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city of innovation

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Department of Planning & Environment
PO BOX 1226
NEWCASTLE NSW 2300

Your Ref:	SCC_2018_WOLLG_001_00
Our Ref:	Z18/363266
File:	DE-2018/211
Date:	18 December 2018

Dear Sir/Madam

APPLICATION FOR SITE COMPATABILITY CERTIFICATE – 120 WALKER STREET HELENSBURGH

Thank you for the opportunity to respond to the above application for a Site Compatibility Certificate. Council recognises the need for the provision of seniors housing within our Local Government Area, including Helensburgh. However, it is considered at this time that such a proposal could be more appropriately located on residential land with closer proximity to the Helensburgh town centre.

Please find attached Council's comments in relation to the proposal.

Yours faithfully

David Farmer
General Manager
Wollongong City Council
Telephone: (02) 4227 7111

Attachment One

Planning

The land is zoned RU2 Rural Landscape. The proposed use of the land for seniors housing was not envisaged as part of the rezoning of the former 7(d) zone, and the RU2 zoning was applied under Wollongong Local Environmental Plan 2009 in recognition of the on-going agricultural land use.

Council's records indicate that the site has the following development history:

Application Number	Proposed Development	Type of Application	Decision
PL-2016/25	Hospital	Pre Lodgement Application	Completed
DA-2014/828	Use of existing premises as a Jockey Training Establishment with an Indoor Horse Training Arena, Worker and Jockey Self-Contained Cabins, Lunchroom, Service Room (Laundry), Waste Storage Area and Teaching Facility	Development Application	Withdrawn
PC-2002/31380	Proposed Additions To Existing Dwelling	Private Certifier Application --	Approved
PC-2002/1380/A	Modification - amendments to dwelling including extension to kitchen and meals room, relocate laundry and construction of lap pool	Private Certifier Application --	Approved
DA-2002/683/A	Modification To Alterations And Additions To Existing Dwelling And Construction Of Lap Pool	Development Application	Approved
DA-2002/683	Alterations And Additions To Existing Dwelling	Development Application	Approved
CC-2000/791	Dwelling	Construction Certificate Application	Approved
DA-2000/659	Manager S Residence For Equestrian Complex	Development Application	Approved
BA-1998/716	Stables, Jockey Accommodation & Toilets	Building Application	Approved
BA-1997/502	Stables	Building Application	Refused
DA-1997/237	7 Stables And Jockey S Quarters (For 4 Jockeys)	Development Application	Deferred Commence ment
BA-1996/2277	Stables	Building Application	Refused
BC-1996/1261	Stables Outdoor Arena - Pound Yard	Building Certificate Application	Approved
BA-1996/911	Indoor Horse Training Arena	Building Application	Approved
BC-1996/647	Workers Cottage	Building Certificate Application	Approved
DA-1996/609	Horse Outdoor Arena Stables & Round Yard	Development Application	Withdrawn
DA-1996/198	Workers Cottage	Development Application	Approved

DA-1996/142	Indoor Horse Training Arena	Development Application	Approved
BA-1995/2443	Storage Shed - DA 754/95	Building Application	Approved
DA-1995/754	Storage Shed	Development Application	Approved
DA-1995/654	Stabled Yards, Training Arena & Yard, Feed Shed & Toilets	Development Application	Withdrawn
RE-1995/66	Demolition	Demolition	Approved
BA-1980/1984	Dwelling & Double Garage	Building Application	Approved

The above approved uses indicate a general consistency with the objectives of the RU2 zone. Redevelopment of the site would result in an inability of the subject site to continue to meet the objectives of the zone.

It is noted that the minimum lot size for the RU2 zoned land including and in the vicinity of the subject site is 39.99ha. Whilst all of these RU2 lots are currently undersized, the proposed redevelopment of the subject site for seniors housing would inhibit opportunities to consolidate land to create appropriately sized lots on which rural and agricultural type development could be carried out. Further, the proposal would effectively create an isolated, undersized rural allotment immediately to the north of the subject site.

The development as presented consists of 193 dwellings, parking for 193 cars plus ancillary buildings. The scale of this development is not considered to be in context with surrounding development which is characterised by single dwellings on rural/environmental allotments. Future residential development of the adjoining sites is restricted by the zoning of the land and the provisions of Clause 4.2A Erection of dwelling houses on land in certain rural and environmental protection zones of Wollongong Local Environmental Plan 2009. As such, it is considered that the character of the area would be unlikely to undergo significant change in the foreseeable future such that the development as proposed would not be in keeping with the character of the street and in harmony with the buildings around it.

Council has the following concerns with the proposal, and considers that the development fails to provide good design, thus not achieving the objectives of the SEPP:

- The proposed use of the existing buildings on site for ancillary and support buildings is considered to be a fragmented and ad hoc design approach. These structures are predominantly rural in nature and as such, have an appearance that is inconsistent with the proposed seniors housing use.
- The location of car parking spaces remote from the dwellings is of concern, particularly as many of the residents will be experiencing mobility issues. The remote location of parking could also result in haphazard unplanned parking as residents try to park closer to their front doors blocking access roads or damaging verges and landscaping.
- The provision of extensive carport areas over parking spaces is not considered to provide a good design outcome. The plans do not clearly indicate if the parking spaces at the rear of the site are covered. It is noted that if the spaces at the rear are proposed as parking for the residents, uncovered parking spaces do not provide a good development outcome.
- The front setback to Walker Street is not supported as this is not consistent with the streetscape, and fails to provide sufficient area for an appropriate landscaping treatment along the Walker Street frontage
- The proposed units are lacking in architectural merit

It is also considered that extensive development of the site is likely to result in ongoing land use conflicts between the surrounding rural/agricultural land uses and the proposed residential land use. As a result, it is possible that the amenity of the future residents of the proposed development will be compromised.

Stormwater/Flooding

Council's records indicate that the site is flood affected and located within an Uncategorised Flood Risk Precinct. Development under the Seniors Living SEPP is categorised as 'Critical Utilities and Uses' as described in Chapter E13 of the Wollongong DCP2009. Schedule 10 of this Chapter identifies Critical Utilities and Uses as an Unsuitable Land Use within the High and Medium Flood Risk Precincts. The application for a Site Compatibility Statement fails to demonstrate compliance with Chapter E13, as sufficient information has not been provided to demonstrate that the proposed development is located wholly outside the High and Medium Flood Risk Precincts.

The Flood Study extract by Rienco Consulting submitted with the proposal has been reviewed and the following comments are noted:

- There is limited detail included in the information presented with respect to input parameters, flood model extents, contributing catchment, input locations, and so on
- The catchment area utilised in the Guidance for Classification of Watercourse by Reinco Consulting underestimates the contributing catchment area to the site.
- The flood modelling does not consider the PMF flood extent

In light of the above, insufficient information has been provided to identify the extent of flood affectation on the site and demonstrate that proposed development could be undertaken in compliance with Chapters E13 and E14 of the Wollongong DCP2009 and Clause 7.3 of the Wollongong LEP2009.

The following information would be required in order to enable a complete assessment of any development proposed for the site:

- The full flood study report prepared by a suitably qualified civil engineer in accordance with Chapters E13 and E14 of the Wollongong DCP2009. Including details of all input parameters, contributing catchment, flood model extents, input locations, WBNM details, and so on.
- The flood study must identify the existing flood extents and delineate existing flood risk precincts on the site inclusive of the total catchment area contributing to the site.
- The flood study must include a plan showing an overlay of the proposed development layout in relation to the delineated flood risk precinct boundaries.
- The flood study must consider the PMF flood event

Environment

Council has concerns with the possible impacts of the proposed development on the water quality of the perched aquifer underlying the site and Gills Creek. Currently, the existing unlined dams on the property intersect the known perched aquifer in the area. Redevelopment of the site would require these dams to be lined and the development would require design, siting, construction and management to ensure protection of the water quality in the area. Ongoing monitoring of water quality would also be required.

The document titled "*Impact of hydrology and hydrochemistry on the ecological continuum of the Maddens Plains Upland Wetlands*" produced by Dr Iradj Yassini is attached for information purposes as it also relates to the subject area.

It is noted that a limited amount of native vegetation that also includes planted specimens exists on the site. Any proposed seniors living development would need to protect and enhance the native vegetation in the identified riparian corridor area on the site (refer to the Guidance for Classification of Watercourse document prepared by Rienco Consulting dated 1 July 2016).

Attachment Two

Impact of hydrology and hydrochemistry on the ecological continuum of the Maddens Plains Upland Wetlands

1.1 Introduction

Maddens Plain Landscape at the Beginning of the Quaternary Period

At the onset of the Quaternary Period, on the eastern margin of the Sydney sedimentary basin, the massive bedded and cross laminated fluvial deposits of the Hawkesbury Sandstone of Triassic age formed the basement rock of the Woronora Plateau.

In the Late Tertiary period, the surface of the Hawkesbury Sandstone, which was uplifted in the mid-Oligocene period (R.W. Young, 1977, in Ann Young, 1986) was carved with numerous shallow and broad ditches, concavities and troughs of various widths and depths at the head water at the eastern margin and deep gorges and canyons towards the west. The depressions and concavities were flanked by shallow ridges and low elevation sandstone crests and flow the slop of the underlying sandstone beds.

These erosive features on Woronora Plateau were called 'Dells' by Ann Young (1986) who provided an age of 17,000 years BP for the oldest dell. However recent work by Keith et al. (2006) and Tomkins and Humphreys (2006) suggest that the oldest dells were 12,800 years BP and the youngest was 300 years BP.

Accumulation of sand, silt and clay within the dells created an extremely porous media and highly productive unconfined, perched aquifers. These perched aquifers are independent of the natural regional water table underlying Hawkesbury Sandstone (N P Merrick, Metropolitan Coal Project, Groundwater Assessment, 2008).

The high water retention capacity of these aquifers is partly due to the accumulation of large volumes of organic detritus within the sediment and formation of humic rich sandy loam. Continuous discharged from these aquifers in Maddens plain, similar to the rest of the Woronora Plateau **support the base flow to the numerous local creeks, the riparian vegetation and the entire upland swamp ecosystems on the plateau**.

The water table in these perched aquifers is generally high and the depth of the water table fluctuates with slope gradient and rainfall - runoff in the catchment. In periods of extended wet weather, the water table rises to the surface and is mixed with the surface runoff. **The shallowness of the water table in these perched aquifers makes them extremely vulnerable to surface contamination**.

A combination of silica rich substrates and sediments with a high humus content leads to acidification of local soil and the groundwater. Soil pH in Madden Plains often ranges between 3 to 4 (Hazelton and Tille, 1990, SEEC Morse McVey, 2007) and groundwater long-term mean pH value varies from 3.7 to 4.5.

Acidic soil and water in the Maddens Plain dell environment are also caused by oxidation of Marcasite iron sulphides which are present in the unweathered fresh surfaces of the Hawkesbury Sandstone (Steve Short, personal communication 8/07/2009 and Chris Wearing, ANSTO, personal communication, 08/07/09).

In the vadose zone, oxidative reactions caused by aerobic or facultative aerobic iron and sulphur oxidising bacteria such as *Thiobacillus ferroxidans, Thiobacillus thiooxidans* and *Gallionell spp.* bacteria takes place as follows (Ribet et al., 1995).

$FeS2 + 7/2\ H20 + 15/4\ O2 \square\square Fe\ (OH)\ 3 + 4H +$ **2SO4**

$4FeS2 + H2O + 15\ O2 \square\square 2Fe2\ (SO4)3 +$ **2H2SO4**

Figure 1- Iron oxidising bacteria forming a thin film on the surface of water at the Outlet of the sedge land drain, near the proposed Lot 1A. Bacteria oxidise the soluble iron (Fe2) into insoluble Fe^{3} and precipitate of Iron hydroxide

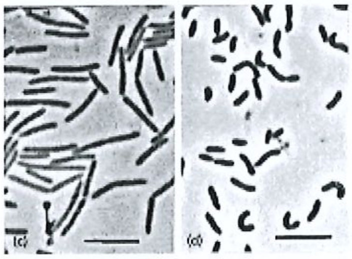


Figure 1a -Scanning Electron micrograph of Iron and sulphur oxidising bacteria

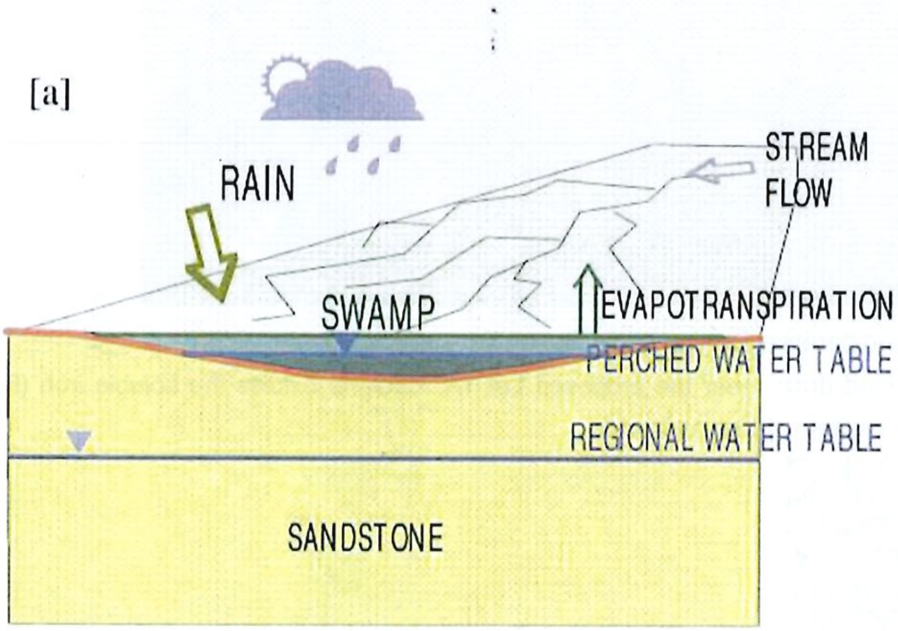
In the upland swamp unconfined aquifer, oxygen is continuously supplied to the groundwater by recharged water or by sedge grasses which pump oxygen into their roots and rhizomes.

Disturbance of the Hawkesbury Sandstone and the local soil would expose the Marcasite to oxidation process and generation of acidic leachate

Progressive invasion of these permanently water logged terrains by hydrophilic and hdyrophytic plants species and their adaptation to the **highly acidic pH and low nutrient conditions** make these swamps a unique environment known as Upland Swamps or Hanging Swamps.

The Upland Swamps/Wetlands host several threaten or endangered plant species (refer to specialist submission on the local fauna and flora). Subsidence caused by coal mining activities in Illawarra is a serious threat to many of these upland swamps. The proposed six hectare size subdivision is another threat to the integrity of water quality of the perched aquifers, the local swamps and creeks.

Subsequent erosion and weathering of the Hawkesbury sandstone in the Holocene period generated the detritus which gradually filled the ditches and concavities on the Woronora Plateau. Carbon dating In the course of transport by stormwater runoff, the weathered detritus were segregated, the clay and silt fraction were deposited along the axes and deeper part of the troughs and ditches, and the medium to coarse sand were deposited in the shallower portion and on the side shoulders of these depositional environment. Accumulation of sand, silt and clay in these concavities created an extremely porous media and formed unconfined, perched aquifers.



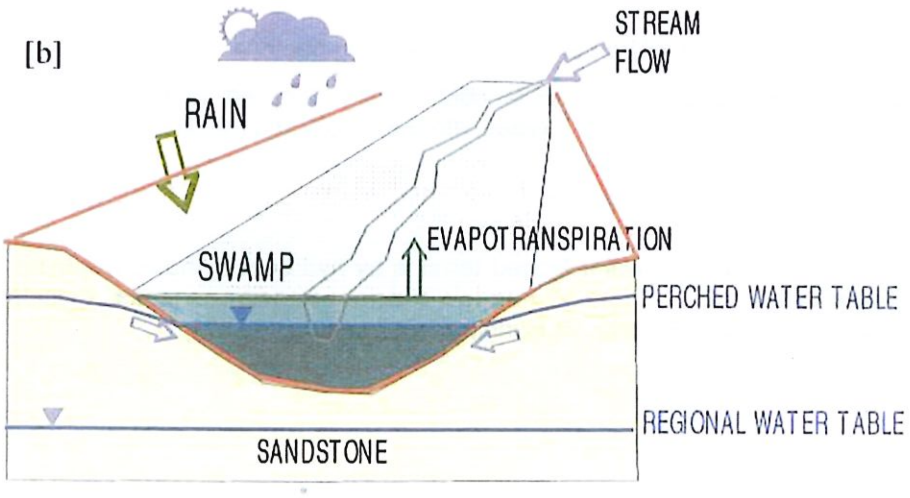


Figure 1 a- b- Schematic drawing showing independence of the perched aquifer water table from the Regional Water Table which is beneath the Hawkesbury Sandstone

(From Metropolitan Hydrological Assessment, 2008)

Figure 2 –Shallow longitudinal ditches dogged into the Hawkesbury Sandstone, on the bed of Stony Creek, downstream of the ICC Dam after construction of the dam. These erosive features are similar to the early Holocene period dells on the Woronora Plateau.

Generalised stratigraphical sequence of the perched aquifer in Madden Plains

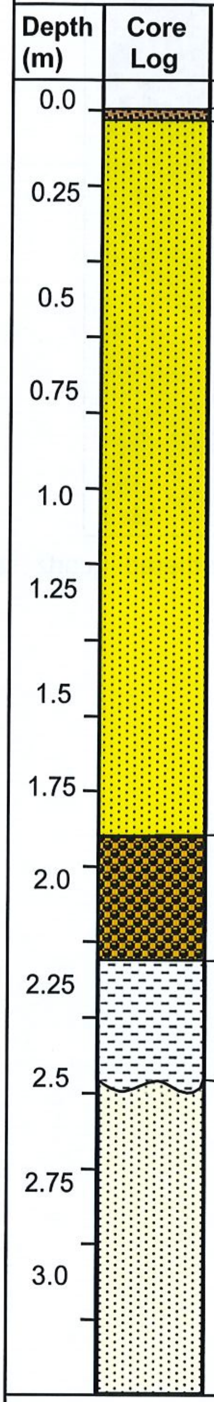
The Quaternary deposits on Madden Plains include the following sequences:

1. 0.1 to 0.15 m thick organic rich horizon (surface crust) composed of organic detritus, fungus, algae and bacteria.
2. 0.5 to 2.25 m thick medium to fine grained unconsolidated white to pink sand with randomly dispersed well rounded quartz gravel.
3. 0.3 to 0.6 m thick reddish brown, aluminium and iron rich gravel and pebbles size pisolith (Laterite). The pisolithes are resulted from leaching of the weathered Hawkesbury Sandstone under humid and warmer climatic conditions.
4. 0.2 to o.3 meters thick yellow- white Kaolinitic clay with red mottles of iron oxides. This basal clay unit acts as a seal at the bottom of the perched aquifers reservoir.

Figure 3- An erosional through in Hawkesbury sandstone and Quatemary depositional Sequences which form the local perched aquifer

Maddens Plain Perched Aquifer Generalised Stratigraphy

Core: Outcrops, Maddens Plains
Location UTM (AGD 1966): N/A
Elevation (AHD): N/A



Colour	Description	Environment of Deposition
	Organic rich horizon (surface crust)	Organic detritus plus fungus, alga and bacteria
	Medium to fine grained unconsolidated sand with randomly dispersed well round gravel sized quartz grains. Sediment is typically white to pink in colour.	Troughs, ditches and concavities on weathered Hawkesbury Sandstone, called Dell
	Red brown aluminium and iron rich pisolithes derived from leaching of weathered Hawkesbury Sandstone.	Leached soil Horizon
	Yellow-white with red mottles Kaolinitic clay rich layer formed from the deposition of mobilised clay derived from weathered Hawkesbury Sandstone. This layer forms basal seal for perched aquifer.	Along the axes of the Dells
	Massive bedded and cross laminated medium to coarse grained sandstone (Hawkesbury Sandstone).	Triassic aged fluvial deposits.

Figure 4- Generalised Quaternary Stratigraphical Sequence in Madden Plain.

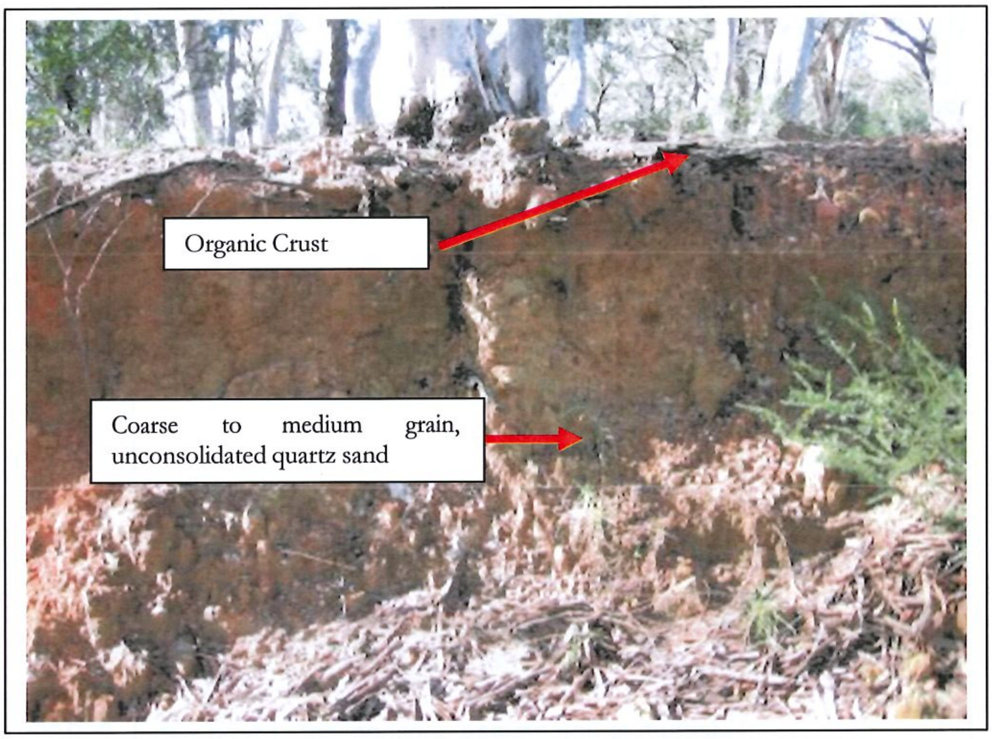


Figure 5- Organic crust and the coarse to medium grain, pinkish white weathered quartz sand which forms the body of the perched aquifers reservoir

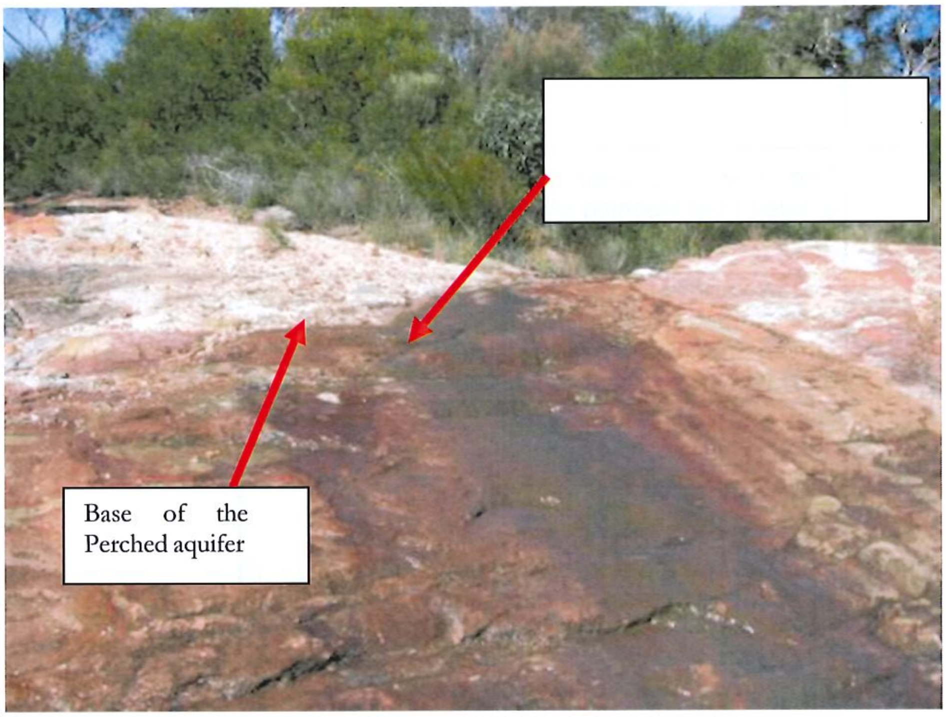


Figure 6 - Showing the contact between the perched aquifer and the massive Hawkesbury Sandstone. Water from the perched aquifer seeping along the contact zone

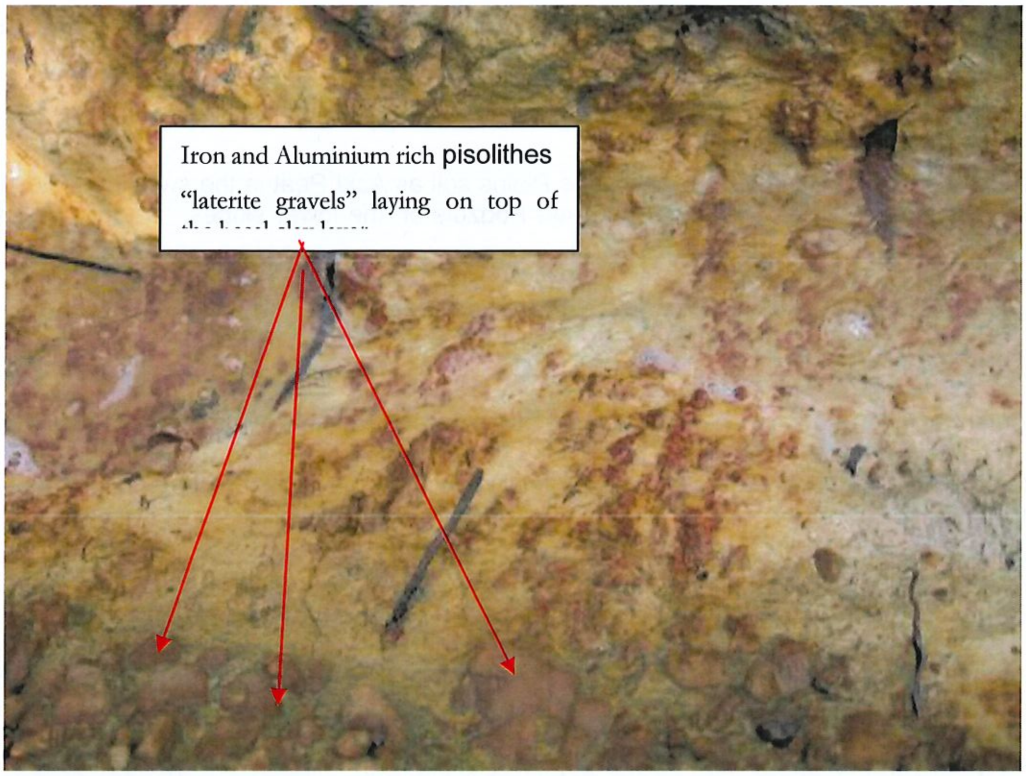


Figure 7 - Showing the yellow- white Kaolinitic clay at the base of the perched aquifer

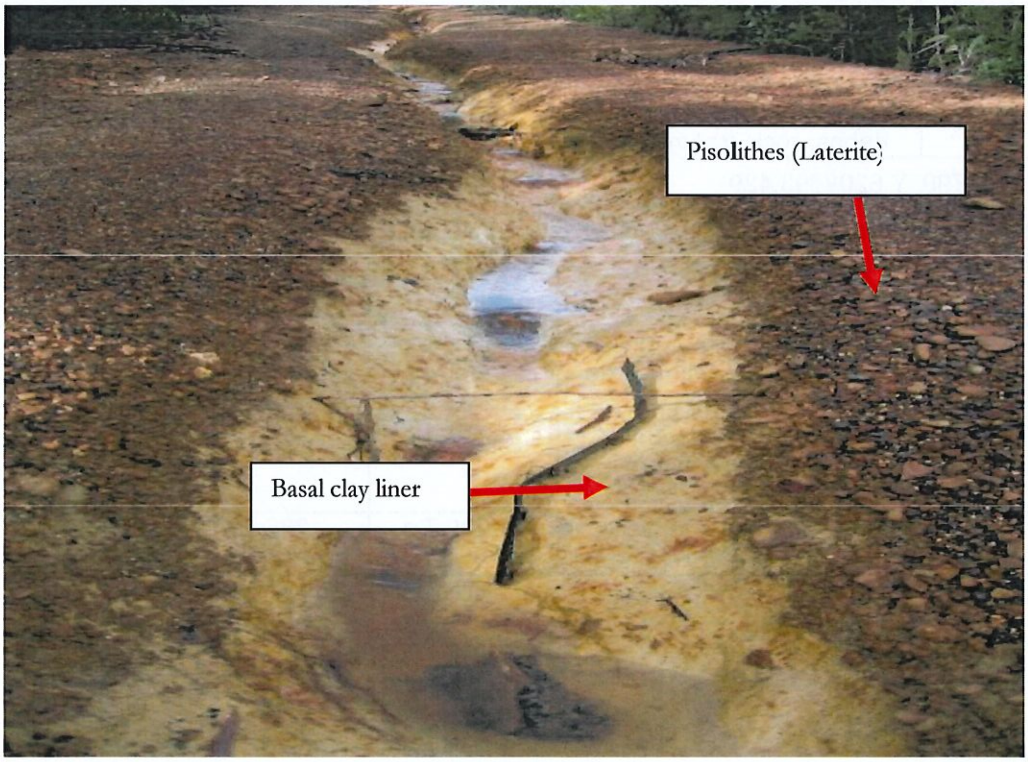


Figure 8 - Longitudinal rill erosion in the basal clay layer and Laterite pisolithes lying on the top of the clay layer. Note erosion of the overlaying unconsolidated sand horizon after construction of the road has exposed the Laterite pisolithes

Water table is shallow and the depth of the water table varies with rainfall in the catchment and the slope of the underlying bed rocks land.

Maddens Plain Soil and Subsoil classification

Hazelton and Tille (1990) have classified the Maddens Plains soil as Acid Peat in the swamps, Gleyed Podzolic soils in the drainage lines, Siliceous Sand and Podzols on the lower slopes, Lateritic Yellow Earth and Lithosol on crests.

Soil and Subsoil moisture content and grain size characteristics

Soil moisture content

Soil moisture content in the three locations investigated varied from 6.92% to 39. 58% on the shallow depth close to the surface at Lot 4 and lot 1A and from16 to 28 % at the depth of 250- 500 mm. Table 2 give description of subsurface sediments and their respective moisture contents at the three auger hole sites.

Table 1- Description of the auger hole samples and their moisture content

Lot 4 (X 311605.0112, Y 6207416.807)

Total depth of the borehole 70 cm, beginning with coarse to medium size gray sand

Sample No.	Depth	Description	Wet Weight	Dry Weight	% Loss
1	0 - 10 cm	Grey sand coarse to medium in size	158.8 g	147.8 g	6.92
2	20 - 25 cm	Grey medium sand with iron hydroxide and humic material	406.4 g	339.8 g	16.58
3	60 - 65 cm	Coarse white to grey sand, with organic debris, rock fragments &	441.3 g	372.3 g	15.63

Lot 3. (X 312759.6799, Y 6209893.429)

Total depth of borehole 60 cm. Beginning of lateritic layer at 46 cm.

Sample No.	Depth	Description	Wet Weight	Dry Weight	% Loss
4	0 - 12 cm	Gravelly - yellow greyish sandy clay, with large rock pieces	531.4 g	489.0 g	7.97
5	50 - 55 cm	Gravelly (lateritic pisolithes) yellow-grey clayey sand	347.1 g	315.7 g	28.8
6	55-70 cm	Gravelly (lateritic pisolithes) sandy clay	290.7 g	266.1 g	8.46

Lot 1A. (X 311918.4234, Y6210636.081)

Total depth of borehole 70 cm. 15 to 20 mm thick organic layer on top.

Sample No.	Depth	Description	Wet Weight	Dry Weight	% Loss
7	0 -12 cm	Organic layer	153.1 g	92.5 g	39.58
8	12 - 22 cm	Grey sand	272.7 g	226.7 g	16.86
9	70 cm	Yellow clayey sand	496.5 g	413.7 g	16.67

Three auger holes to the depth of 800 mm were sunken in the building envelope of the proposed Lot 1A, Lot 3 and Lot 4. Figure 8 shows the location of the auger holes, water samples and photography illustrated in this statement.

Figure 9- Auger hole at the proposed Lot 1A, showing organic crust on the top of weathered unconsolidated sand horizon

Two duplicate soil samples were collected at each auger hole site. Samples were collected at three different intervals based on the changes in soil colour and texture.

One lot of the samples were analysed for moisture content and grain size by Wollongong City Council's NATA accredited Geotechnical laboratory.

The second lot was send to Envirolab analytical laboratory in Chatswood for pH, EC, Cation Exchange Capacity and P sorption tests.

Major grain size categories of the soil samples from the proposed Lot 1A, Lot 3 and Lot 4 are summarised in table 1 and Appendix...gives details of soil grain size analysis.

It is clear that the coarse fractions are dominant in all three lots and closely correlate with soil poor Cation Exchange Capability and soil P sorption results.

Table 2- Summary of the soil and sub- soil fractional analysis

Location	Fraction ►1000µm (Gravels)	Fraction 600 µm - 300 µm (Coarse sand)	Fraction 150 µm - >75 µm (Fine sand and silt)	**Total Fraction >75 µm Fine sand to Gravel**	Fraction >75 µm- 13 µm (Silt and Clay)
Lot 4					
0-10cm depth	8%	65%	7%	**79%**	19.2%
60- 65 cm depth	3%	53%	8%	**64%**	13.4%
Lot 3					
0-12cm depth	43%	21%	16%	**80%**	12.5%
55- 70 cm depth	46%	17%	16%	**79%**	18.8%
Lot 1A					
0-12cm depth	10%	27%	38%	**75%**	24%
70 cm depth	2%	18%	17%	**37%**	26.5%

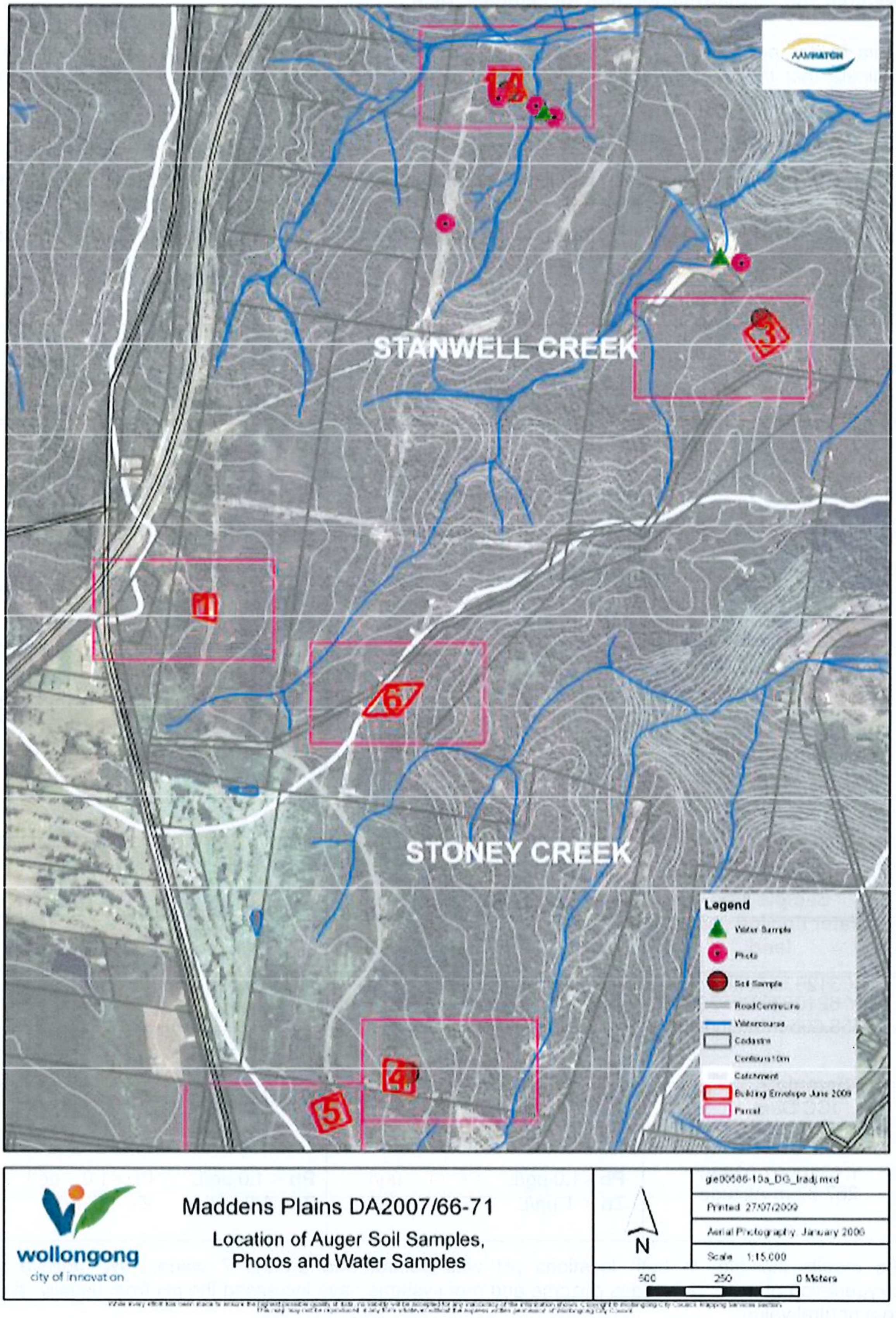


Figure 10- Location of photography, water samples and soil samples

Rainfall and Evapo-transpiration on Maddens Plan

Data for the period 1894 to 2006 from Bureau of Meteorology rain station 68024 at Darkes Forest indicate that the average annual rainfall in Maddens Plain is around 1420 mm and the average annual pan evaporation for Nowra RAN Air station is 1600 mm

Madden plain perched aquifer groundwater quality

On 6 of July 2007 two duplicate samples, one unfiltered and one in situ filtered through 0.45µm Teflon membrane were collected from the outflow of the sedge land (Figure) and from the ICC dam immediately behind the weir. Samples were sent to the Envirolab in Chatswood under the chain of custody for testing.

Table 3 - Analytical results of the water quality samples of July the 6, 2009

Sample Location	**Sample 1** 0.45um filtered mg/L — unfiltered mg/L	**Sample 2** 0.45 filtered mg/L — unfiltered mg/L
Sample 1 Water flowing From the sedge land X 312039.962071 Y 6210570.99123 358.695 m Altitude **Sample 2 ICC Dam** X 312622.987669 Y 6210097.92829 267.37 m Altitude	**pH** 7.0 **EC** µS/cm 19 0 **Phosphate** <0.05 mg/L **Total P** <0.05 mg/L **NOx** <0.1 mg/L **NH3** <0.1 mg/L **Al** 20 µg/L **Al** 80 µg/L **Fe** 780 µg/L **Fe** 3300µg/L **Mn** 100 µg/L **Mn** 95 µg/L **Cu** <1.0 **Cu** <1.0 µg/L **Pb** <1.0 µg/L **Pb** <1.0 µg/L **Zn** <1.0 µg/L **Zn** 4.0 µg/L	**pH** 7.1 **EC** µS/cm 140 **Phosphate** <0.05 mg/L **Total P** <0.05 mg/L **NOx** <0.1 mg/L **NH3** <0.1 mg/L **Al** 230 µg/L **Al** 500 µg/L **Fe** 320 µg/L **Fe** 630 µg/L **Mn** 10 µg/L **Mn** 10 µg/L **Cu** <1.0 µg/L **Cu** <1.0 µg/L **Pb** <1.0µg/L **Pb** <1.0 µg/L **Zn** <1.0 µg/L **Zn** 3.0 µg/L
Duplicates Sample 1 (x) Water flowing sedge land X 312039.962071 Y 6210570.99123 358.695 m Altitude **Sample 2 (k) ICC Dam** X 312622.987669 Y 6210097.92829 267.37 m Altitude	**pH** 7.2 **EC** µS/cm 200 **Phosphate** <0.05 mg/L **Total P** <0.05 mg/L **NOx** <0.1 mg/L <0. 1 **NH3** < 0.1 mg/L <0.1 **Al** 20 µg/L **Al** 80 µg/L **Fe** 860 µg/L **Fe** 3000 µg/L **Mn** 90 µg/L **Mn** 90 µg/L **Cu** <1.0 µg/L **Cu** <1.0 µg/L **Pb** <1.0 µg/L **Pb** <1 µg/L **Zn** < 1 µg/L **Zn** 3.0 µg/L	**pH** 7.3 **EC** µS/cm 140 **Phosphate** <0.05 mg/L **Total P** <0.05 mg/L **NOx** <0.1 mg/L **NH3** <0.1 mg/L **Al** 230 µg/L **Al** 520 µg/L **Fe** 330 µg/L **Fe** 600 µg/L **Mn** <5.0 µg/L **Mn** 10 µg/L **Cu** < 1.0 µg/L **Cu** <1.0 µg/L **Pb** < 1.0 µg/L **Pb** <1.0 µg/L **Zn** <1.0 µg/L **Zn** 4.0 mg/L

As results indicate, in both locations pH was neutral and around 7 values. We believe that oxygenation of water by sedges rhizome and root systems have increased the pH from usually acidic to a neutral value.

It should be noted that concentration of Nitrogen species and phosphorus in both unfiltered and filtered samples was very and no difference between filtered and unfiltered samples were observed.

In Sample 2 which was collected behind ICC dam soluble aluminium was several folds above the ANZECC Water Quality Guidelines 2000, the trigger values for 95% protection of ecosystem in the freshwater where the pH value is above pH> 6.5 is 55 µg/L

Soil Cation Exchange Capacity (CEC)

Cation exchange Capacity (CEC) is a measure of soil's capacity to hold nutrient; specially, positively charged ions such as K, Ca, and Mg. Clay and soil organic matter contribute to cation exchange capacity, thus soils with high CEC will retain nutrient better than low CEC soils.

The following rating for cation exchange capacity is given by P. Hazelton and Brian Murphy (CSIRO, 2007)

Table 4 – Rating of soil based on Cation Exchange Capacity

Rating	CEC cmol(+)/Kg
Very Low	<6
Low	6-12
Moderate	12-25
High	25-40
Very high	>40

As the analytical results of our soil samples from Lot 4, Lot 3 and Lot 1A (table 4) indicate the CEC values for the studied samples varies between <1 and 1.6 (meq/100 g) which is far below the very low CEC category.

This is an indication that the nutrient retention capacity of the soil in the proposed allotments is extremely poor. If one decided to lay the lawn or create garden bed, one need to import soil to cover the existing natural landscape or to apply large quantity of P and N fertilizer to overcome the natural limitation.

Importation of soil also means introducing various types of bacteria, fungi, parasites and seeds to this natural landscape.

The acidic nature of the local soil will quickly mobilise and washes away the applied fertiliser through the perched aquifer . the mobilised fertilisers will end up in the upland swamps and local creek and contribute to nuisance algal growth and weed infestation of the existing landscape..

Table 5 - Analytical results of the Cation Exchange Capacity and P-Sorption of the soil samples from Lot 1A, Lot3 and Lot 4

Depth cm below the surface	Date Sampled	pH	Electrical Conductivity	Total Organic Carbon	NOx as N in soil	Ammonia as N in soil	Phosphorus Sorption	Exchangeable Al*	Exchangeable Ca*	Exchangeable K*	Exchangeable Mg*	Exchangeable Na*	Cation Exchange Capacity*
		1:5 soil:water	1:5 soil:water	(Walkley Black)									
		pH Units	µS/cm	mg/kg	mg/kg	mg/kg	mg/kg	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g	meq/100g
			<1	<1000	<0.5	<0.5	<1	<0.01	<0.01	<0.01	<0.01	<0.01	<1
		LAB.1	LAB.2	LAB.13	LAB.55	LAB.57	Ext-020	Metals.23	Metals.23	Metals.23	Metals.23	Metals.23	Metals.23
0-10	21/07/2009	5.5	62	16000	<0.5	1.1	**4.6**	1	0.51	0.26	0.43	0.37	**1.6 Auger hole 1(Lot 4)**
0-10 dup	21/07/2009	5.4	55	16000	[NT]	0.9	[NT]	1	0.5	0.25	0.42	0.36	**1.5**
20-25	21/07/2009	5.6	11	10000	<0.5	<0.5	**4.7**	0.89	0.14	0.1	0.08	0.13	**<1**
60-65	21/07/2009	5.7	18	8400	<0.5	0.8	**4.3**	1	0.11	0.2	0.12	0.17	**<1**
0-12	21/07/2009	5.8	7	8200	<0.5	0.7	**4.5**	0.81	0.1	0.12	0.08	0.12	**<1 Auger hole 2 (Lot 3)**
50-52	21/07/2009	5.6	10	6200	<0.5	0.9	**4.4**	0.57	0.08	0.12	0.08	0.12	**<1**
58-59	21/07/2009	5.5	12	4700	<0.5	0.6	**4.4**	0.37	0.06	0.12	0.08	0.11	**<1**
0-25	21/07/2009	4.6	64	63000	<0.5	3.8	**4.8**	3.6	1.7	0.33	1.1	0.36	**3.4 Auger hole 3 (lot 1A)**
20-22	21/07/2009	5.8	10	7800	<0.5	<0.5	**5.1**	1.1	0.16	0.14	0.3	0.14	**<1**
80	21/07/2009	5.3	18	3900	<0.5	<0.5	**6.1**	1.1	0.09	0.13	0.22	0.13	**<1**

P-Sorption Capability:

Soil phosphorus retention capability is measurable when a sample of soil is shaken with 1000 mg P/ L and the percentage of P retained

The method originated from the need to differentiate between soils exhibiting high and low P retention

There is a clear relation between soil pH and soil P sorption capability. The lowest P sorption occurs in acidic soil and highest sorption in alkaline environment. As table 5 shows in Maddens Plain soil acidic pH which generally fluctuate between 4.5 and 5.5 is sever limitation for Phosphorus retention.

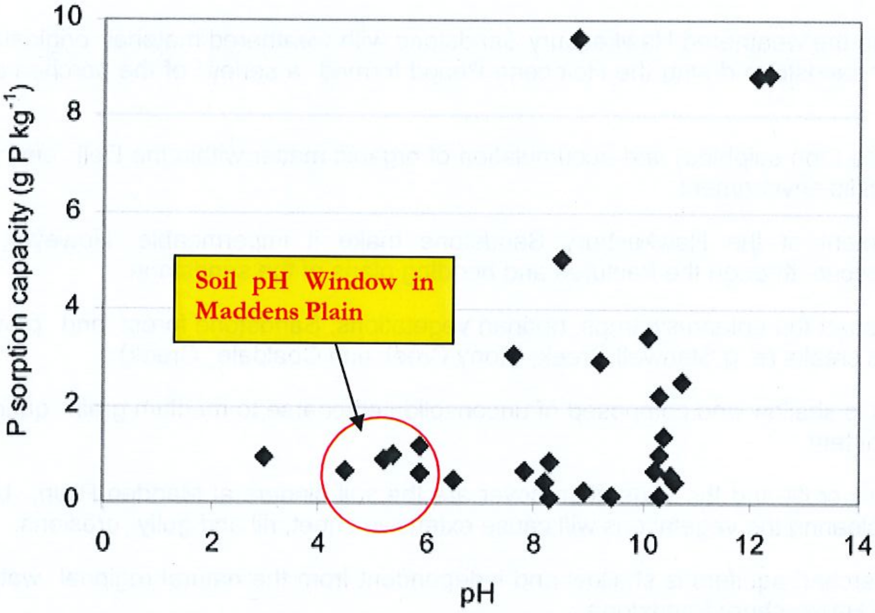


Figure 11- Relationship between the P sorption capacity and pH

Based on soil phosphorus retention capability five classes of soil are identified: very low < 10%, low 10-30%, medium 30-60%, high 60-90% and very high >90%. Soil in Maddens Plan fall within the <10 % category in relation to phosphorous retention.

Low P sorption capability and very low cation exchange capability make the

Analysis of soil samples from Illawarra Ridge Golf Resort (Conceptual Water Quality Management Plan, SEEC Morse McVey, 2008) indicated that the Maddens Plains soils have very low Cation Exchange Capacity. As table... shows, the phosphorus sorption capacity is particularly very low.

Soil horizon	P sorp. (mg/Kg)	P sorp. index
Upper weather sand horizon	3.32- 5.25	2.6- 3.6
Lower weathered Sand horizon	4.63- 4.76	3.3- 3.4

If soil absorption capacity is below 2000 mg/Kg, that means the soil would be unable to immobilise the excess P. If the future owners of the proposed lots decided to laid turf in their property, as the local soil is poor in phosphorous and the soil P retention capacity is limited, to maintain a healthy lawn they need to apply larger quantities of fertiliser. If the rate of P fertiliser application in a normal sandy loam is approximately 500- 700 Kg / hectare, they must apply something around 1300 Kg/hectare. As the soil is porous, acidic and with little clay content majority of the applied fertilizers would be quickly washed away and through the groundwater aquifer discharged into the adjacent wetlands and Creeks.

Increase in P or N in these low nutrient regulated upland swamps and creeks will encourage nuisance algal growth and infestation of exotic species.

Maintenance of the lawn and ornamentation plants often requires application of pesticide and fungicides, in this land of

Impact of fertilizers on native flora and weed infestation of the site Impact of pesticides and herbicide of Aquatic Ecosystems

Conclusions

- By Quaternary period the Paleo-surface of Hawkesbury sandstone was carved with erosional throughs, gullies, ditches and concavities of various shapes, lengths and depths. These erosional features are called "Dell"
- Infilling of the dells on the weathered Hawkesbury Sandstone with weathered material originated from parents Hawkesbury sandstone during the Holocene Period formed a series of the perched aquifers on Maddens Plain.
- Oxidation of Marcasite (iron sulphide) and accumulation of organic matter within the Dell environment created a strongly acidic environment.
- Clay and silica cement of the Hawkesbury Sandstone make it impermeable. However, lateral movement of water occurs through the fractures and bedding plans of the sandstone.
- Perched aquifers support the upland swamps, riparian vegetations, Sandstone forest and provide the base flow to the local creeks (e. g Stanwell Creek, Stony Creek and Coaldale Creek)
- Soil in Madden Plain is shallow and composed of unconsolidated coarse to medium grain quartz sand with very little clay content.
- A thin layer of organic crust and the vegetation cover are the soil binders at Madden Plain, breaking the organic crust or clearing the vegetations will cause extensive sheet, rill and gully erosions.
- Water table of the perched aquifers is shallow and independent from the natural regional water table which is beneath the Hawkesbury Sandstone.
- Shallow water table of the Maddens Plain perched Aquifers makes them vulnerable to surface contamination.
- Soil in Maddens Plain is poor in nutrient and the perched aquifers Phosphorus and nitrogen contents is also very low
- Soil CEC data from 9 auger holes soil samples at Lot 1A, Lot 3 and Lot 4 as well as soil CEC results from nearby Illawarra Ridge Golf Resort soil indicate that the soil P sorption capacity is very low. If fertilizers are applied to this soil, they will be quickly washed away by groundwater.
- Strong acidity of groundwater is responsible for iron and aluminium mobilisation.

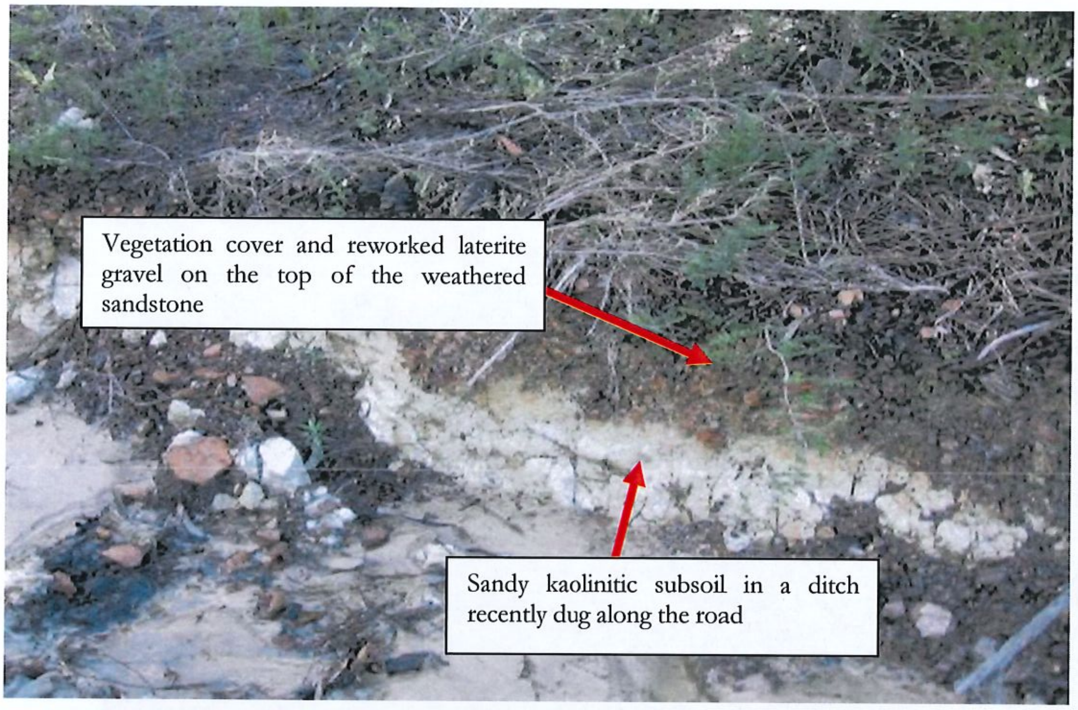


Figure 12– Soil and subsoil horizons in a recently excavated ditch along the road

Figure 13- Gully erosion within the coal wash layer used for road construction on the road

Figure 14- Close up picture of erosion pathway along the road shoulder, where coalwash was used.

Figure 15- Freshly deposited sediment in the drainage line along the recently upgraded road

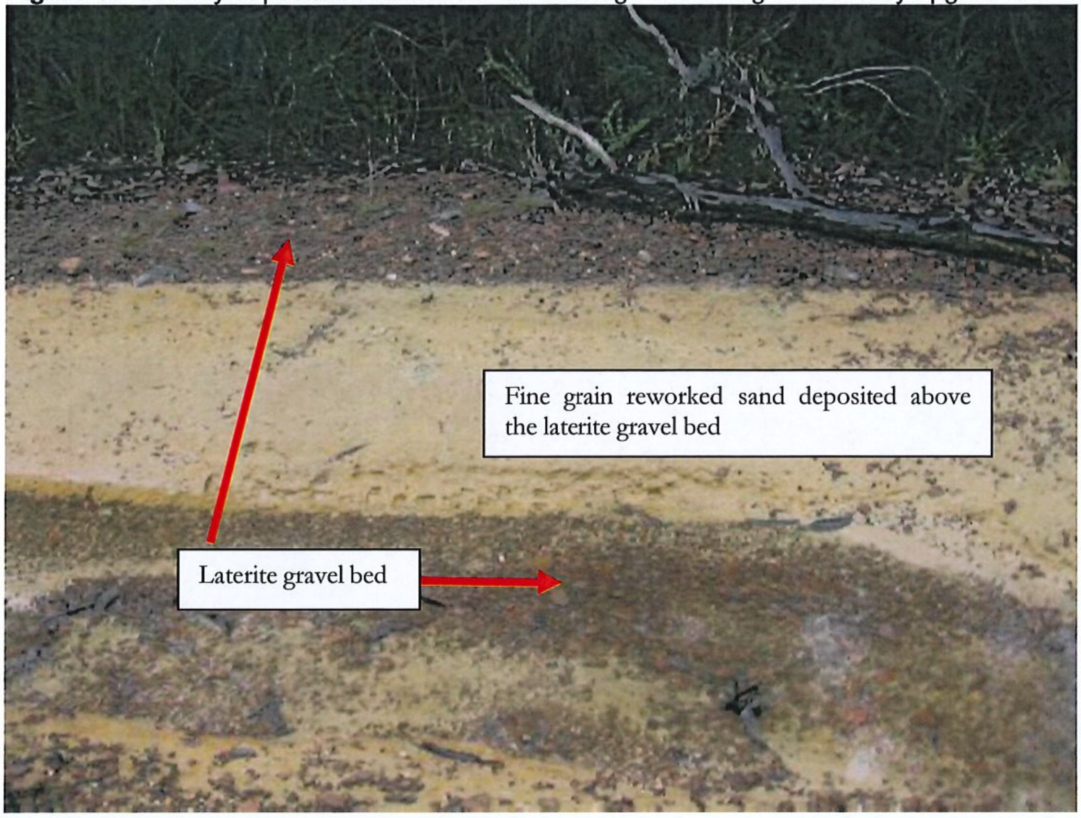


Figure 16- Deposition of the recently reworked fine sand on the top of pisolithes layer

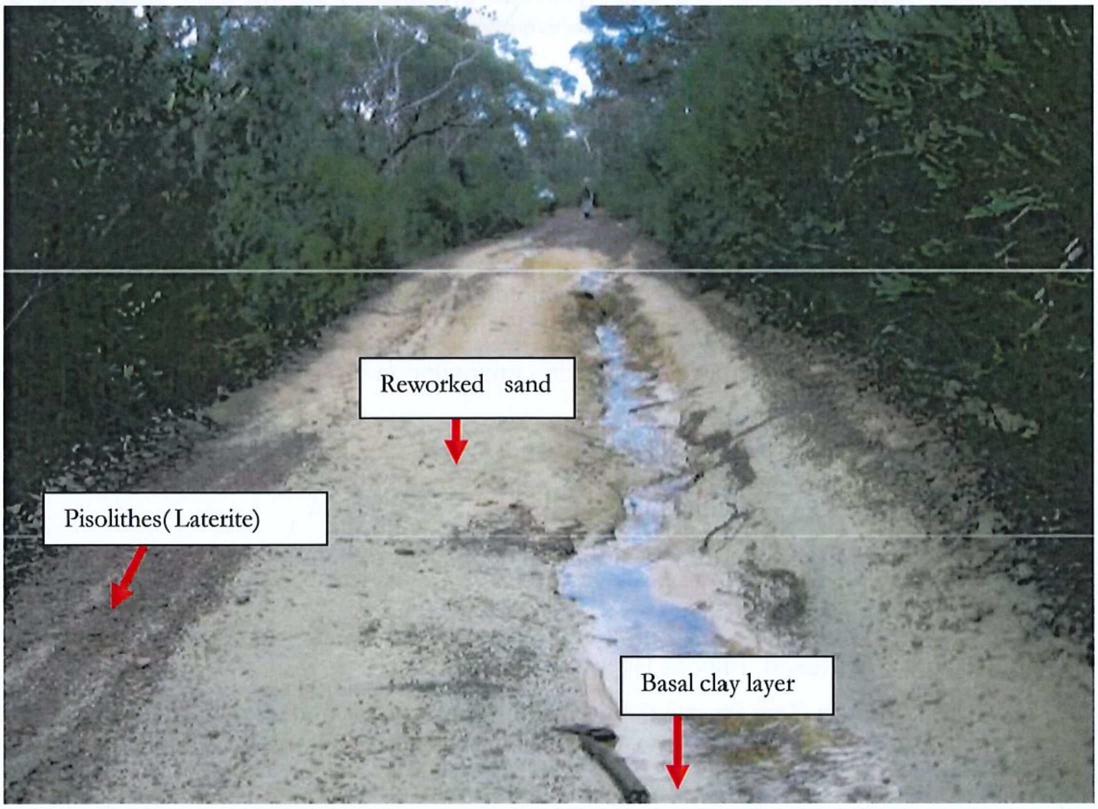


Figure 17- Rill erosion along the axes of the road showing pisolithes layer, overlaying weathered sand and a basal clay horizon. Perched Aquifer, groundwater hydrochemistry

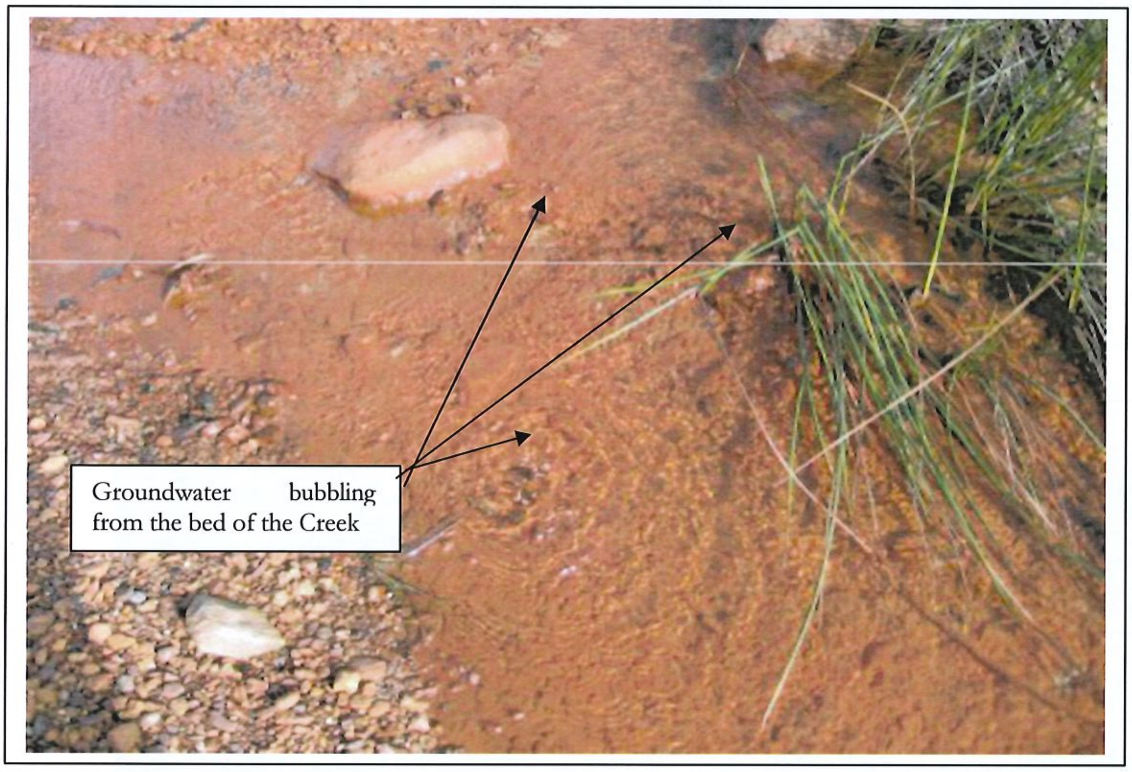


Figure 15- Groundwater discharges from the *Leptocarpus tenax Schoenus bervifolius Schoenus paludosis* dominated sedge wetland and Iron hydroxide precipitates on the road crossing of the sedge wetland

References

Young Ann - 1983- Upland swamps-dells- on Woronora Plateau, near Wollongong, New South Wales. University of Wollongong, 1983

Hazelton P.A. and P.J. Tille 1990- Soil Landscapes of the Wollongong-Port Hacking 1:100 000 Sheet, Soil Conservation of NSW.

Read, H.W. and A.C. Cook, 1970- Note on Coal Containing Marcasite Plant Petrifactions, Yarrunga Creek Sydney Basin, New South Wales The Royal Society of NSW.

Read H. W. and A.C. Cook, 1973- Ripple –Drift Cross-Lamination in the Hawkesbury Sandston, New South Wales. Royal Society of NSW

Chafer, Chris J. 2007- Wildfire Catchement Health and Water Quality: a review of knowledge derived from research undertaken in Sydney Water Supply Catchement 2002-2007. Catchment Operation and Major Project Division, Sydney Catchment Authority, Penrith.

Ecological impact of Longwall Mining In the Southern Coalfield of NSW- A review. Scientific Services Section, Department of Environment and Climate Change.

Andrew Macleod 2007- For SEEC Morse McVey. Conceptual Water Quality Management Plan For proposed Illawarra Ridge, Golf Resort, Princes Highway Darkes Forest.

Merrick N.P. 2008- Metropolitan Coal Project Groundwater Assessment, A Hydrological Assessment is Support of Metropolitan Colliery Longwalls 20 to 44 Environmental Assessment, for Helensburgh Coal Pty Ltd, PO Box 402, Helensburgh NSW 2508.

Keith David, S. Rodoreda., L. Holman L and J. Lemmon- 2006- Monitoring Changes in Upland Swamps in Sydney's Water Catchments: the roles of fire and rain. Sydney Catchment Authority Special Area Strategic Management Research and Data Program.

Yassini, Iradj, 1995- Geotechnical and Groundwater Quality Assessment of the proposed Builders Refuse Tip, Lot 2, Halls Road, Helensburgh. Wollongong City Council, Reference Library LR 363.728 YAS.

Yassini, Iradj, 2004- Pulsative discharge of dissolved metals from copper slag emplacements into the Windang Unconfined Sandy Aquifer adjacent to Lake Illawarra. Wetlands (Australia) Vol.21, No 2, pp 253-273

Yassini, Iradj, Daniel Robson 2006 Nitrogen Sources and species in the unconfined Sandy Aquifer of the Windang Peninsula, Illawarra Coast of New South Wales. September 2006 River Symposium, Brisbane, Australia.