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FLOODING AND STORMWATER MANAGEMENT ASSESSMENT

LOCAL ENVIRONMENTAL STUDY
RAMSGATE ESTATE
WYEE POINT, N.S.W.

FOR LAKE MACQUARIE CITY COUNCIL

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EXECUTIVE SUMMARY

The following report details a Flooding and Stormwater Management Assessment for land in the Lake Macquarie Local Government area. The land investigated in this report consist of a parcel of land situated on the shores of Lake Macquarie at Wyee Point. The parcel of land consists of all lots in D.P. 1596 and Lot 1 D.P. 124592 and covers an area of approximately 37.5 hectares.

Hydraulic investigations indicate that the 1 in 100 year Average Recurrence Interval storm event will cause flooding on parts of the subject site. Flooding of parts of the subject site is also expected during more frequent storm events.

Sea level rise due to climate change has been identified as a major contributing factor in the extent of areas within the subject site which could be affected by flooding. Lake Macquarie City Council guidelines require that an allowance be made for this when considering minimum finished floor levels.

Investigations of the Probable Maximum Flood event for the subject site indicate that there would be adequate egress away from flood affected land should the Probable Maximum Flood event occur.

Stormwater runoff from the site, if left untreated, may negatively impact on downstream ecosystems, most noteably a SEPP 14 wetland along the north western boundary of the site. To minimise the impact and fulfil the requirements of Lake Macquarie City Council's development control guidelines, a number of water quality treatment philosophies and methodologies could be incorporated within the future development.

It has been determined that due to the subject sites proximity to the receiving waters it would be unwarranted for post-development peak flows to be required to be attenuated to equal or less than pre-development flows. Stormwater discharge towards the wetlands, however, should be maintained at natural levels and methodologies of maintaining infiltration into the subsurface water system should be encouraged to ensure base flows towards the wetlands are not affected.

In summary, the hydraulic and hydrologic review of the subject site presented in this report has identified a portion of the parcel of land as being suitable for future development with regard to stormwater runoff and flooding, provided appropriate stormwater runoff quality and flood management strategies are implemented.

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1 INTRODUCTION

1.1 Investigation Objectives

Northrop Consulting Engineers Pty Ltd were engaged by 'RPS Harper Somers O'Sullivan' to prepare a Flooding and Stormwater Management Assessment for consideration in the assessment of a proposed rezoning of a parcel of land known as Ramsgate Estate, Wyee Point.

This report investigates the potential for flooding within the subject site, and the potential impact of future development on water quantity and quality within and downstream of the site. This report identifies additional requirements for the discharging of stormwater in order to reduce the potential impacts on the wetlands downstream of the site.

The intent of this report is to assess the suitability of the study area for rezoning for use as a mixture of urban development and conservation. This report will attempt to discuss these issues at a level appropriate for a rezoning application, and does not attempt to provide detailed design solutions to all issues. Rather, this report provides an overview of potential issues within the study area and identifies possible outcomes for future development.

The recommendations of this report have been determined in accordance with Lake Macquarie City Council's (LMCC) Development Control Plan (DCP) and the N.S.W. Government's Floodplain Development Manual and with consideration of LMCC Lifestyle 2020 Strategy.

1.2 Site Location

The subject site is located at the southern end of Lake Macquarie in the Lake Macquarie Local Government Area (LGA). The site is located to the east of the Newcastle to Sydney Freeway to the south east of Morisset. The study area covers an area of approximately 37.5 hectares.

The subject site is bounded by Lake Macquarie to the north and residential allotments to the east. To the west is an unnamed tributary to Lake Macquarie and to the south rural residential lands.

The subject site comprises all lots in D.P. 1596 and Lot 1 in D.P. 124592. D.P. 1596 divided the subject site into 606 individual lots which are collectively known as Ramsgate Estate.

The site is relatively undeveloped at present. The subject site had initial clearing and preliminary construction of roads commence, however this was aborted due to a dispute with the owner of the adjacent land over legal access. These preliminary works were abandoned some time before 1887. Since this time the majority of the site has been covered by regrowth of trees and grasses.

There are four distinct watersheds on the subject site. The majority of the site is covered by two watersheds which fall towards an unnamed flow path which flows from south to north through the centre of the subject site and drains into Lake Macquarie. An additional watershed flows to an unnamed tributary to the west of the site. The fourth watershed falls to a small flow path which runs near the eastern boundary of the subject site. There is a SEPP 14 wetland (number 888) along the north western boundary.

Figure 1.1 overleaf provides an overview of the subject site as well as watersheds and other key features.

Figure 1.1 - Site Locality and Features

2 FLOODING IMPACTS

2.1 Investigation Scope

This report identifies and investigates the potential sources of flooding for the subject site. These potential sources include flooding from Lake Macquarie as well as flooding from an unnamed tributary to Lake Macquarie which flows along the north western boundary of the subject site. It also investigates potential flooding from a number of minor flow paths running through the subject site. These potential sources of flooding are discussed in more detail in Sections 2.3, 2.4 and 2.5 of this report.

Peak flows for the 1 in 1, 1 in 5, 1 in 10, 1 in 20 and 1 in 100 year Average Recurrence Interval (ARI) events have been investigated for the subject site based on the existing site characteristics. The peak flows have been calculated based on existing conditions, as it has been assumed that any future development upstream of the subject site would be required to attenuate site discharge back to natural levels. The calculated peak flows for the subject site are discussed further in Section 2.2 of this report. Estimated peak flood levels for the subject site and adopted watershed characteristics have been investigated for the 1 in 20 and 1 in 100 year ARI events and are discussed in Sections 2.3, 2.4, 2.5 and 2.6 of this report.

The potential for increased flood levels for the subject site, caused by climate change, has been investigated in accordance with the Lake Macquarie City Council report “Guidelines for Development in Areas adjoining the Lake Macquarie Waterway that are Vulnerable to the Impacts of Sea Level Rise”. An assessment of the impacts on each of the potential sources of flooding is discussed in Sections 2.3, 2.4 and 2.5 of this report.

The Probable Maximum Flood (PMF) for the site has been investigated in relation to access and egress from developed lands, which may to be affected by extreme flooding, in accordance with the requirements of the N.S.W. Governments Floodplain Development Manual. The estimated PMF for the subject site and access and egress is discussed in Section 2.7 of this report.

An assessment of the hydraulic and hazard categories has been undertaken in accordance with the guidelines set down in the N.S.W. Government’s Floodplain Development Manual, and is discussed further in Section 2.8 of this report.

2.2 Estimation of Peak Flows

Peak discharges were estimated for each of the sub-catchments for the ARI’s mentioned in Section 2.1. The Peak Discharges were estimated using the probabilistic rational method as outlined for use in eastern N.S.W. in the Australian Rainfall and Runoff - Volume 1 (1987) (AR&R). The calculation of the peak discharges included:

- The delineation of contributing catchment boundaries.
- The determination of the Intensity-Frequency-Duration for the local area using methods set out in the AR&R 1987.
- Determination of catchment hydrological parameters.

Figure 2.1 shows the extents of the catchments analysed as part of this investigation.

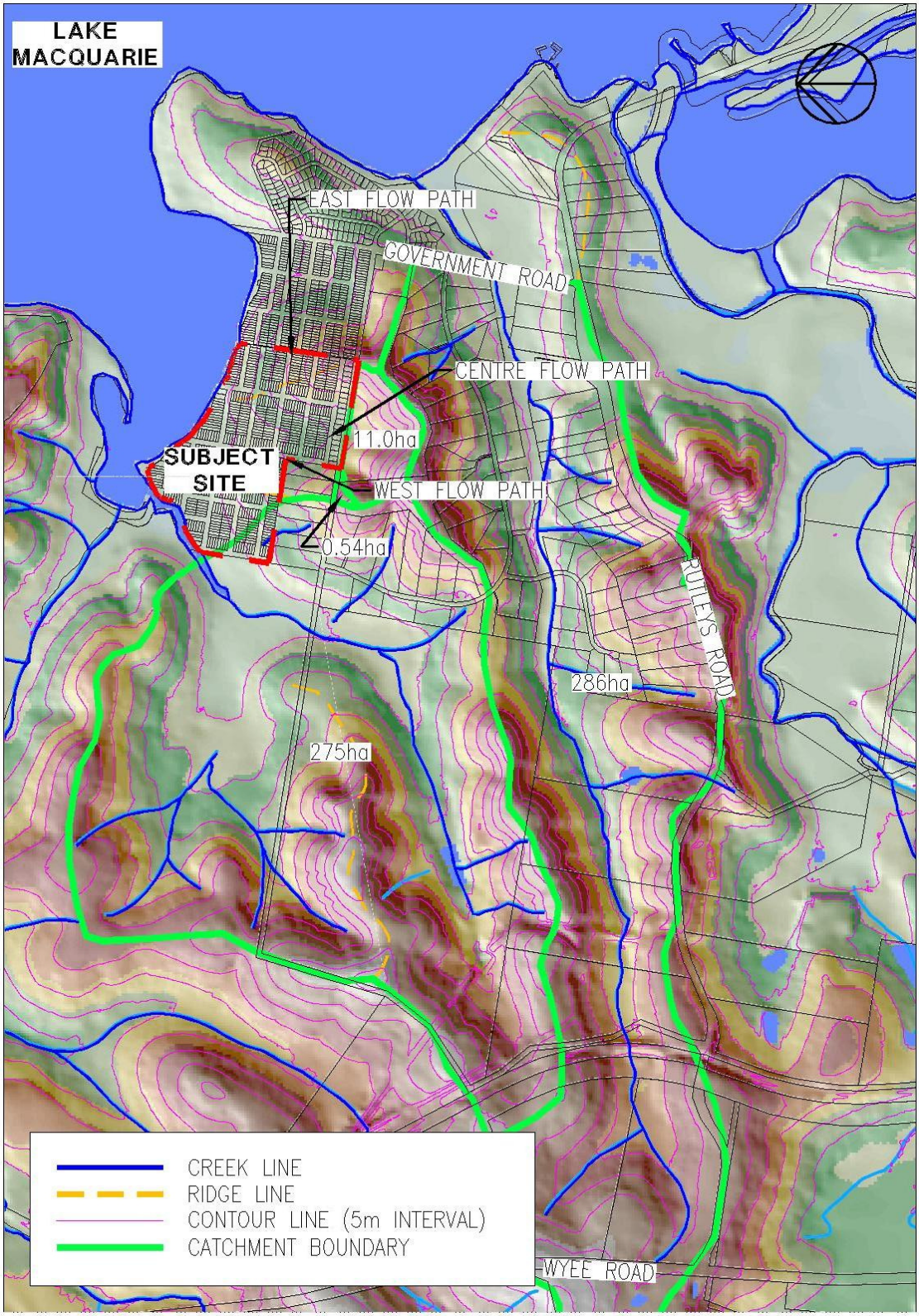

Figure 2.1 - Modelled Catchments

Table 2.1 below gives a summary of the peak discharges calculated at key locations for each of the ARI's investigated.

Table 2.1- Peak Discharges ($m^3.s^{-1}$)

Catchment	1 in 1	1 in 5	1 in 10	1 in 20	1 in 100
West Tributary	6.03	14.37	18.54	24.01	38.72
West flow path	0.04	0.09	0.11	0.15	0.23
Centre flow path	0.52	1.22	1.56	2.02	3.22
East flow path	NA	NA	NA	NA	NA
Government Rd	6.57	15.67	20.21	26.17	42.19

Note - Peak Discharges calculated using the Probabilistic Rational Method.

The potential for an increased flood level due to an increase in rainfall intensities, as a result of climate change, will also need to be considered for the tributaries running through the site. The N.S.W Government Department of Environment and Climate Change Floodplain Risk Management Guideline – Practical Consideration of Climate Change recommends that a sensitivity analysis be conducted with an increase of 10%, 20% and 30% in peak rainfall 'until more work is completed in relation to the climate change impacts on rainfall intensities. The most current information should be considered at the time of planning and design for future development to ensure appropriate consideration is given to climate change and the potential for increased rainfall and hence flooding. Table 2.2 below gives a summary of the potential Peak Discharges with increased peak rainfall intensities due to climate change.

Table 2.2- Peak Discharges due to Climate Change ($m^3.s^{-1}$)

Catchment	1 in 20		1 in 100	
	+10%	+30%	+10%	+30%
West Tributary	26.41	31.21	42.59	50.34
West flow path	0.17	0.20	0.25	.30
Centre flow path	2.22	2.63	3.54	4.19
East flow path	NA	NA	NA	NA
Government Rd	28.79	34.02	46.41	54.85

Note - Peak Discharges calculated using the Probabilistic Rational Method.

2.3 Potential Flooding from Lake Macquarie

Lake Macquarie is a tidal lake which forms the northern boundary of the subject site. Lake Macquarie has a surface area of approximately 110 square kilometres and a total catchment area of approximately 684 square kilometres. Lake Macquarie is outlet to the Pacific Ocean via the Swansea Channel.

The flood level of Lake Macquarie is determined by a combination of rainfall runoff from the contributing catchment, the sea water elevation at the Swansea channel outlet and the ability of the rainfall runoff to escape through the Swansea Channel. The flood level for Lake Macquarie is further influenced by the wind and wave conditions.

The potential for flooding from Lake Macquarie was considered particularly relevant for the subject site given that the northern boundary of the site forms part of (approximately 1.5km) of the Lake Macquarie foreshore.

A flood study was undertaken by Manly Hydraulics Laboratory for the NSW Department of Public Works and Services and Lake Macquarie City Council in order to determine the probable maximum flood levels for Lake Macquarie for a number of different rainfall event intervals. A flood height of 1.38m AHD was estimated as the 100 year ARI flood level whilst the 20 year ARI flood level was estimated as 0.97m AHD.

Council's sea level rise policy requires that the potential for sea level rise due to climate change be considered when assessing the habitable floor heights in areas predicted to be affected by flood behaviour. The document "Guidelines for Development in Areas adjoining the Lake Macquarie Water that are Vulnerable to the Impacts of Sea Level Rise" determines that an allowance of "0.91m increase in sea level, and a 0.2m increase in Lake Flood level due to increased rainfall, by the year 2100" be made for the 100 year ARI flood level. The guidelines do provide scope for these allowances to be varied on a case-by-case basis where it is deemed fit. This is generally only in cases where the development is designed to have a shorter economic life than 2100, where the development involves an extension to an existing building where it is impractical to increase the floor level or where the nature of the activity requires close proximity to the lake.

It is considered that a development such as the one proposed would not fit into any of these cases and the 1.11m allowance for an increase in the 1 in 100 year flood level should be adopted. Whilst this allowance was current at the time of writing this report, further research and understanding of the potential impacts of sea levels rise due to climate change is on-going and therefore the most recent policies should be considered for the proceeding stages of planning and design for future development. For the purposes of this report, the adopted 1.11m potential increase in the Lake Macquarie flood level will give a 100 year flood level of 2.5m AHD, by the year 2100.

2.4 Potential Flooding from Unnamed Tributary

This investigation has identified an unnamed tributary to Lake Macquarie which runs near the north western boundary of the site as a potential source of flooding for the subject site. The unnamed tributary drains a catchment of approximately 2.65 square kilometres to the south west of the subject site. The unnamed tributary runs along the north western boundary of the subject site before discharging to Lake Macquarie near the north western corner of the site. Potential flooding of the subject site from this source was considered under a couple of different scenarios.

The first scenario is when the lake is experiencing a peak event, 1 in 100 year ARI flood that results in downstream control for flow derived from the unnamed tributary catchment. It was considered that the peak discharge from the local catchment is extremely unlikely to coincide with the peak water level in Lake Macquarie. The flood level in this scenario was therefore considered assuming a 20 year ARI peak discharge with a 100 year ARI peak lake flood level.

The second scenario for potential flooding of the subject site would occur when the peak discharge from the catchment for the unnamed tributary were to flow past the subject site. The peak flood level from this scenario would be influenced by the volume of rainfall runoff from the contributing catchment and the ability of this water to escape from the catchment to the lake. It was considered that the peak discharge from the local catchment is extremely unlikely to coincide with the peak water level in Lake Macquarie. The flood level in this scenario was therefore considered assuming a 100 year ARI peak discharge with a 20 year ARI peak lake flood level. This scenario was not considered to be as severe as the scenario above.

The scenario which was considered likely to give the highest flood level within the unnamed tributary was the scenario in which the 100 year flood level from Lake Macquarie backs up into the tributary. Whilst under this scenario there would likely be a small volume of water discharging off the contributing catchment, at a flood level of 1.38m AHD (100 year Lake Macquarie flood level) the tributary would be approx 80m wide at the narrowest point parallel to the subject site, meaning that a water level increase due to discharge would be, for all intents and purposes, hydraulically insignificant. It has therefore been considered that the lake 100 year ARI peak flood level could justifiably be used to estimate the 100 year ARI peak flood level within the tributary, giving a peak 100 year ARI flood level of 1.38m AHD.

In accordance with council's sea level rise policy, an allowance of 0.91m increase in sea level, and a 0.2m increase in lake flood level due to increased rainfall should be applied in order to estimate the peak 100 year ARI Lake flood level by the year 2100. This would give a peak 100 year flood level within the tributary of 2.5m AHD, by the year 2100.

2.5 Potential Flooding from Site Flowpaths

There were three flowpaths within the subject site investigated as potential sources of flooding. These flow paths have been called 'West flow path', 'Centre flow path' and 'East flow path' and are identified on Figure 1.1.

The West flow path runs from the outlet headwall of a 375mm diameter stormwater pipe and flows north towards Lake Macquarie. The pipe has been calculated to have a contributing catchment area of approximately 0.54 hectares, which consists of natural vegetation and roadway. It is considered that the flows from this outlet could easily be managed using conventional drainage methods (i.e. pipes or open channels integrated as part of a development) and is therefore not considered to be a potential source of flooding for the subject site in the context of future site development.

The Centre flow path is formed in the low point of an unformed fire trail along the southern border of the site, and runs north towards Lake Macquarie. This flow path has a contributing catchment area of approximately 11 hectares. The topography of the land in this area would mean that any flows within this flow path would have a wide shallow flow width. It is considered that the flows conveyed within this flow path could be easily managed using conventional drainage methods, and is therefore not considered to be a potential source of flooding for the subject site in the context of future site development.

The East flow path runs near the eastern boundary of the subject site. Site observation determined that this flow path does not have any formalised banks. There is almost nil upstream catchment for this flow path. The contributing catchment of this flow path is all derived from the subject site and the urban area to the east. Any development within the subject site would alter the topography of the contributing catchment and need to consider the flows within the planning and design. It is considered that the flows from this flow path could easily managed using conventional drainage methods and is therefore not considered to be a potential source of flooding for the subject site in the context of future site development.

Our assessment has found the three site flow paths are deemed to be of little significance in relation to flooding in the context of planning for future development of the site. Each flow path could easily be managed by conventional drainage means (pipes or open channels integrated as part of a development).

2.6 Estimated Peak Flood Levels

The peak flood levels for a number of potential sources of flooding have been estimated as outlined in Sections 2.3, 2.4 and 2.5 of this report. Table 2.3 below summarises the peak flood levels which have been estimated as part of this investigation.

Table 2.3- Estimated Peak Flood Levels (m(AHD))

Catchment	1 in 20	1 in 100	2100, 1 in 100
Lake Macquarie	0.97	1.38	2.50
West Tributary	0.97	1.38	2.50
West flow path	NA	NA	NA
Centre flow path	NA	NA	NA
East flow path	NA	NA	NA

Figure 2.2 depicts how these calculated flood levels for Lake Macquarie will impact on the subject site.

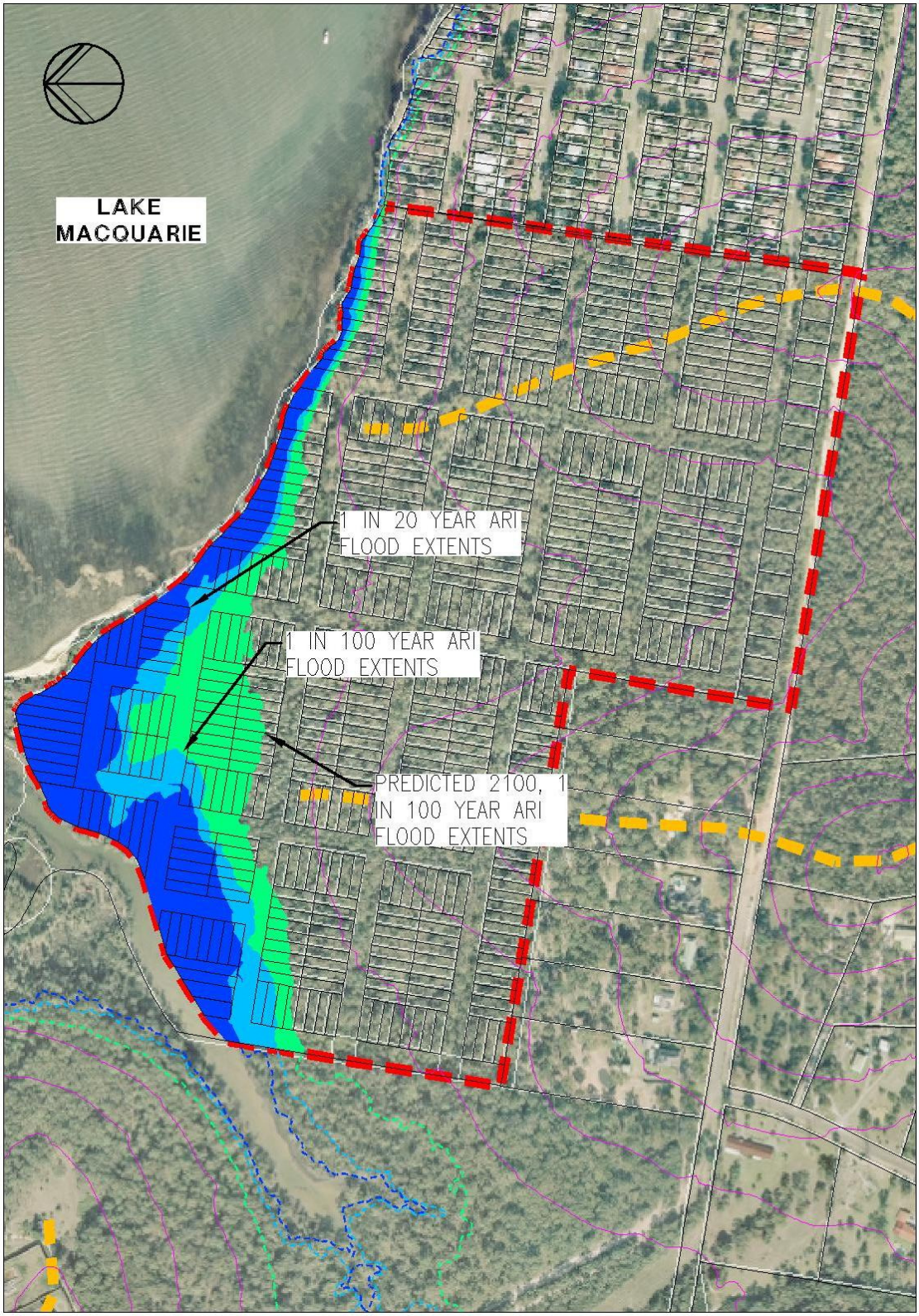

Figure 2.2 - Peak Flood Extents

The flood levels and flood extents identified above represent the calculated peak flood levels for the 20 year, 100 year and 2100, 100 year ARI flood events. Lake Macquarie's Engineering Guidelines generally require that an additional 500mm be allowed, above the 100 year ARI peak flood levels, to habitable floor levels. Therefore, under council's current sea level rise policy, the habitable floor level of all dwellings would need to be a minimum of 500mm above the 2100, 100 year ARI peak flood level (i.e. 3.00m). The most recent policies and documents, concerning this, should be considered for the proceeding stages of planning and design for the future development when considering the habitable floor levels due to flooding constraints.

2.7 Probable Maximum Flood

The Probable Maximum Flood (PMF) was investigated to assess the potential impact of flooding on the site during extreme events. A PMF level for Lake Macquarie was simulated for the Lake Macquarie Flood Study undertaken by Manly Hydraulics. The PMF level for Lake Macquarie was determined to be 2.63m AHD. This PMF flood level for the lake does not take into consideration the effects of Sea Level Rise due to global warming. If we were to adopt the 1.11m potential sea level rise by 2100 (albeit an estimate for the 1 in 100 year event), then the PMF would be approximately 3.74m AHD by 2100.

The PMF event is not typically used to determine floor levels or building areas, but provides an idea of the upper limit of flooding for use in emergency response planning in order to address the safety of residents. Of primary concern is the egress from affected areas. As shown on Figure 2.3, the topography of the site allows a multitude of egress paths away from potentially affected areas to higher ground. The maintenance of these egress paths away from the areas potentially affected by the PMF should be given due consideration when planning the layout of the subdivision.

Emergency access to the site during a major flood event is also considered of prime concern. Currently the only route of road access to the subject site is provided via Government Road. Government Road runs from Ruttleys Road, to the south of the site, to Lake Macquarie. There is a low point in Government Road where it crosses Cobra Creek, which runs in a west to east direction and joins Lake Macquarie in Wyee Bay. This road crossing of Cobra Creek is below the Lake Macquarie PMF level and it is therefore considered that the subject site could be cut off from road access during the PMF event.

Once across Cobra Creek, Government Road joins with Ruttleys Road which runs close to a ridge line towards the west. It is considered that Ruttleys Road unlikely to be inundated by flood flows during a PMF event.

The potential for Government Road to be inaccessible during major flood events, and the possible hazards associated with this, should be given due consideration at the master planning stage of the development.

Figure 2.3 depicts how these calculated PMF levels will impact on the subject site.

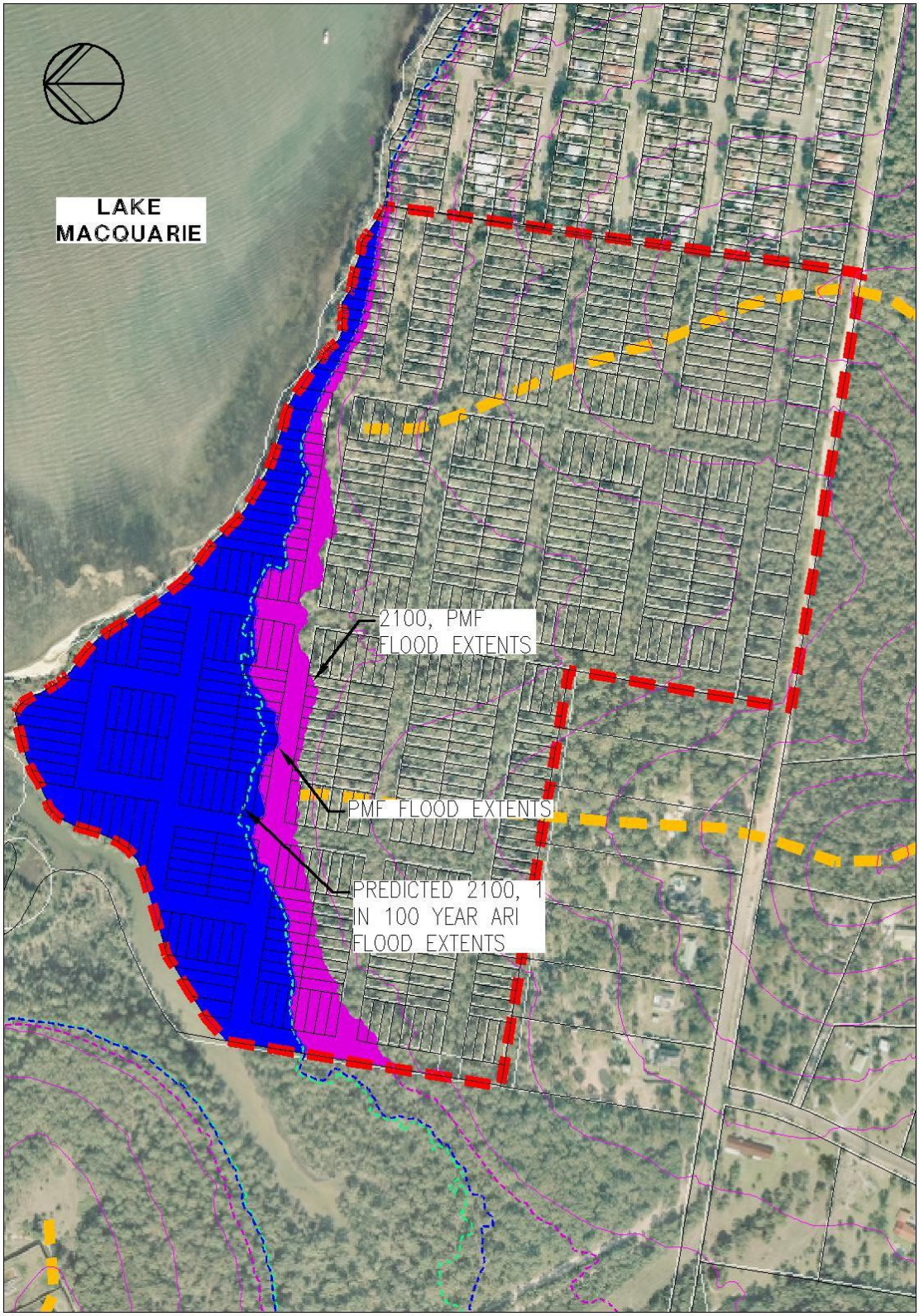

Figure 2.3 - Probable Maximum Flood Extents

2.8 Flood Hydraulic and Hazard Categories

The N.S.W. Government's Floodplain Development Manual identifies hydraulic and hazard categories to help determine appropriate types of development within flood liable land. Hydraulic categories define the characteristics of flow dependent on how development will affect flood behaviour. Hazard categories define how flood flows are likely to affect development.

The manual breaks flood flows into three hydraulic categories: 'Floodways', 'Flood Storage' and 'Flood Fringe'. Generally Floodways are aligned with the obvious natural channels and are those areas where a significant volume of water flows during floods. These areas, even if only partially blocked, are likely to cause a significant increase in flood levels and/or a significant redistribution of flood flows. Flood storage is those areas of a flood plain which provide temporary storage of flood waters during the passage of a flood. If the flood storage capacity is significantly reduced, flood levels in nearby areas may rise and the peak discharge downstream may be increased. Flood fringe is the remaining area of flood affected land once floodways and flood storage areas have been defined.

The manual defines two hazard categories to measure the possible adverse effects of flooding. These hazard categories are 'high hazard' and 'low hazard'. To define a hazard category consideration needs to be taken of the threat to life, the potential for damage, the danger and difficulty of evacuating people and possessions and the extent of social disruption and loss of production caused by a flood. The process of evaluating a hazard category involves; firstly, evaluating the hazard based purely on hydraulic principles, and then refining the category based on other relevant factors.

The manual notes that velocities in excess of $2ms^{-1}$ are considered excessive, and may pose a high hazard to vehicles, structures, animals and pedestrians. It is considered likely that flow velocities within the unnamed tributary will be in excess of $2ms^{-1}$ during many storm events. Whilst this is considered likely, these velocities would occur within the centre sections of the tributary. The velocities within the overbank sections of the river would most likely be much less.

Velocities much less than this can be defined as high hazard dependent on the depth of flow. Area within Lake Macquarie would be well in excess of the 1m depth, which the manual defines as high hazard. Whilst this is the case, it is considered that the fringe areas of the lake which people are most likely to come in contact with will generally not be in excess of this 1m depth and therefore could be considered low category.

The floodplain development manual recommends revision of the preliminary hazard categorisations, which were made based on hydraulic considerations alone, following an assessment of a range of other factors, including:

- Size of flood;
- Effective warning time;
- Flood readiness;
- Rate of rise of floodwaters;
- Duration of flooding;
- Evacuation problems;
- Effective flood access;
- Type of development; and
- Complexity of stream network.

A revision of the hazard category, taking into account the other contributing factors as well as hydraulic factors was undertaken. It is considered that flood events could be generally categorised as low hazard across the investigated ARI's for the flood fringe areas, assuming that future residential development will be outside of the

flooding extents, and that emergency access and egress from flood affected lands can and would be provided within the future development layout. The Hazard category within the middle section of the watercourse could be considered as high, however the development layout should take this into account. Generally the areas located above the 2100, 100 year ARI flood level could be considered as appropriate for future development with regard to stormwater and flood management. We note, the likely warning time associated with the flowpaths is likely to be relatively short, hence due consideration should be given to development zonings to prevent “high risk” development (i.e., schools, aged care, etc) being developed without adequate provision for safety. These “high risk” developments should preferentially be limited to areas outside of the PMF flood extents.

3 RIPARIAN CORRIDORS TO WATERCOURSES

3.1 General

Riparian Corridors are reserved corridors of land along either bank of a watercourse (extending from the top of a watercourse bank). Riparian Corridors are designed with the intent of retaining existing vegetation and environmental integrity of the watercourse, as well as allowing large flows to be safely conveyed.

As a general rule, buildings, roadways and other significant infrastructure are not permitted within Riparian Corridors. However, soft items such as landscaping, seating, educational signs, footpaths and service infrastructure (including stormwater drainage) may be acceptable within the Riparian area.

Appropriate Riparian Corridor widths for significant watercourses are determined by the Department of Water and Energy (DWE) in accordance with the controlled activities provisions in the 'Water Management Act 2000'.

Prescribed Riparian Corridor widths vary, depending on the size or significance of the watercourse, the existing environmental integrity of the watercourse and the potential for either improving or maintaining desirable environmental outcomes. Typical Riparian Corridor widths prescribed by the DWE are in the range between 10-60m.

3.2 Site Riparian Corridors

A preliminary study of the 1:25 000 topographic map of the region does not identify any 'blue lines' or watercourses (defined by having a banked profile with a distinct 'top' and 'toe')as flowing through the subject site. A site visit conducted in June of 2009 did not identify any formalised watercourses running through the subject site. Based on the 'blue line' rule of thumb it is considered that there should not be any Riparian Corridors imposed by the DWE to any of the flowpaths within the subject site for hydraulic purposes. However, further consultation with the DWE will have to be undertaken to confirm this.

The ecological aspects of the Riparian Corridors will be assessed by others.

4 STORMWATER MANAGEMENT ON SITE

4.1 General

Stormwater management within the rezoning area should, where practical, comply with industry best practice principles for Water Sensitive Urban Design (WSUD) and sustainable water use, as well as Council's development guidelines. The design and construction of stormwater infrastructure within the subject site should therefore aim to generally adhere to the following guidelines:

- Holistic Management of stormwater generated from the developed site should be adopted, with allotment scale measures integrated into the wider subdivision context. This would involve the use of collection and treatment measures on individual lots, overflowing during larger rainfall events into a trunk drainage system;
- The design of the trunk drainage system should be sensitive to maintaining or improving the condition of downstream watercourses and flowpaths within the subject site;
- The drainage system (both volume and quality devices) should be visually integrated into the subdivision and landscape context, and where possible form part of the open space amenity of the site;
- Dispersed release of runoff to drainage lines should be encouraged to reduce scour at outlet points. Discharge of concentrated, high velocity, and high erosive potential flows should be avoided;
- Source control devices (grassed swales, infiltration/retention trenches, rainwater tanks, bioretention swales, permeable paving, etc) should be used to control water quality, instead of large traditional end of line controls;
- Watercourse Riparian Corridors should be designed such that they act as open space corridors (Section 3 outlines riparian corridors in detail).
- Detailed integrated stormwater management and development layout planning should be undertaken in consideration of existing site topography, dams, flowpaths, and outlets, and should seek to make use of opportunities these features present.

4.2 Hydrology and Runoff Regimes

Development of the subject site and the ensuing construction of impervious surfaces will increase peak flows from the site. Council's policy generally requires that new developments manage stormwater such that peak developed flows are attenuated to equal to or less than the peak pre-developed flows for all storm events and durations up to and including the 100 year ARI. It is considered that this requirement would be unwarranted for the whole of the subject site given the proximity to the receiving waterways.

Stormwater discharge towards the wetlands, however, should be given extra consideration. The NSW Wetlands Management Policy requires that 'New developments will require an allowance for suitable water distribution to and from wetlands." Under a natural flow regime water will drain over the surface or infiltrate into the ground in the local catchment. Subdivisions will generally increase the impervious area of a site which reduces the infiltration and increases the runoff from a catchment. Devices which will encourage infiltration of stormwater runoff back into the subsurface water system should be incorporated into the development such that the quantity and dispersion of base flows to the wetlands is maintained at pre development levels.

Stormwater infrastructure should be designed such that surface flows to the wetlands are also maintained at pre development levels and outlets are designed to disperse flows to the wetlands.

In order to encourage infiltration of stormwater into the subsurface water system, following development, runoff should be managed as much as possible at the allotment level. Where practical, this should be achieved through actively minimising the impervious area on allotments, and through the collection of runoff in devices designed to encourage infiltration. Devices which could be incorporated within a development and could help achieve this aim include:

- Gravel trenches (to store and infiltrate runoff into the ground);
- Pervious paving (to reduce impervious area on lots);
- Swales and bio-retention systems; and
- Ponds and Wetlands.

4.3 Stormwater Quality

Water quality will play a major part in the planning of any development.

As a result of changes to land uses within the subject site, through development, it is expected that pollutant loads from the subject site would be increased. As such, stormwater runoff will need to be treated to minimise adverse impacts upon the ecology of the downstream ecosystem.

Litter, course sediments, fine particles, oils and greases, total phosphorus and total nitrogen are typical pollutants likely to be generated from residential development. In line with current best practice, the design of future stormwater management systems for the site should meet targets for pollutant removal in keeping with Table 4.1.

Table 4.1- Pollutant Removal Target

Pollutant	Target Pollutant Removal Efficiency
Gross Pollutants	70%
Total Suspended Solids	80%
Total Phosphorus	45%
Total Nitrogen	45%

Source: Urban Stormwater: Best Practice Environmental Management Guidelines.

Stormwater quality improvement devices (SQUID's) should be integrated within the development of the subject site to act as a treatment train. In a treatment train, individual devices treat stormwater runoff for different pollutants and to different efficiencies, with the net result being adequate treatment of all pollutants. It is anticipated that detailed design of these devices will be undertaken at the concept and detail design stages of the development. Devices should, where possible, be based on the principle of at source control, and could include:

- First Flush Devices;
- Rainwater Tanks;
- Grassed Swales;
- Retention Trenches;
- Vegetated buffer strips;
- Bio-retention swales;
- Wetlands; and
- Wet/dry basins.

Where source control devices do not provide adequate treatment, proprietary treatment devices may be required. Inclusion of these devices should only be as a last resort to supplement at source treatment.

Establishment and on-going maintenance is a key consideration in the selection of treatment devices, as Council would not wish to inherit maintenance liabilities. Appropriate selection of treatment measures should be made, with the nature of the pollutants and the performance measures to be met both forming key inputs into

the device selection. The selection of appropriate devices within the treatment train will play a large part in the maintenance costs for SQUID's.

4.4 Site Constraints

It should be noted that not all of the devices mentioned above are suitable for use on all potential development sites. There are many specific limitations which help determine the suitability of devices for use within sites.

Topography is an important consideration when planning the location and type of stormwater management systems. Areas of steep slopes (generally greater than 5%) generally do not lend themselves to WSUD facilities such as bioretention swales. In these areas, flow attenuation via vegetated swales and bioretention systems are less desirable due to the potential for excessive flow velocities which can lead to potential scouring and reduced detention times. Devices such as check dams may be required within swales on steeper grades to help reduce the velocity of flows.

The limitations of the soils would need to be considered when planning the appropriate devices to include within the development. Some soils have a high susceptibility to erosion and would need to be considered when planning the use of devices such as swales and buffer strips. The use of infiltration basins is not ideal where there are clayey soils with a low infiltration rate.

The specific climate and rainfall of a region is an important factor to take into consideration when planning the types of stormwater management devices to include in a development. Areas which do not experience rainfall all year round generally do not lend themselves to vegetated WSUD systems due to the likelihood of the vegetation dying off during the dry period. This can lead to erosion of systems such as swales when the wet period arrives. Additionally devices such as wetlands and bioretention basins require the vegetation to perform biological processes, hence generally require consistent runoff. Additionally water tanks generally perform more efficiently in areas of consistent rainfall.

4.5 Existing Water Quality

Water quality testing was undertaken at a location on the Northern part the subject site with multiple samples collected on the 6th of July 2009. Additional visits to the site were undertaken on the 22nd and 27th of October 2009 in order to collect further samples, however there was insufficient water in the flowpaths to collect samples from. The water samples taken were tested by LabMark Environmental Laboratories for a number of contaminants. Table 4.2 below summarises the concentrations of these contaminants, as determined by the laboratory. The full laboratory report is included as Appendix A of this report.

The results of the water quality tests have been compared against the guidelines set out in the Australian and New Zealand Environment and Conservation Council's National Water Quality Management Strategy – Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC 2000). The ANZECC 2000 identifies default 'trigger values' for contaminant concentrations, which are given as a threshold value or as a range of desirable values. The 'trigger values' considered most appropriate for this investigation were those values for the Ecosystem protection in Lowland Rivers in South-East Australia. The ANZECC doesn't provide guidelines as to appropriate trigger values for the Ecosystem protection in Lowland Rivers in South-East Australia for all the contaminants tested. This guideline identifies concentrations of the contaminant at which 95% of species will be protected. Where no guidelines for the Ecosystem protection have been provided the values for the Recreational use of water have been used.

Table 4.2 - Water Quality Results

	EQL	Units	Results	ANZECC Trigger Value
Unfiltered Metals				
Arsenic	5	µg/L	*<20	50
Cadmium	0.5	µg/L	<0.5	5
Chromium	5	µg/L	<5	50
Copper	5	µg/L	*<10	1000
Nickel	5	µg/L	*<10	100
Lead	5	µg/L	<5	50
Zinc	5	µg/L	*<10	5000
Mercury	0.1	µg/L	*<0.2	1
Filtered Metals				
Arsenic	1	µg/L	*<20	
Cadmium	0.1	µg/L	*<0.2	
Chromium	1	µg/L	<1	
Copper	1	µg/L	*<10	
Nickel	1	µg/L	*<10	
Lead	1	µg/L	<1	
Zinc	5	µg/L	*<10	
Mercury	0.1	µg/L	*<0.2	
pH	0.1	pH units	7.4	6.5-7.5
Ammonia (as N)	0.01	mg/L	0.02	0.9
Total Nitrogen (as N)	0.1	mg/L	1.6	0.5
Total Phosphorus (as P)	0.01	mg/L	<0.1	0.05
Total Organic Carbon (TOC)	1	mg/L	<1	
Dissolved Organic Carbon (DOC)	1	mg/L	<1	
Total Dissolved Solids (TDS)	5	mg/L	30300	
Total Suspended Solids (TSS)	5	mg/L	<5	
Biological Oxygen Demand (BOD)	2	mg/L	4	

Source: LabMark Environmental Laboratories report E043647.
EQL: Estimated Quantitation Limit.
*: EQL increased due to matrix interference.

The ANZECC 2000 guidelines don't provide guidelines as to the acceptable concentrations for all of the contaminants tested for.

The results generally indicate that the values were within the desirable range of the ANZECC 2000 guidelines; hence the quality of water, given the limited testing regime, seems reasonable for the intended purpose.

5 RECOMMENDATIONS

Development of the subject site for residential purposes will require the adoption of a number of initiatives to manage stormwater runoff and flooding, and to minimise the impact of the development on downstream watercourses and wetlands. This is a common philosophy and should employ principles of industry best practice.

Impacts of flooding and stormwater runoff could be mitigated within the future development of the subject site, by incorporating the following:

- Habitable floor levels designed a minimum of 500mm above peak 2100 100 year ARI flood levels on site, in accordance with Council's requirements;
- Adoption of a holistic approach to site and allotment scale stormwater management, based on Water Sensitive Urban Design principles of at source control;
- Use of appropriate at source and subdivision scale stormwater quantity and quality control devices within the development.

Stormwater management for the development should comply with the requirements of Lake Macquarie City Council's DCP and current best practices.

Site topography, flowpaths, runoff regimes and flooding characteristics should be considered during development planning for the site. Design of the stormwater management strategies should be integrated with development layout planning.

From our investigations and for the purpose of a rezoning assessment, it is apparent that stormwater and flood management can be provided for future development of this site in a safe and practical manner. Further engineering assessment will be required in order to provide detailed design solutions for the site which adequately cater for desired development layouts and fully respond to topographical and geotechnical characteristics.

It is our opinion that a portion of the subject site is appropriate for future development with regard to stormwater and flooding management. From a water management perspective, rezoning of the subject site as a residential precinct should therefore be supported.

6 REFERENCES

- Australian and New Zealand Environment and Conservation Council (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000);
- Commonwealth Scientific and Industrial Research Organisation (2006) Urban Stormwater: Best Practice Environmental Management Guidelines;
- Department of Land and Water Conservation (1997) The NSW State Groundwater Policy Framework Document;
- Department of Land and Water Conservation (1998) The NSW Groundwater Quality Protection Policy;
- Department of Land and Water Conservation (2000) The NSW Wetlands Management Policy;
- Department of Land and Water Conservation (2002) The NSW State Groundwater Dependent Ecosystems Policy;
- Lake Macquarie City Council () Lifestyle 2020 Strategy;
- Lake Macquarie City Council (1999) Stormwater Management Plan;
- Lake Macquarie City Council (2003) DCP No.1 – Volume 2 – Engineering Guidelines – Stormwater Treatment Framework and Stormwater Quality Improvement Device Guidelines;
- Lake Macquarie City Council (2004) Lake Macquarie Local Environmental Plan 2004;
- Lake Macquarie City Council (2006) DCP No.1 – Volume 1 – Guidelines - Water Cycle Management Guidelines;
- Lake Macquarie City Council (2008) Guidelines for Development in Areas Adjoining the Lake Macquarie Waterway that are Vulnerable to the Impacts of Sea Level Rise;
- Lake Macquarie City Council (2009) Lake Macquarie Development Control Plan (DCP) No. 1;
- Manly Hydraulic Laboratory (1998) Lake Macquarie Flood Study;
- New South Wales (2001) Floodplain Development Manual: the management of flood liable land
- New South Wales Government Department of Environment and Climate Change (2007) Floodplain Risk Management Guideline – Practical Consideration of Climate Change;
- New South Wales Government Department of Planning (2006) Lower Hunter Regional Strategy 2006-31;
- The Institute of Engineers, Australia (1987) Australian Rainfall and Runoff - A Guide to Flood Estimation;
- The Institute of Engineers, Australia (2005) Australian Runoff Quality – A Guide to Water Sensitive Urban Design;
- Webb, McKeown & Associates Pty. Ltd. (2000) Lake Macquarie Floodplain Management Study;
- Webb, McKeown & Associates Pty. Ltd. (2001) Lake Macquarie Floodplain Management Plan.

APPENDIX A – WATER QUALITY TESTING RESULTS

LabMark
ENVIRONMENTAL LABORATORIES

Accreditation No. 13542

AQIS
AUSTRALIAN QUARANTINE AND INSPECTION SERVICE

SYDNEY License No. N0356.

Accredited for compliance with ISO/IEC 17025. The results of tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the APLAC mutual recognition arrangement for the mutual recognition of the equivalence of testing, calibration and inspection reports.

Quarantine Approved Premises criteria 5.1 for quarantine containment level 1 (QCI) facilities. Class five criteria cover premises utilised for research, analysis and testing of biological material, soil, animal, plant and human products.

CUSTOMER CENTRIC - ANALYTICAL CHEMISTS

FINAL CERTIFICATE OF ANALYSIS - ENVIRONMENTAL DIVISION

Laboratory Report No:	E043647	Cover Page 1 of 4 plus Sample Results
Client Name:	RPS-Harper Somers O'Sullivan	
Client Reference:	Wyee Point	
Contact Name:	Darren Holloway	
Chain of Custody No:	na	Date Received: 07/07/2009
Sample Matrix:	WATER	Date Reported: 17/07/2009

This Final Certificate of Analysis consists of sample results, DQI's, method descriptions, laboratory definitions, and internationally recognised NATA accreditation and endorsement. The DQO compliance relates specifically to QA/QC results as performed as part of the sample analysis, and may provide an indication of sample result quality. Transfer of report ownership from Labmark to the client shall only occur once full & final payment has been settled and verified. All report copies may be retracted where full payment has not occured within the agreed settlement period.

QUALITY ASSURANCE CRITERIA

Accuracy:	matrix spike:	1 in first 5-20, then 1 every 20 samples
	lcs, crm, method:	1 per analytical batch
	surrogate spike:	addition per target organic method
Precision:	laboratory duplicate:	1 in first 5-10, then 1 every 10 samples
	laboratory triplicate:	re-extracted & reported when duplicate RPD values exceed acceptance criteria
Holding Times:	soils, waters:	Refer to LabMark Preservation & THT table VOC's 14 days water / soil VAC's 7 days water or 14 days acidified VAC's 14 days soil SVOC's 7 days water, 14 days soil Pesticides 7 days water, 14 days soil Metals 6 months general elements Mercury 28 days
Confirmation:	target organic analysis:	GC/MS, or confirmatory column
Sensitivity:	EQL:	Typically 2-5 x Method Detection Limit (MDL)

QUALITY CONTROL GLOBAL ACCEPTANCE CRITERIA (GAC)

Accuracy:	spike, lcs, crm surrogate:	general analytes 70% - 130% recovery phenol analytes 50% - 130% recovery organophosphorous pesticide analytes 60% - 130% recovery phenoxy acid herbicides, organotin 50% - 130% recovery
	anion/cation bal:	+/- 10% (0-3 meq/l), +/- 5% (>3 meq/l)
Precision:	method blank:	not detected >95% of the reported EQL
	duplicate lab RPD (metals):	0-30% (>10xEQL), 0-75% (5-10xEQL) 0-100% (<5xEQL)
	duplicate lab RPD:	0-50% (>10xEQL), 0-75% (5-10xEQL) 0-100% (<5xEQL)

QUALITY CONTROL ANALYTE SPECIFIC ACCEPTANCE CRITERIA (ASAC)

Accuracy:	spike, lcs, crm surrogate:	analyte specific recovery data <3xsd of historical mean
Uncertainty:	spike, lcs:	measurement calculated from historical analyte specific control charts

RESULT ANNOTATION

Data Quality Objective	s:	matrix spike recovery	p:	pending	bcs: batch specific lcs
Data Quality Indicator	d:	laboratory duplicate	lcs:	laboratory control sample	bmb: batch specific mb
Estimated Quantitation Limit	t:	laboratory triplicate	crm:	certified reference material	
not applicable	r:	RPD relative % difference	mb:	method blank	

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NEPC GUIDELINE COMPLIANCE - DQO

1. GENERAL

A. Results relate specifically to samples as received. Sample results are not corrected for matrix spike, lcs, or surrogate recovery data.

B. EQL's are matrix dependant and may be increased due to sample dilution or matrix interference.

C. Laboratory QA/QC samples are specific to this project.

D. Inter-laboratory proficiency results are available upon request. NATA accreditation details available at www.nata.asn.au.

E. VOC spikes & surrogates added to samples during extraction, SVOC spikes & surrogates added prior to extraction.

F. Recovery data outside GAC limits shall be investigated and compared to ASAC (historical mean +/- 3sd). If recovery data <20%, then the relevant results for that compound are considered not reliable.

G. Recovery data (ms, surrogate, crm, lcs) outside ASAC limits shall initiate an investigative action. Anomolous QC data is examined in conjunction with other QC samples and a final decision whether to accept or reject results is provided by the professional judgement of the senior analyst. The USEPA-CLP National Functional Guidelines are referred to for specific recommendations.

H. Extraction (preparation) date refers to the date that sample preparation was initiated. Note that certain methods not requiring sample preparation (eg. VOCs in water, etc) may report a common extraction and analysis date.

I. LabMark shall maintain an official copy of this Certificate of Analysis for all tracable reference purposes.

2. CHAIN OF CUSTODY (COC) & SAMPLE RECEIPT NOTICE (SRN) REQUIREMENTS

A. SRN issued to client upon sample receipt & login verification.

B. Preservation & sampling date details specified on COC and SRN, unless noted.

C. Sample Integrity & Validated Time of Sample Receipt (VTSR) Holding Times verified (preservation may extend holding time, refer to preservation chart).

3. NATA ACCREDITED METHODS

A. NATA accreditation held for each in-house method and sample matrix type reported, unless noted below (Refer to subcontracted test reports for NATA accreditation status).

B. NATA accredited in-house laboratory methods are referenced from NEPC, ASTM, modified USEPA / APHA documents. Corporate Accreditation No. 13542.

C. Subcontracted analyses: Refer to Sample Receipt Notice and additional DQO comments.

Reported by LabMark Environmental Sydney, NATA accreditation No. 13542

Reported by Sydney Analytical Laboratories, NATA accreditation No.1884.

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4. QA/QC FREQUENCY COMPLIANCE TABLE SPECIFIC TO THIS REPORT

Matrix: **WATER**

Page:	Method:	Totals:	#d	%d-ratio	#t	#s	%s-ratio
1	Unfiltered metals (M7)	1	0	0%	0	0	0%
2	Unfiltered metals	1	0	0%	0	0	0%
3	Filtered metals (M7)	1	0	0%	0	0	0%
4	Filtered mercury	1	0	0%	0	0	0%
5	pH in water	1	0	0%	0	0	0%
6	Ammonia as N	1	0	0%	0	0	0%
7	Total Nitrogen (as N)	1	0	0%	0	0	0%
8	Unfiltered metals	1	0	0%	0	0	0%
9	Total Organic Carbon (TOC)	1	1	100%	0	0	0%
10	Dissolved Organic Carbon	1	1	100%	0	0	0%
11	Total Dissolved Solids	1	0	0%	0	0	0%
12	Total Suspended Solids	1	0	0%	0	0	0%
13	BOD	1	0	0%	0	0	0%

GLOSSARY:

#d	number of discrete duplicate extractions/analyses performed.
%d-ratio	NEPC guideline for laboratory duplicates is 1 in 10 samples (min 10%).
#t	number of triplicate extractions/analyses performed.
#s	number of spiked samples analysed.
%s-ratio	USEPA guideline for laboratory matrix spikes is 1 in 20 samples (min 5%).

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Environmental Laboratory Industry Group
Foundation Member

Laboratory Report: E043647

5. ADDITIONAL COMMENTS SPECIFIC TO THIS REPORT

A. All tests were conducted by LabMark Environmental Sydney, NATA accreditation No. 13542, unless indicated below.
B. The following tests were conducted by Sydney Analytical Laboratories, NATA accreditation No.1884. :- Total Organic Carbon & Dissolved Organic Carbon.
C. Samples received and analysed outside of technical holding time for pH and BOD analysis- please refer to sample receipt notice.

Laboratory QA/QC data shall relate specifically to this report, and may provide an indication of site specific sample result quality. LabMark DOES NOT report NON-RELEVANT BATCH QA/QC data. Acceptance of this self assessment certificate does not preclude any requirement for a QA/QC review by a accredited contaminated site EPA auditor, when and wherever necessary. Laboratory QA/QC self assessment references available upon request.

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ENVIRONMENTAL LABORATORIES

Laboratory Report No: E043647
Client Name: RPS-Harper Somers O'Sullivan
Contact Name: Darren Holloway
Client Reference: Wyee Point 25757

Date: 17/07/09
This report supercedes reports issued on: N/A

Final
Certificate
of Analysis

Laboratory Identification		**216576**	**lcs**	**mb**							
Sample Identification		25757	QC	QC							
Depth (m)		--	--	--							
Sampling Date recorded on COC		6/7/09	--	--							
Laboratory Extraction (Preparation) Date		9/7/09	9/7/09	9/7/09							
Laboratory Analysis Date		10/7/09	9/7/09	9/7/09							
Method : E022.1											
Unfiltered metals (M7)	**EQL**										
Arsenic	5	*<20	82%	<5							
Cadmium	0.5	<0.5	97%	<0.5							
Chromium	5	<5	83%	<5							
Copper	5	*<10	84%	<5							
Nickel	5	*<10	85%	<5							
Lead	5	<5	95%	<5							
Zinc	5	*<10	85%	<5							

Results expressed in ug/l unless otherwise specified

Comments: *EQL increased due to matrix interference.

E022.1: 25 ml digested in nitric/hydrochloric acid. Analysis by ICP-MS.

Laboratory Identification		**216576**	**lcs**	**mb**							
Sample Identification		25757	QC	QC							
Depth (m)		--	--	--							
Sampling Date recorded on COC		6/7/09	--	--							
Laboratory Extraction (Preparation) Date		9/7/09	9/7/09	9/7/09							
Laboratory Analysis Date		10/7/09	8/7/09	8/7/09							
Method : E026.1											
Unfiltered metals	**EQL**										
Mercury	0.1	*<0.2	92%	<0.1							

Results expressed in ug/l unless otherwise specified

Comments: *EQL increased due to matrix interference.

E026.1: 25ml digested with nitric/hydrochloric acid. Analysis by CV-ICP-MS or FIMS.

Laboratory Identification		**216576**	**lcs**	**mb**							
Sample Identification		25757	QC	QC							
Depth (m)		--	--	--							
Sampling Date recorded on COC		6/7/09	--	--							
Laboratory Extraction (Preparation) Date		9/7/09	9/7/09	9/7/09							
Laboratory Analysis Date		9/7/09	9/7/09	9/7/09							
Method : E022.1											
Filtered metals (M7)	**EQL**										
Arsenic	1	*<20	98%	<1							
Cadmium	0.1	*<0.2	99%	<0.1							
Chromium	1	<1	119%	<1							
Copper	1	*<10	108%	<1							
Nickel	1	*<10	111%	<1							
Lead	1	<1	104%	<1							
Zinc	5	*<10	103%	<5							

Results expressed in ug/l unless otherwise specified

Comments: *EQL increased due to matrix interference.

E022.1: Filtered HNO3 preserved sample directly analysed by ICP-MS.

Laboratory Identification		**216576**	**lcs**	**mb**							
Sample Identification		25757	QC	QC							
Depth (m)		--	--	--							
Sampling Date recorded on COC		6/7/09	--	--							
Laboratory Extraction (Preparation) Date		9/7/09	9/7/09	9/7/09							
Laboratory Analysis Date		10/7/09	10/7/09	10/7/09							
Method : E026.1											
Filtered mercury	**EQL**										
Mercury	0.1	*<0.2	83%	<0.1							

Results expressed in ug/l unless otherwise specified

Comments: *EQL increased due to matrix interference.

E026.1: Analysis by CV-ICP-MS or FIMS following BrCl pre-treatment.

Laboratory Identification		**216576**									
Sample Identification		25757									
Depth (m)		--									
Sampling Date recorded on COC		6/7/09									
Laboratory Extraction (Preparation) Date		8/7/09									
Laboratory Analysis Date		8/7/09									
Method : E018.1											
pH in water	**EQL**										
pH (pH units)	0.1	7.4									

Results expressed in pH units unless otherwise specified

Comments:

E018.1: Direct measurement by pH ion selective electrode.

Laboratory Identification		**216576**	**lcs**	**mb**							
Sample Identification		25757	QC	QC							
Depth (m)		--	--	--							
Sampling Date recorded on COC		6/7/09	--	--							
Laboratory Extraction (Preparation) Date		8/7/09	8/7/09	8/7/09							
Laboratory Analysis Date		8/7/09	8/7/09	8/7/09							
Method : E036.1/E050.1											
Ammonia as N	**EQL**										
Ammonia	0.01	0.02	91%	<0.01							

Results expressed in mg/l unless otherwise specified

Comments:

E036.1/E050.1: Determined by colour. Sample filtered through 0.45um prior to analysis.

Laboratory Identification		**216576**	**lcs**	**mb**							
Sample Identification		25757	QC	QC							
Depth (m)		--	--	--							
Sampling Date recorded on COC		6/7/09	--	--							
Laboratory Extraction (Preparation) Date		8/7/09	8/7/09	8/7/09							
Laboratory Analysis Date		10/7/09	10/7/09	10/7/09							
Method : E039.1/E053.1											
Total Nitrogen (as N)	**EQL**										
Total Nitrogen (as N)	0.1	1.6	90%	<0.1							

Results expressed in mg/l unless otherwise specified

Comments:

E039.1/E053.1: Total Nitrogen by calculation.

Laboratory Identification		**216576**	**lcs**	**mb**							
Sample Identification		25757	QC	QC							
Depth (m)		--	--	--							
Sampling Date recorded on COC		6/7/09	--	--							
Laboratory Extraction (Preparation) Date		9/7/09	9/7/09	9/7/09							
Laboratory Analysis Date		9/7/09	9/7/09	9/7/09							
Method : E020.1/E030.1											
Unfiltered metals	**EQL**										
Phosphorus	0.1	<0.1	101%	<0.1							

Results expressed in mg/l unless otherwise specified

Comments:

E020.1/E030.1: 25ml digested in nitric/hydrochloric acid. Analysis by AAS and/or ICP-OES. (Silicon&Titanium determination are not covered by NATA accreditation).

Laboratory Identification		**216576**	**216576d**	**216576r**	**mb**						
Sample Identification		25757	QC	QC	QC						
Depth (m)		--	--	--	--						
Sampling Date recorded on COC		6/7/09	--	--	--						
Laboratory Extraction (Preparation) Date		16/7/09	16/7/09	--	16/7/09						
Laboratory Analysis Date		16/7/09	16/7/09	--	16/7/09						
Method : E2580											
Total Organic Carbon (TOC)	**EQL**										
Total Organic Carbon	1	<1	<1	--	<1						

Results expressed in mg/l unless otherwise specified

Comments: -

E2580: TOC analyser.

LabMark
ENVIRONMENTAL LABORATORIES

Laboratory Report No: E043647
Client Name: RPS-Harper Somers O'Sullivan
Contact Name: Darren Holloway
Client Reference: Wyee Point 25757

plus cover page
Date: 17/07/09
This report supercedes reports issued on: N/A

Final
Certificate
of Analysis

Laboratory Identification		**216576**	**216576d**	**216576r**	**mb**						
Sample Identification		25757	QC	QC	QC						
Depth (m)		--	--	--	--						
Sampling Date recorded on COC		6/7/09	--	--	--						
Laboratory Extraction (Preparation) Date		16/7/09	16/7/09	--	16/7/09						
Laboratory Analysis Date		16/7/09	16/7/09	--	16/7/09						
Method : E2585											
Dissolved Organic Carbon	**EQL**										
Dissolved Organic Carbon	1	<1	<1	--	<1						

Results expressed in mg/l unless otherwise specified

Comments:

E2585: Sample filtered through 0.45um filter and analysed by TOC analyser.

Laboratory Identification		**216576**	**lcs**	**mb**							
Sample Identification		25757	QC	QC							
Depth (m)		--	--	--							
Sampling Date recorded on COC		6/7/09	--	--							
Laboratory Extraction (Preparation) Date		8/7/09	8/7/09	8/7/09							
Laboratory Analysis Date		13/7/09	13/7/09	13/7/09							
Method : 4110											
Total Dissolved Solids	**EQL**										
Total Dissolved Solids	5	30300	96%	<5							

Results expressed in mg/l unless otherwise specified

Comments:

4110: Gravimetric analysis. Results expressed in mg/L.

Laboratory Identification		**216576**	**lcs**	**mb**							
Sample Identification		25757	QC	QC							
Depth (m)		--	--	--							
Sampling Date recorded on COC		6/7/09	--	--							
Laboratory Extraction (Preparation) Date		8/7/09	8/7/09	8/7/09							
Laboratory Analysis Date		13/7/09	13/7/09	13/7/09							
Method : 4100											
Total Suspended Solids	**EQL**										
Total Suspended Solids	5	<5	102%	<5							

Results expressed in mg/l unless otherwise specified

Comments:

4100: Gravimetric analysis. Results expressed in mg/L.

Laboratory Identification		**216576**	**lcs**	**mb**							
Sample Identification		25757	QC	QC							
Depth (m)		--	--	--							
Sampling Date recorded on COC		6/7/09	--	--							
Laboratory Extraction (Preparation) Date		8/7/09	8/7/09	8/7/09							
Laboratory Analysis Date		14/7/09	13/7/09	13/7/09							
Method : 4050-4051											
BOD	**EQL**										
BOD	2	4	80%	<2							

Results expressed in mg/l unless otherwise specified

Comments:

4050-4051: Five days incubation. Determined by oxygen electrode.

LabMark
ENVIRONMENTAL LABORATORIES

Report Date : 8/07/2009
Report Time : 4:11:42PM

Sample **Receipt** Notice (SRN) for **E043647**

Quality, Service, Support

Client Details		Laboratory Reference Information	
Client Name:	RPS-Harper Somers O'Sullivan	**Please have this information ready when contacting Labmark.**	
Client Phone:	02 4961 6500		
Client Fax:	02 4961 6794	**Laboratory Report:**	**E043647**
Contact Name:	Darren Holloway	**Quotation Number:**	- Not provided, standard prices apply
Contact Email:	darren@rpshso.com.au	**Laboratory Address:**	Unit 1, 8 Leighton Pl. Asquith NSW 2077
Client Address:	PO Box 428 Hamilton NSW 2303	**Phone:**	61 2 9476 6533
		Fax:	61 2 9476 8219
Project Name:	Wyee Point		
Project Number:	25757	**Sample Receipt Contact:**	Ros Schacht
CoC Serial Number:	- Not provided -	**Email:**	Ros.Schacht@labmark.com.au
Purchase Order:	15451	**Reporting Contact:**	Leanne Boag
Surcharge:	No surcharge applied (results by 6:30pm on due date)	**Email:**	leanne.boag@labmark.com.au
Sample Matrix:	WATER		
Date Sampled (earliest date):	06/07/2009	**NATA Accreditation:**	13542
Date Samples Received:	07/07/2009	**TGA GMP License:**	185-336 (Sydney)
Date Sample Receipt Notice issued:	08/07/2009	**APVMA License:**	6105 (Sydney)
Date Preliminary Report Due:	14/07/2009	**AQIS Approval:**	NO356 (Sydney)
Client TAT Request Date:	14/07/2009	**AQIS Entry Permit:**	200521534 (Sydney)

Reporting Requirements: Electronic Data Download required: No

Invoice Number: 09EA4878

Sample Condition: COC received with samples. Report number and lab ID's defined on COC.
Samples received in good order .
Samples received with cooling media: Ice bricks .
Samples received chilled.
Security seals not required. Direct Labmark's custody taken .
Sample container & chemical preservation suitable .

Comments: Sample ID & analysis as previously reported | Sample rec'd & analysed by LabMark Sydney outside THT for BOD and pH | TOC & DOC by SAL - results may be delayed | Sample lab filtered for dissolved metals

Holding Times: Date received allows for sufficient time to meet Technical Holding Times.
Note: There are Samples within this batch that have been received by the laboratory 0 day(s) after Technical Holding Times expire. LabMark cannot guarantee THT compliance, refer to the extraction dates detailed in the sample grid for confirmation.

Preservation: Chemical preservation of samples satisfactory for requested analytes.

Important Notes:

LabMark shall responsibly dispose of spent customer soil and water samples which includes the disintegration of the sample label. A sample disposal fee of $1.00 is applicable on all samples received by the laboratory regardless of whether they have undergone analytical testing. Sample disposal of environmental samples shall be 31 days (water) and 3 months (soil, HN03 preserved samples) after laboratory receipt, unless otherwise requested in writing by the client. Samples requested to be held in non-refrigerated storage shall incur $5.00/ sample/ 3 months. Additional refrigerated storage shall incur $30/ sample/ 3 months. Combination prices apply only if requested. Transfer of report ownership from LabMark to the client shall occur once full and final payment has been settled and verified. All report copies may be retracted where full payment does not occur within the agreed settlement period.

Analysis comments:

Subcontracted Analyses:

Reported by LabMark Environmental Sydney, NATA accreditation No. 13542
Reported by Sydney Analytical Laboratories, NATA accreditation No.1884.

Thank you for choosing Labmark to analyse your project samples.
Additional information on www.labmark.com.au

LabMark
ENVIRONMENTAL LABORATORIES

Report Date : 8/07/2009
Report Time : 4:11:42PM

Sample **Receipt** Notice (SRN) for **E043647**

Quality, Service, Support

The table below represents LabMark's understanding and interpretation of the customer supplied sample COC request (refer to SRN comments section on first page for external subcontracting method details). Please confirm that your COC request has been entered correctly. Due to THT and TAT requirements, testing shall commence immediately as per this table, unless the customer intervenes with a correction prior to testing.

GRID REVIEW TABLE

			Requested Analysis																		
No.	**Date**	**Depth**	**Client Sample ID**	BOD	Filter water samples	Filtered mercury	Unfiltered metals	Filtered metals (M7)	Unfiltered metals (M7)	Ammonia as N	NOx (as N)	pH in water	PREP Not Reported	Total Dissolved Solids	TKN (as N)	Total Nitrogen (as N)	Total Phosphorus (as P)	Total Suspended Solids	External Dissolved Organic Carbon	External Total Organic Carbon (TOC)			
216576	06/07		25757	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			
			Totals:	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			

'PREP Not Reported' refers to an internal laboratory instruction - client confirmation of this parameter is not required.

Thank you for choosing Labmark to analyse your project samples.
Additional information on www.labmark.com.au

LabMark
ENVIRONMENTAL LABORATORIES

Report Date : 8/07/2009
Report Time : 4:11:42PM

Sample **Receipt** Notice (SRN) for **E043647**

Quality, Service, Support

No.	Date	Depth	Client Sample ID	Requested Analysis																		
				M8 - M7-F_W	M8 - M7-T_W																	
216576	06/07		25757	●	●																	
			Totals:	1	1																	

Thank you for choosing Labmark to analyse your project samples.
Additional information on www.labmark.com.au

☐ **MELBOURNE**
Ph: (03) 9538 2277 **Fax**: (03) 9538 2278
1868 Dandenong Road Clayton VIC 3168
E: enviro.melbourne@labmark.com.au

☐ **BRISBANE**
Ph: (07) 3902 4600 **Fax**: (07) 3902 4646
1/21 Smallwood Place Murarrie QLD 4172
E: enviro.brisbane@labmark.com.au

☒ **SYDNEY**
Ph: (02) 9476 6533 **Fax**: (02) 9476 8219
Unit 1/8 Leighton Place Asquith NSW 2077
E: enviro.sydney@labmark.com.au

Call:
1300 0 LABMARK

Environmental Analysis Request – Chain Of Custody (COC)

Company: RPS HSO
Address: PO BOX 428
HAMILTON NSW 2303
Contact: DARREN HOLLOWAY
Telephone: (02) 49616500 **Fax:** (02) 49616794
Email: darren@rpshso.com.au

Project Name: WYEE POINT
Project Number: 25757
Quote Reference:
Send Results to: DARREN HOLLOWAY (email)
Results Required by*: 24 hrs ☐ 48 hrs ☐ 5 Day ☐ Other ☒ As soon as possible
* Note: TAT of less than 5 days must be pre-arranged with the laboratory and surcharges may apply.

COC Number#:
#The COC number will act as a purchase order number if not supplied
Purchase Order No: 15451

SAMPLE DESCRIPTION / **ANALYSIS REQUIRED**

Lab ID	Sample ID	Date & Time Sampled	Soil / Water Other	Comments#	COMPOSITE	TPH – C6-C9	TPH – C10-C36	MAHs	BTEX	PAHs	PCBs	OCs	OPs	Total Phenolics	Speciated Phenols	Metals – Std 17	Metals – Specify **	Mercury	VicEPA 448.3 Screen	Metals 8	Phos	BOD	TOC	DOC	TSS	TDS	pH	Ammonia	TKN	TN
	25757-1	06//07/09	WATER																						X	X	X			
	25757-2	06//07/09	WATER																			X								
	25757-3	06//07/09	WATER																									X	X	X
216576	25757-4	06//07/09	WATER																				X	X						
	25757-5	06//07/09	WATER																	X	X									
	25757-6	06//07/09	WATER																	X	X									
Totals:																														

Please Provide Field PID Readings where possible

** **METALS** (Please circle): Al; Sb; **As**; Ba; Be; Bi; B; **Cd**; Ca; Cs; **Cr**; Co; **Cu**; Fe; **Pb**; Li; Mg; Mn; Mo; **Ni**; Pd; P; Pt; K; Se; Si; Ag; Na; Sr; S; Tl; Th; Sn; Ti; W; U; V; **Zn**

Chain of Custody

Relinquished by: Paul
Date/Time:
Received by: Ay Aurisch
Date/Time: 7/7/09 1-30pm
Relinquished by:
Date/Time:
Received by:
Date/Time: 8.7.09 1300
Relinquished by:
Date/Time:
Received by:
Date/Time:

Special Requirements (eg. OHS issues etc.)

Sample Receipt Advice (Lab Use Only)

All Samples Received in Good Condition ☑
All Documentation in Proper Order ☑
Samples Received with an Attempt to Chill ☑
Samples Received Within Holding Times ☒
Average sample temp on receipt: (°C) 10.5
For enquires please quote Ref. No. E043647