superior quality of water and the degree of quality reduces depending on the environmental needs. Different water quality effects of water pollution. Poor quality of water have far reaching

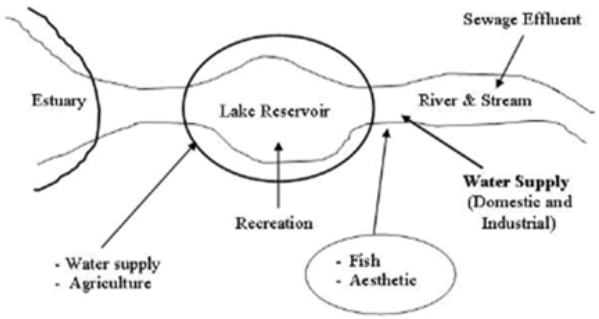

Figure 5. Sketch diagram of different environment and the associated water quality, (Protection of the Environment, 2012).

effects in terms of Public Health (pathogen, pesticides, and heavy metals - leads to water-borne diseases and bioaccumulation), Aesthetics (floating and suspended, colour, odours (H_2S), taste (algae, high Cl_2) - leads to aesthetic degradation) and Aquatic ecology (Low DO, high BOD and high nutrients such as N and P - leads to ecological

Today's water resources management is focused on optimum usage, minimum wastage, providing greater benefits to the environment and maintenance of a vibrant ecosystem and greater social acceptance.

The key objective of integrated management is to close the "water loop" by preventing wastage and pollution of water resources and re-use water whenever possible. Campbelltown is located within the catchment of two Principal Sydney waterways, The Georges River shown in Figure 6 and Nepean River systems (Protecting Sydney's Water Supply, 1980; Rogers, 1970). The chemical analysis of the Georges and Nepean River shown in Figure 7 and Table 1, that the overall water quality in the catchment remains fair (Sydney Water Catchment Management Act, 1993; The Clean Water Act, 1970 and The Water Act, 1912). Water quality monitoring are carried out in line with the National Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ (2000). Under the updated strategy, risks

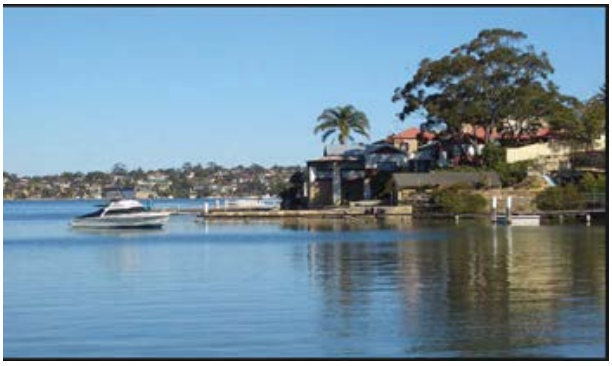

Figure 6. Flows from Georges River.

Figure 7. Nepean River flow.

Table 1. Macarthur Water Quality Reporting (Macarthur Water Quality Report, 2012).

		The Woolwash, O'Hares Creek	Menangle Bridge, Nepean River	Wedderburn Gorge, Georges River	Frere's Crossing, Georges River
Aquatic ecosystems	Dissolved oxygen	78	77	80	91
	pH	100	100	73	91
	Electrical conductivity	60	96	91	82
	Turbidity	50	48	27	27
	Total nitrogen	73	33	0	58
	Total phosphorus	73	67	58	75
	Chlorophyll A	91	75	75	83
Primary contact	Faecal coliform	n/a	83	n/a	n/a
	Enterococci	n/a	33	n/a	n/a
Secondary contact	Faecal coliform	n/a	100	n/a	n/a
	Enterococci	n/a	33	n/a	n/a

Key	Good	Fair	Poor	Very poor
	>75%	51-75%	25-50%	<25%

associated with recreational water are handled as per guidelines (Campbelltown State of the Environment, 2012; Local Government Act, 1993; NHMRC, 2008).

Air Pollution

Air pollution is normally defined as the addition of harmful gases and other toxic particulates in excess of certain concentrations in the atmosphere resulting in damage to health and/or the environment contamination of the oxygen and atmospheres around us. Air pollution is created by human activity such as driving, producing electricity, and gaseous emissions produced during industrial production (The Air Act, 1981; The New cities of Campbelltown Camden and Appin, 1973; Rogers, 1970). On a global scale shown in Figure 8, air pollution has lead to: Depletion of Ozone layer - a natural shield against the sun's UV rays; Global warming or the greenhouse gas effects leading to climate change. On a regional scale, trans-boundary air pollution and acid rain have become major areas of concern. On a local scale, air pollution is causing health impacts ranging from irritation to premature deaths, damage to vegetation, water quality impacts and reducing visibility. The following key pollutants are regarded as the most toxic matter and substances effecting public health and the environment today: Particulate Matter (PM10 or PM2.5); Carbon Monoxide (CO); Nitrogen Dioxide (NO_2); Ozone (O_3); Sulphur Dioxide

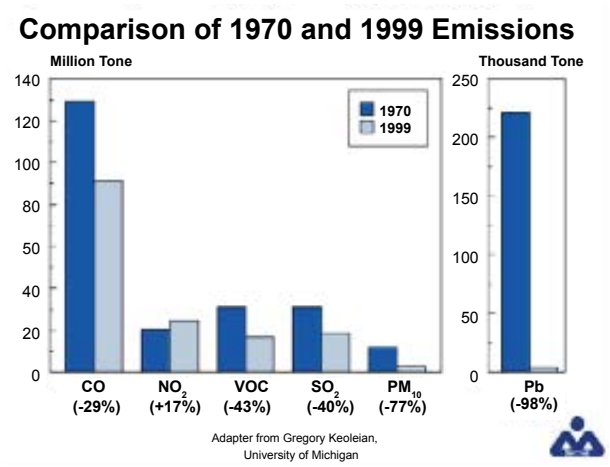

Figure 8. Comparison of Global Air Pollution Emission Level

(SO_2); Lead (Pb); Volatile Organic Carbon (VOC's) and other air toxic materials (Environmentally Hazardous Chemicals Act, 1985). But the major Urban Air Pollution is caused by Six Principal Player: CO, NOx, SOx, O_3, Particulate Matter and Pb. Air Pollution is expressed in terms of units of PPM (parts per million) or mg/m^3.

A comparison of global air pollution shown in Figure 8, indicates that the emission level is slowly decreasing but it far below than the desired level. The DEH measures and records ambient levels of air pollution across Sydney, Ilawarra and the Lower Hunter areas twice a day. Since 2008, pollutant data's recorded and represented as the Regional Air Quality Index (RAQI) The RAQI is based on the five criteria pollutants (ozone, carbon monoxide, sulphur dioxide, nitrogen dioxide and air particles) plus visibility (as per standard set by the NSW Government). The RAQI values are categorised as follows: Very good, 0-33, Good, 34-66, Fair, 67-99, poor, 100-149, Very Poor, 150-199 and Hazardous, >200. Analysis of Macarthur region RAQI shown in Figure 9 monthly average with that of Sydney South West Air Quality Index (AQI) for the reporting period 2011-2012 shown in Table 2. When compared with previous year data it shows that the RAQI has declined confirming significant achievement in Air Quality Improvement (Campbelltown State of the Environment 2012). The concern over gaseous emissions from industrial premises and associated impacts on air quality and public health has prompted Campbelltown Council to take a leading role to convince NSW EPA to revise the "Protection of the Environment Operations Act 1998". In June 2012 NSW EPA amended the guidelines and by virtue of this amendment all major industries are obliged to publish all emission data including all sensitive data required to monitor the state of the environment.

PROPOSED DEVELOPMENT (CHILD DAY CARE CENTRE)

Current Land Use

The project area is currently being used as a petrol gas service station shown in Figure 2. Service stations plays a dominant role in polluting the surrounding environment, the soil on which it was built and occasionally it also pollutes

Table 2. Macarthur Region Air Quality reporting (Macarthur Region Air Quality Reporting, 2012).

Four	Indicators	Air	Quality	Reporting	Year	*******
Year		2008 -2009	2009-2010	2010-2011	2011-2012	4 Year Trend
Air	Macarthur AQI	Good	Good	Good	Good	<-------->
Quality	Sydney SW Region - RAQI	Good	Fair	Good	Fair	Down
Reporting	No. of Complaints Received by Council	60	55	74	54	Down
2008-	No. of Complaints received by OEH	61	9	20	18	Down
2012	No. of Current Pollution Facilities Licenses	10	10	13	-1	

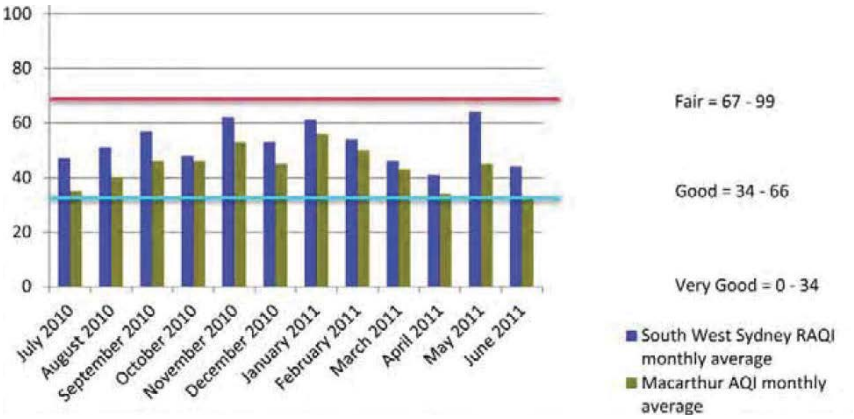

Figure 9. Macarthur RAQI monthly average against Sydney SW AQI (Macarthur Region Air Quality Reporting, 2012).

the sub-surface environment including the groundwater resources. A consequence which is very much undesirable.

Why Child Care Centre

Children's are helpless angels who require extra support beyond their normal parental care. On the other hand protection of the environment from further degradation has become absolutely vital. The proposed land use change will bring two fold benefits to the society: (1). It will clean the polluted environment. This is a great opportunity to bring multi-faceted benefit to the soil, land, water, biodiversity and environment. It is an ideal example of ESD (ecologically sustainable development); and (2). A good childcare centre has the capability to train the children to become an ideal citizen for tomorrow. Child and adolescent psychologists recognise that the ideal environment for raising the new born and children under two years is in home with the natural parents and family to promote bonding. But as child grow older they need friends of equal age for positive interaction and fun loving environment where they will have a great time while learn the most important basic skills of life and gets the best training for school readiness. Present day working pattern is such that both parents these days need to work to pay their ever increasing bills and those parents needs a safe, caring and academic environment to keep their children for most of the working hours. A modern Child Day Care Centre shown Figure 10a and 10b performs the above functions very successfully.

EXISTING CONTAMINATION, IMPACTS AND REMEDIATION

Permanent Site Decommissioning

Under the terms of the petroleum Licence the Local

Figure 10a. Design of modern Child Care Centre at Campbelltown.

Figure 10b. Play ground of modern child friendly environment.

Authority should be notified that the site will be closed permanently (WMD-REM-9, 2004). Removal of all waste products from the site must be made in accordance with current legal requirements. Following the closure, the site will remain dormant for a considerable time as decided by EPA prior to redevelopment. Decommissioning begins with the following tasks: (1). the tanks made safe, together with the corresponding pipework; (2). the dispenser removed and the electrical installation disconnected; and (3). the separator/interceptor cleaned. Licensing Authority will require seeing documentary evidence that the work has been undertaken to recognised standards by competent contractors.

Soil-Gas Survey and Site Investigation

A full scale Site assessment will be carried out by a professional licensed Assessor. The assessment will conform the Australia New Zealand Guidelines for the Assessment and Management of Contaminated Sites (ANZECC and ARMCANZ, 2000). The Site Assessor will carry out a proper desk top study followed by a detailed field investigation as per EPA guideline (Remediation of Land, 1998; Waste Avoidance & Resource Recovery Act, 2001). In the end the Site Assessment will be documented in a Site Assessment Report.

Summary of Field Work: The field investigation will include: Identification of the service station entire technical set-up; Full nature and extent of any contamination; Screening of Volatile Organic Compounds (VOC); a standard Soil sampling protocol will be maintained.

Groundwater Contamination and Assessment

The groundwater samples should be taken at the point where the saturated zone meets the unsaturated zone, or at greater depth based on field observations of Contamination (NSW WRC, 1992). Standard sampling technique should be adapted (EPA recommended procedure) to collect water sample and analysed by NATA approved laboratory (National Association of Testing Authorities Australia, 2018; Water Board, NSW 1983). If groundwater contamination is confirmed, then the extent of off-site migration should be assessed by drilling at least two monitoring wells down the hydraulic gradient of the tank pits and/or other potential contaminant sources, and at least one well up the hydraulic gradient as a control.

Water/Groundwater Threshold Concentration: Groundwater quality is protected in NSW by many Guidelines, Regulations and Acts (section. 5.1 and References). The objective is to protect the quality of water/groundwater resources, to ensure that resources can support their identified uses and values in a sustainable and economically, socially and environmentally acceptable manner.

Remediation of Contamination

The following EPA preferred options, in decreasing order of preference, will be adapted to remediate contaminated soil and/ or water (groundwater) at service station site (Remediation of Land, 1998) : On site in-situ remediation of soil and groundwater, example: air sparging soil venting, and nutrient injection; On-site in-situ treatment and remediation of soil and groundwater, example: enclosed bioremediation cells and pump and treat systems with emission controls; On-site land farming with enhanced bioremediation and comprehensive odour and stormwater controls, at sites where the soils are contaminated with low concentrations of volatiles or at sites remote from residential areas; Off-site controlled soil treatment; Off-site controlled remediation of soil at a licensed waste depot and subsequent use as cover material; Off-site disposal to a licensed waste depot as contaminated soil after EPA approval; "Cap and Contain" strategy with human health /ecological risk assessment to confirm remediation is appropriate. Emission Controls:

If in-situ treatment processes designed to prevent emissions cannot be used, then ex-situ systems (example: enclosed bioremediation cells with exhaust gas treatment) should be used wherever practicable. Controlled land farming and enhanced bioremediation may be sufficient remediation for sites that are remote from residential areas or that have soils with low concentrations of volatiles so long as all potential odour and stormwater problems are thoroughly managed. If there are high concentrations of volatiles present and the soil is to be excavated, the soil may need to be vented and emissions controlled before excavation. During any excavation operation, the site assessor should use work practices that are designed to minimise the impact of emissions (example: using water sprays, minimising the working face, and taking local weather conditions into account.

Using controlled land farming and enclosed bioremediation cell techniques at landfill depots and other private facilities enables the remediated soil to be used as cover at the depot, or even as clean fill. Such operation must be carried out under the control of the EPA's Regional Office, but they avoid the expensive practice of using waste depots as a direct means of disposing of contaminated soil.

LEGAL REQUIREMENTS AND BEST PRACTICE

Standards, Guidelines, Regulations and Acts

The Legal requirement got its momentum with the inception of Acts (The Clean Water Act, 1970 and The Water Act 1912; Rogers, 1970). World Commission on Environment under the direction of UN published the concept of sustainability entitled "Our Common Future" which is popularly known as "Brundtland Commission Report" (Brundtland Commission Report, 1987). Subsequent to the Brundtland Commission Report the Council of Australia endorsed the National

Strategy for Ecologically Sustainable Development (ESD). Prior and after the UN report Australia has been developing many Standards, Guidelines, Regulations and Acts, some of them are included in the reference list. Based on current water quality standards, our rivers, estuaries and our lakes should meet legislatively mandated goals.

Decontamination Best Practice

Water pollution control: Raising awareness to the community level is most vital to control sources of water pollution (ANZECC and ARMCANZ, 2000; NSW WRC, 1992; State Environmental Planning Policy, 1980), so that everyone remains vigilant in keeping waste and waste water out of: (1) drinking water supply; (2) surface water such as streams, rivers and lakes; and (3) Groundwater contamination. It is lot easier to control and remediate surface water pollution but remediation of groundwater pollution is very expensive, time consuming and in some cases impossible. Some common methods are: Pump and Treat; Air Sparging/Soil Vapour Extraction; *In Situ* Oxidation; Permeable Reactive Barriers; phytoremediation; natural Attenuation; Intrinsic and Enhanced Bioremediation.

Air pollution control: Limiting emissions into the air is both technically difficult and expensive. Current best practices to reduce air pollution (The Air Act, 1981; Protection of the Environment, 2012; Rogers,1970), to a sustainable level include the following Five control measures: (1) Source Correction - either change of process or product; (2) Collection of Pollutants - before releasing in to atmosphere; (3) Cooling - includes dilution, quenching and heat exchange of gaseous substances before leasing into atmosphere; (4) Treatment (includes particulate control includes the use of Cyclones, Wet Collectors, Fabric Filters, and Electrostatic precipitators; and (5) Dispersion.

RECOMMENDED POLLUTION CONTROL MEASURES

The bottom line is the pollution level must be minimised to protect the environment and to protect our globe from further destruction. It is time to act decisively, to formulate; Short Term Measures to stop further polluting the environment and Log Term Measures are remediate the pollution so that environmental sustainability can be achieved. Theses measures will make positive contribution and will bring ecologically sustainable benefit to the environment, to the society and will rejuvenate biodiversity.

Short Term Control Measures

1. The decommission of current service station will stop further pollution which in itself is a positive contribution to the local environment.
2. Service station clean up process in the remediation will bring long term sustainable multi-faceted benefit to the soil, land, water, biodiversity and environment of the Macarthur Region.
3. For greater success in any initiative the government has to play the leading role in two major front: (a). To government must invest to educate the general public so that they can become the guardian angels rather than becoming polluter themselves; and (b). The government must strictly enforce regulatory principles and make monitoring program more effective so that pollution generating industries and services are forced to do their part to protect the environment.
4. The wastage in water usage in all walks of life (Potable, Non-potable, Industrial. Agricultural and other household purposes) must be stopped in short term by plugging the loopholes, installation of water efficient technology and better water management system.
5. Gaseous emissions produced during industrial production must be treated before releasing to the wider atmosphere.
6. In the short term all pollution generating industries and services must install closed-pipe-treatment procedures their business. Gaseous emission must be treated before releasing to the atmosphere.

Long Term Pollution Control Measures

1. Primary water sources of the City of Campbelltown is the "Georges River and Nepean River System". It is apparent that theses Rivers are being over used and the current practice is unsustainable. There is a need to decrease our River water demand and find alternative water sources particularly for activities that can utilise lower grade water quality through water recycling.
2. The concept and practice of greater utilization of Rain Water through the installation of Rain Water Tank in the approval process of new building (domestic and industrial) construction is a praises worthy initiative and will make significant contribution in water conservation. This practice should to extender to all old building as a mandatory requirement.
3. The construction of "Artificial Wetlands" has also been mandatory for all development of new suburbs. This will bring multiple benefits to water resources management, water conservation, and environmental development and put in place the WSUD concept (Campbelltown City Council, 2010), for future Urban Development Projects is shown in shown in Appendixes 1-5.
4. All urban redevelopment and refurbishment must

include WSUD concepts in their new design so that gradually and steadily ecologically sustainable development are integrated in all major urban development planning.

5. Gaseous emissions from Industries and Automobiles are a major source of pollution to the environment and their use need to be properly managed. The implementation of following management option will bring positive results: (1). alternative environment friendly energy source should be developed (example hybrid car); (2). Renewable eco-friendly energy source should be readily available and where possible should be used to replace petrol and diesel; and (3) Service station should be more vigorously regulated and their distribution in urban area should be reduced while setting up some new ones in rural areas and making it more environment friendly with modern environment friendly equipment and setup.
6. Use of Computer, Mobile Phone and other electronic devices has become part of our daily life and has brought revolution to out communication technology. Use of theses technologies and web browser system has successfully reduced paper usage to its minimum making a great contribution to the environment. But on the other hand it has created two significant problems: (a). Significant increase in energy usage; and (b). Producing more greenhouse gas emission which is not desirable at all. One suggested solution could be a mandatory switch off and unplug computers and other energy dependent equipments during night time and /or when not in operation for a significant amount of time.
7. Creation of more eco-friendly parks wherever possible should be a matter of priority. Any new or redevelopment activities must adapt the concept of WSUD in their design and construction shown in Appendixes 6-10.
8. Use of normal Plastics (such as water bottle, polyethylene bags and other products) should be replaced with biodegradable one and its use should gradually be limited and replaced at faster rate with environment friendly alternatives (for example all park should be provide with drinking water taps and people should be advised that those facilities have been installed and there is no need to take water bottle with then any more and in fact government may consider a ban in bringing those items to these amenity parks.

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REFERNCES

The Air (Prevention and Control of Pollution) ACT, 1981.

ANZECC and ARMCANZ (2000) water quality guidelines. Revision of Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Brundtland Commission Report (1987). Report of the World Commission on Environment and Development: Our Common Future, Oslo, Norway.

Council Report, 2012. Campbelltown State of the Environment (Macarthur Region Air Quality Reporting).

Campbelltown City Council (2010). Menangle park WSUD Strategy. Report prepared by AECON.

Council Development Report (1979). Physiographic Map of Greater Campbelltown Districts.

Council Report (1973). The New cities of Campbelltown Camden and Appin, the future Plan.

Environmentally Hazardous Chemicals Act (1985).

Environmental Planning and Assessment Act (1979). (Substantial amendments made in 1997 & 2008 and under revision April 2013).

Environmental Planning and Assessment Regulation 2000, (First version in 1980 and amended in 1993).

Groundwater Protection Policy for NSW, A Component Policy of the NSW State Groundwater Policy (NSW WRC 1992).

Local Government Act 1993 No 30 (Current version for 8 January 2019 to date (accessed 30 March 2019).

National Association of Testing Authorities Australia (ISO/IEC 17025 Assessment Worksheet (2018)

NHMRC (2008). Australian Guidelines for Water Recycling: Managing Heath.

Protection of the Environment (Macarthur Water Quality Report, 2012).

State Environmental Planning Policy, SEPP 55 - Remediation of Land (1998).

State Environmental Planning Policy, SEPP 58 - Protecting Sydney's Water Supply (1980).

Slaper TF and Hall TJ (2011). “The Triple Bottom Line: What is it and how does it work ? Indiana Business Review. Spring. 86(1).

Sydney Water Act (1994), (accessed 30 March 2019).

Sydney Water Catchment Management Act (1993), (accessed 30 March 2019).

The Clean Water Act 1970 and The Water Act 1912.

Rogers PG, The Pollution Control Act, 1970.

The Protection of the Environment Administration Act, 1991. (accessed 30 March 2019).

Waste Avoidance & Resource Recovery Act 2001. (accessed 30 March 2019).

Walker (1980). The Australian Soil Resources Information System, Australian Collaborative Land Evaluation Program.

Water Board, NSW (1983). Environmental Assessment of Proposed Macarthur Water Quality Project.

WMD-REM-9. (2004). Contaminated Site Closure-A property Owners Guide. New Hampshire Department of Environmental Services.