

Salinity risk reassessment process and criteria for the Lloyd residential subdivision

Lloyd Salinity Risk Assessment

Report Number 22316.



Prepared for

by

Wagga Wagga Salinity Committee

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This document provides information to address the intent of Project Number as agreed to by Wagga Wagga Salinity Committee.

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1. Summary of recommendations for monitoring and reassessment

1.1 Developable area

E.A. Systems recommend that approval for residential development be granted upon satisfactory assessment of final detailed master plans for the area depicted as 'blue' in "Lloyd Master Plan Stage 2" (below). Assessment should be undertaken by duly qualified persons using the model and values developed and applied in the current study to ensure compliance with the initial recharge outcomes predicted. This assessment should incorporate approval of the groundwater monitoring network against the recommendations provided in the current study.

The order in which the area depicted 'blue' in "Lloyd Master Plan Stage 2" (Figure 1 below) may be left to the discretion of the developers.

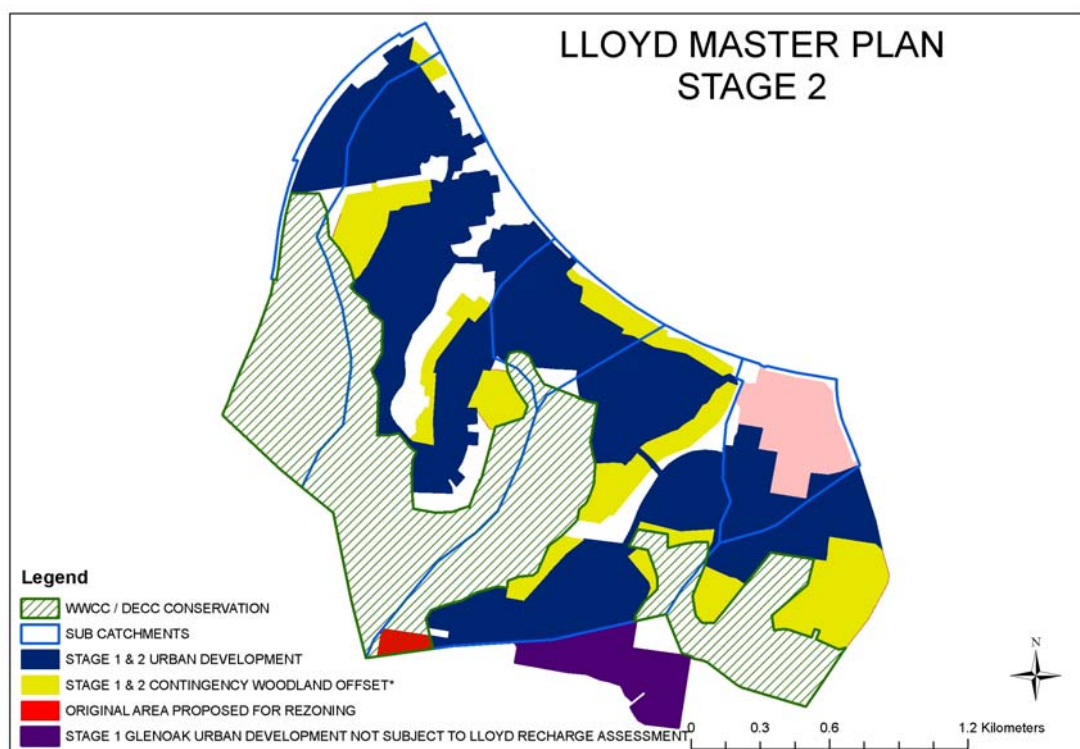


Figure 1: Lloyd Masterplan Stage 2

1.2 Re-charge reassessment (time)

E.A. Systems recommends a reassessment of predicted recharge be undertaken when 75% of the land area indicated safe for development ('blue' area) in "Lloyd Master Plan Stage 2" (Figure 1 above) has been occupied.

1.3 Monitoring and reassessment (Method)

1.3.1 Recharge assessment

E.A. Systems recommends the following data be collected and applied in the reassessment of predicted recharge using the model developed and applied in the current study:

- External water usage data should be collected from the commencement of the development. Specific data on water use must be able to be attributed to the corresponding number of 'occupied house lots' and period of occupation (averaged). It is anticipated that data could be made available from Riverina Water County Council. Water usage should be differentiated at least seasonally.
- Climate data is readily available from a number of local Bureau of Meteorology Stations.
- The predominant vegetation (type and extent) established within residential house lots should be determined at the time of reassessment.

1.3.2 Ground water monitoring

E.A. Systems recommend that immediately upon approval of the detailed master plans the groundwater monitoring network is installed and monitoring commenced by a suitably qualified third party. Groundwater level data from the piezometer network should be collected at least quarterly to determine the occurrence of any increase in standing water levels (over baseline conditions).

1.4 Vegetation of transitional areas

Upon approval of the detailed master plans E.A. Systems recommend a perennial pasture be established in all offset areas to minimise groundwater recharge in the interim period. Following reassessment, the revised offset area should be established to grassy woodland.

2. Background

2.1 Introduction

The Lloyd precinct of Wagga Wagga NSW has been proposed in the draft Local Environment Plan (LEP) (2009) to be zoned for residential development to support the future growth of the city. The development footprint of the proposed Lloyd subdivision is situated within a catchment previously identified as affected by salinity and flagged as a potential groundwater recharge site by NSW Department of Environment, Climate Changes and Water (DECCW).

Wagga Wagga City is subject to urban salinity associated with previously unmitigated development. The Wagga Wagga Salinity Steering Committee required assurance that urban development at Lloyd would not exacerbate existing salinity issues. E.A. Systems was commissioned to undertake a scientifically defensible investigation to determine the risk to urban salinity associated with the proposed development of Lloyd.

2.2 The salinity investigation

The objectives of the investigation were to:

- Determine if groundwater recharge under the proposed residential development could be less than under current agricultural land use at Lloyd; and
- Determine the conditions (development controls) upon which recharge below current levels could be achieved and recommend a process for development which enabled the management of any risk.

An intensive soil survey was conducted, from which groundwater recharge rates were predicted for each of the various land uses proposed (Residential, Native Conservation, Existing Agricultural). Recharge rates were applied to potential subdivision layouts to enable comparison between predicted pre and post development groundwater recharge.

2.3 Results of the investigation

With appropriate design of the sub-division, the study predicted that residential development could be achieved with groundwater recharge rates less than or equal to the current agricultural state (recharge compliance). On this basis urban salinity in Wagga Wagga is not expected to be exacerbated as a result of the development of Lloyd, provided a number of recommendations are incorporated into the appropriate planning instruments. These recommendations are detailed in full in E.A. Systems (EAS) document (Doc.) 22316.35327 (*Summary of Recommendations: Lloyd Salinity Risk Assessment and Mitigation*).

2.4 Risk mitigation

The modelling conducted in the investigation employed a number of assumptions in order to predict potential recharge attributable to pre and post urban development land use scenarios. The assumptions and values used in the modelling, although based on the best available data are subject to error and/or future revision due to the acquisition of new knowledge. Notwithstanding the accuracy of the model used to predict recharge associated with each of the various land uses across the Lloyd precinct, the input parameter subject to the greatest potential for error (+ or -) is the lawn irrigation requirement. Lawn and garden irrigation rates can be extremely variable and are influenced by:

- Personal opinion of individual residents as to amount of water required to maintain a lawn or garden;
- The value that individual residents (and indirectly community) place on the quality of their lawns and gardens. For instance, some individuals may allow a lawn to 'hay off' and wilt to an extent during the summer months, while others may water to ensure a 'lush' / actively growing lawn is present throughout all seasons;
- The type of lawn and garden established. Native style gardens require substantially less irrigation than 'European Style' lawns and gardens; and
- The cost and/or availability of water.

The investigation also incorporated a number of measures to 'err' on the side of caution with respect to ensuring that ground water recharge would not increase as a result of the development (i.e. the study sought to over estimate the recharge that might occur under urban development): These measures are detailed below:

- All non pervious areas of residential lots were assumed to be lawn, whereas in reality, areas of low water use vegetation would be incorporated into residential lots;
- The lawn was assumed to be of 'English style' temperate species with high irrigation demand;
- No account was made for the removal of water via near surface drainage associated with engineering standards for urban areas; and
- Groundwater extracted by trees was not deducted from the groundwater recharge estimate.

2.5 Area suitable for initial development

Previous documents (22316.32182 *Lloyd Salinity Investigation Issue 1* and 22316.35327 *Lloyd development summary of recommendationsV2*) provide a number of maps representing various development scenarios deemed feasible for the range of recharge predictions that were developed during the course of the Lloyd Salinity Investigation.

Based on the recharge predictions derived from the full extent of the data available and the measures outlined above (Section 2.4) being incorporated so as to 'err' on the side of caution, the land area depicted as 'blue' in Figure 2: Lloyd Masterplan Stage 2 (below) was deemed suitable for initial development (subject to a number of design criteria associated with pervious to impervious surface ratios being applied).

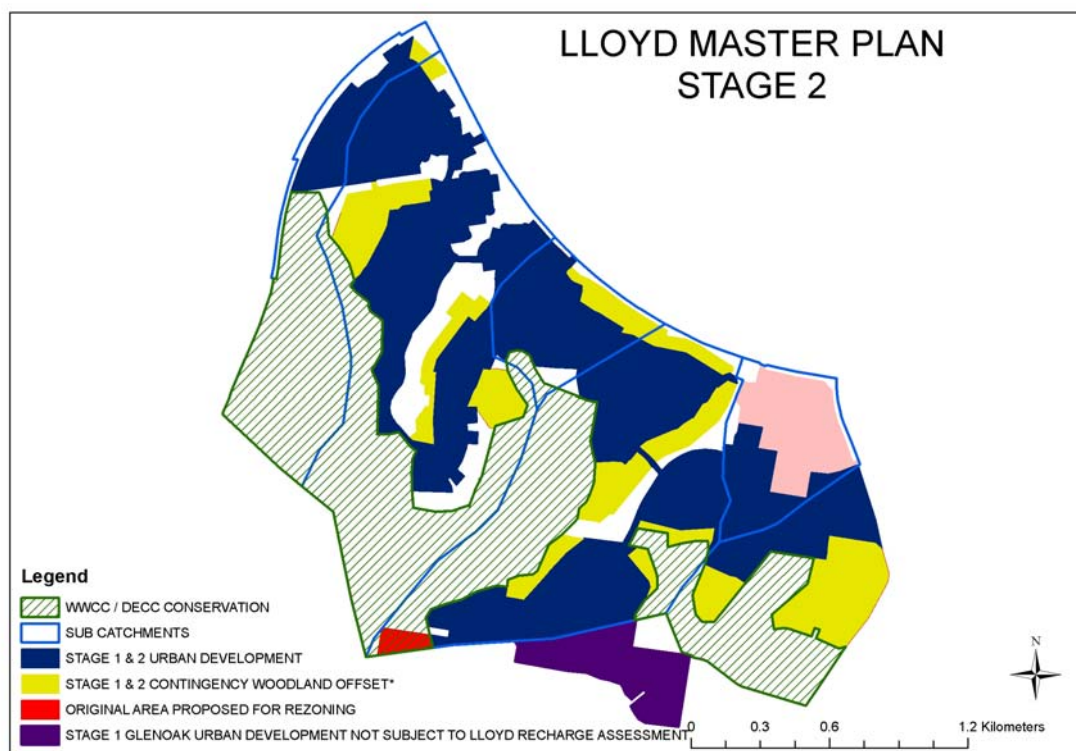


Figure 2: Lloyd Masterplan Stage 2

3. Recommended monitoring and reassessment

To accommodate the potential for error (+ or -) with respect to recharge predicted by the current study, E.A. Systems recommends a monitoring and reassessment process be applied during the course of the development of the Lloyd precinct.

The proposed process will accommodate the collection of empirical data regarding groundwater recharge and water use under a developed scenario, in order to undertake a reassessment of the predictions made by the current study.

3.1 Initial approval of detailed master plans

E.A. Systems recommend detailed master plans for the land area designated for development ('Blue' areas in Figure 2: Lloyd Masterplan Stage 2) be initially designed and balanced using the assumptions and methodologies provided in the previous reports (22316.32182 *Lloyd Salinity Investigation Issue 1* and 22316.35327 *Lloyd development summary of recommendationsV2*).

It should be noted that maps depicting land areas for development presented in the reports associated with the current study, indicate the area of land associated with each land use required to meet the predicted recharge balance. The exact locations of the residential subdivisions and lot boundaries may be varied marginally during the development of the detailed master plans.

The detailed master plans should identify the locations of piezometers to be installed for the on-going monitoring of ground water levels as recommended previously (refer 22316.35327 *Lloyd development summary of recommendationsV2*).

E.A. Systems recommend that approval be granted upon satisfactory assessment of final detailed master plans for the area depicted as 'blue' in Figure 2: Lloyd Masterplan Stage 2. Assessment should be undertaken by duly qualified persons using the model and values developed and applied in the current study to ensure compliance with the initial recharge outcomes predicted. This assessment should incorporate approval of the ground monitoring network against the recommendations provided in the current study.

3.2 Potential order of development

The area depicted as 'Stage 1' in previous reports and below (Figure 3: Lloyd Masterplan Stage 1) shows in 'blue', 50% of the land area deemed by the current study to be safe for development with respect to mitigating urban salinity.

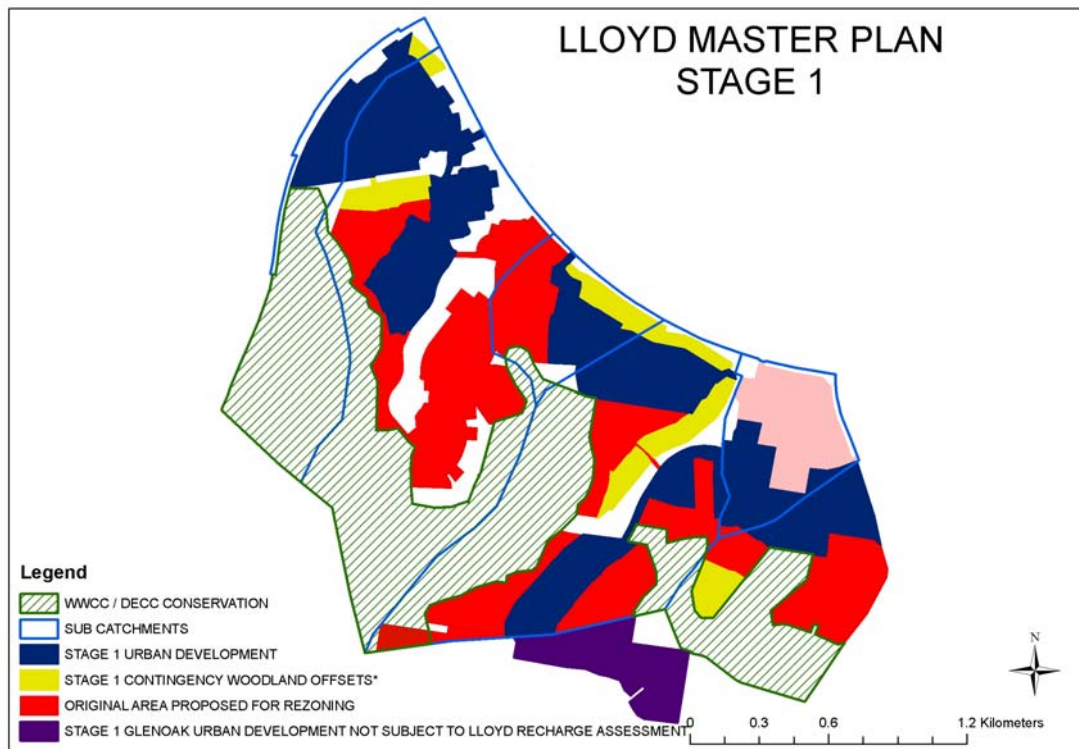


Figure 3: Lloyd Masterplan Stage 1

This area was determined in discussion with the proponents to be most aligned with the provision of services and therefore most likely to be developed first. **However, E.A. Systems proposes the order of development of the area depicted ‘blue’ in Figure 2: Lloyd Masterplan Stage 2 be left to the discretion of the developers.**

3.3 Recharge reassessment (time)

To provide an indication of the sensitivity of the recharge predictions to land use allocation, recharge was predicted for the scenario whereby only 50% of the land area deemed by the current study to be safe for development was developed (refer Figure 3: Lloyd Masterplan Stage 1 above).

Development restricted to this scenario was shown to accommodate an underestimation of recharge of between 64% and greater than 100%.

Taking into account the measures incorporated into the recharge predictions to ‘err’ on the side of caution in favour of reducing salinity (refer Section 2.4), **E.A. Systems recommend a reassessment of recharge be undertaken when 75% of the land area indicated safe for development (‘blue’ area) in Figure 2: Lloyd Masterplan Stage 2 is occupied.**

At this point in time it is anticipated that enough residential lots will have been fully developed and occupied for sufficient time (5 – 10 years) to obtain valid empirical data on water use, vegetation type, and climate for re-estimating recharge. It also leaves sufficient undeveloped area (~25%) in the unlikely event that a requirement for additional recharge offset is indicated.

3.4 Recharge reassessment (method)

Empirical data on external water use against plant requirements and climate (rainfall and evaporation) is required to validate the values applied in the recharge modelling undertaken by the current study. **E.A. Systems recommend the following data be collected to enable a reassessment of predicted recharge:**

- **External water usage data should be collected from the commencement of the development. Specific data on water use must be able to be attributed to the corresponding number of 'occupied house lots' and period of occupation (averaged). It is anticipated that data could be made available from Riverina Water County Council. Water usage should be differentiated at least seasonally.**
- **Climate data is readily available from a number of local Bureau of Meteorology Stations.**
- **The predominant vegetation (type and extent) established within residential house lots should be determined at the time of reassessment.**

Additionally, separate metering systems for external water use could be installed on a representative sample of house lots developed in the early stages of the development. The houses selected for detailed water monitoring should follow a random selection process undertaken by an independent third party.

3.5 Groundwater monitoring

E.A. Systems recommend that immediately upon approval of the detailed master plans the groundwater monitoring network be installed and monitoring commenced by a suitably qualified third party. Groundwater level data from the piezometer network should be collected at least quarterly to determine the occurrence of any increase in standing water levels (over baseline conditions).

Baseline conditions are considered to be the water levels observed upon bore construction or average levels up until development in the sub-catchment has commenced. To cater for this requirement, the prescribed monitoring bore network is to be installed before construction begins. To provide for ongoing transparency, the proponents should be required to submit the results of groundwater monitoring to WWCC on an annual basis.

It should be noted that it is unlikely that significant changes in groundwater levels will be observed over the short term or that any changes observed could be validly attributed to the development of Lloyd. None the less, correlation of changes in standing water level to urban development at Lloyd should be attempted as data becomes available. Similarly, regardless of the cause of any changes in ground water levels, the monitoring network will provide a valuable additional warning system regarding the suitability of specific locations for development.

4. Alternative methods

During the development of Lloyd the proponent may also wish to carry out any additional data collection and studies that may provide more accurate data. Any alternate method of data collection or reassessment should first be approved by the NSW Department of Environment Climate Change and Water (DECCW) and Wagga Wagga City Council (WWCC). Possible alternate studies include lysimetry, or water potential investigation.

5. Potential outcomes from reassessment

Based on the results of the prescribed reassessment and/or an alternative approved assessment method the following actions could be implemented:

Should the recharge predicted under development by the current study be shown to be an over estimate, the following actions could be considered:

1. Permit a greater land area in relevant sub-catchments to be developed to residential (i.e. a commensurate area of that initially allocated as 'offset' ['yellow area' in Figure 2: Lloyd Masterplan Stage 2 excluding 'yellow area' indicated in Figure 4: Lloyd Masterplan Stage 3 'below']);
2. Decreasing the ratio of impervious to pervious surface required for residential lots;
3. Associated with (2) above, increase average lot size; and
4. Relax any restrictions that may have been imposed on irrigation.

Note: should the current study be shown to have over estimated recharge to the extent that the area allocated for offset is greater than required to mitigate urban salinity, development should be permitted to extend to a commensurate area indicated 'blue' in Figure 4: Lloyd Masterplan Stage 3 (below). E.A. Systems recommend that under no circumstances should the area depicted 'yellow' in Figure 4: Lloyd Masterplan Stage 3 (below), be developed in advance of the area depicted 'blue' in the same map.

Should the recharge predicted under development by the current study be shown to be an under estimate, a commensurate area of as yet undeveloped land (i.e. within the 'blue' area in Figure 2: Lloyd Masterplan Stage 2) should be withheld from development.

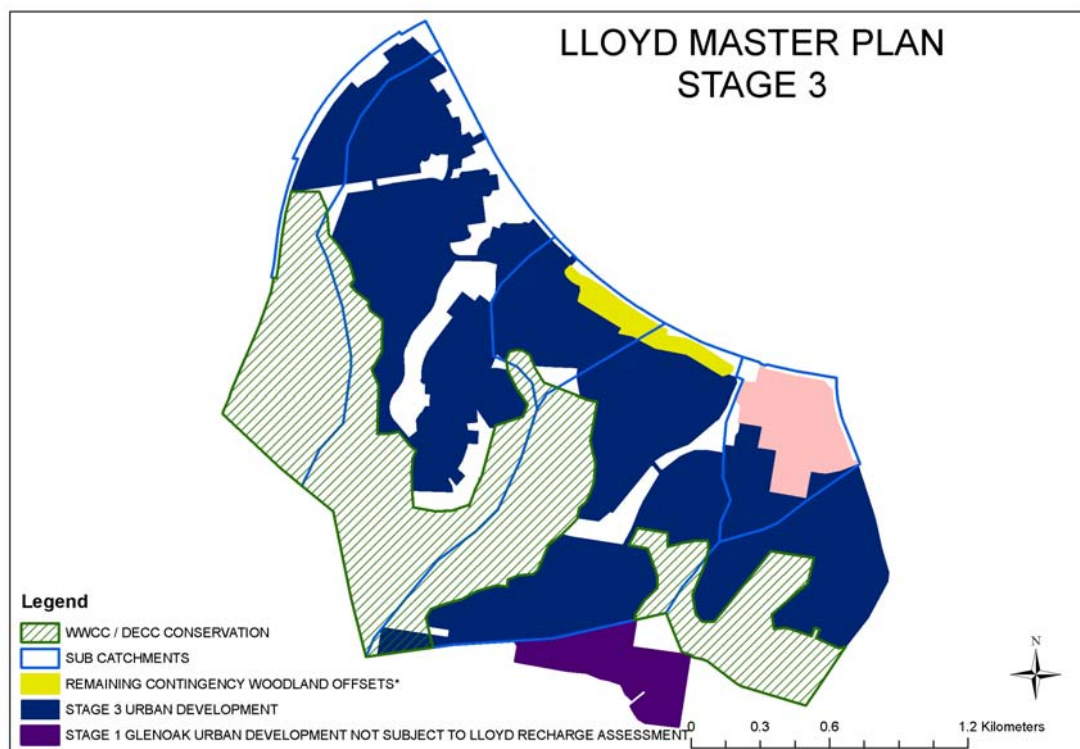


Figure 4: Lloyd Masterplan Stage 3

6. Vegetation of transitional areas

Upon the approval of the detailed master plans E.A. Systems recommend a perennial pasture be established in all offset areas to minimise groundwater recharge in the interim period. Following reassessment, the revised offset area should be established to grassy woodland.

7. Roles and Responsibilities

From discussions undertaken during the course of the current study it was proposed that the recommended groundwater monitoring, water use data collection and recharge reassessment be funded over the entire development period by the proponents. Upon the completion of all permissible development WWCC will bear the responsibility and cost of all further monitoring and maintenance of the monitoring bore network.

The proposed assessment process and criteria assumes a number of roles and responsibilities for key stakeholders. The assumed roles and responsibilities are outlined for each key stakeholder in Table 1 below.

Table 1 Key Roles and Responsibilities for Staged development at Lloyd

Key Roles and Responsibilities for Staged Development at Lloyd	
Stakeholder	Key Roles
Proponents for development	Design and submit master plans for developable area ('blue' area in Figure 2: Lloyd Masterplan Stage 2) in accordance with the principals outlined in EAS Doc. 22316. 32182. Design and submit master plans in accordance with any other development controls and contingent policies agreed to.
Independent third party	Assess detailed master plans and recalculate recharge using the model developed in the current study. Assess submitted master plans with regard to the location of woodland offsets and groundwater monitoring bores. If required, review alternate methods of data collection, sources of data and/or recharge prediction methods and provide a review to DECCW and WWCC. Undertake on-going groundwater monitoring and determine correlation between changes in standing water levels and urban development of Lloyd. Conduct an investigation into any dangerous increases in standing water levels and prepare a mitigation plan. Carry out the recharge reassessment and provide outcomes in report format to WWCC.
NSW Department of Environment, Climate Change and Water (DECCW).	Review and approve alternate methods of water usage data collection and reassessment methodologies if these are to the satisfaction of DECCW. Review submitted master plans for appropriateness of offset and groundwater monitoring bore locations if referred to from WWCC. Review mitigation plans if any dangerous increase in groundwater levels are correlated to urban development at Lloyd. Review submitted reassessment reports.

Wagga Wagga City Council (WWCC).	Review and approve alternate methods of water usage data collection and reassessment methodologies if these are to the satisfaction of DECCW. Review submitted master plans for appropriateness of offset and groundwater monitoring bore locations. WWCC may refer master plans to the DECCW if required. Review reassessment reports and approve master plans for the ensuing Stage if minimum or approved alternate criteria have been met.
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Key Responsibilities

Proponents for development	Relevant proponents for the development will bear of the cost of; • The design and installation of a monitoring bore network as per the specifications on EAS Doc. 22316.32182 • The minimum quarterly monitoring of standing water levels (groundwater levels) in the Lloyd groundwater monitoring network until reassessment is discontinued and Lloyd can be developed no further. • Any required maintenance of the Lloyd groundwater monitoring network until reassessment is discontinued and Lloyd can be developed no further. • Any fees incurred by the third party for key roles undertaken by the third party. • Establishing perennial pasture and grassy woodland offsets. • Maintaining perennial pasture and grassy woodland offsets to the minimum specification for a period of five years after reassessment is discontinued and Lloyd can be developed no further. • Maintaining any works associated with the mitigation of dangerous increases groundwater levels for a period of five years after reassessment is discontinued and Lloyd can be developed no further. Relevant proponents for the development are to maintain honest and open communication channels with WWCC and all relevant authorities.
Independent third party	The third party is to act in an impartial manner on all required third party roles.
NSW Department of Environment, Climate Change and Water (DECCW).	The DECCW is to carry all required reviews and assessment in an impartial manner and approve prescribed submissions should they meet the minimum or approved alternate data and reassessment methodologies. The DECCW is to make appropriate provisions to ensure this process and criteria are made known to new staff in the event of staff turnover. The DECCW are to maintain honest and open communication channels with the proponents and all relevant authorities.

Wagga Wagga City
Council (WWCC).

WWCC will bear of the cost of;

- The monthly monitoring of standing water levels (groundwater levels) in the Lloyd groundwater monitoring network after reassessment is discontinued and Lloyd can be developed no further.
- Any required maintenance of the Lloyd groundwater monitoring network after reassessment is discontinued and Lloyd can be developed no further.
- Maintaining perennial pasture and grassy woodland offsets to the minimum specification from the date five years after reassessment is discontinued and Lloyd can be developed no further.
- Maintaining any works associated with the mitigation of dangerous increases groundwater levels from the date five years after reassessment is discontinued and Lloyd can be developed no further.
- Any addition third party role after reassessment is discontinued and Lloyd can be developed no further.

The WWCC is to make appropriate provisions to ensure this process and criteria are made known to new staff in the event of staff turnover.

WWCC is to carry all required reviews and assessment in an impartial manner and approve prescribed submissions should they meet the minimum or approved alternate data and reassessment methodologies

WWCC are to maintain honest and open communication channels with the proponents and all relevant authorities.

8. References

EAS Doc. 22316.32182 (2009), *Salinity Risk and Mitigation Assessment: Lloyd Subdivision Wagga Wagga NSW*, E.A. Systems Pty Ltd Wagga Wagga NSW.

EAS Doc. 22316.35327 (2009), *Summary of Recommendations: Lloyd Salinity Risk Assessment and Recommendations*, E.A. Systems Pty Ltd Wagga Wagga NSW.