Multiplex Construction Pty Ltd

New Maitland Hospital - Stage 2 (SSI-9775)
Construction site water balance assessment

September 2019

Executive summary

The New Maitland Hospital (NMH) is a multi-storey Hospital in Metford proposed by Health Infrastructure NSW (HI), who engaged Multiplex Construction Pty Ltd (Multiplex) as the Principal Contractor for the construction. The NMH construction program is being delivered across two stages.

As part of the Stage 1 approval process, HI engaged GHD Pty Ltd (GHD) to undertake a surface and groundwater assessment including a water balance assessment of the operation of the NMH that satisfied the relevant Secretary's Environmental Assessment Requirements (SEARs). The water balance assessment concluded that minor surface water impacts were expected to be mitigated by onsite controls and no interception of groundwater was expected.

The Stage 2 approval process is currently underway, with HI responding to submissions. The Department of Planning, Industry and Environment (DPIE) made a submission:

- Noting that disposal of produced groundwater may require EPA approval due to the presence of background heavy metals
- Requesting a better understanding of the proposed water used on site during the construction process.

No measurable volumes of groundwater have been or are expected to be intercepted during construction and therefore no approval for the disposal of produced groundwater has been sought or required.

A site water balance was not required under the SEARs for Stage 2 and therefore not included in the Stage 2 EIS (Ethos Urban 2019). The surface and groundwater assessment (GHD 2018) assesses the potential surface water and groundwater impacts of the concept proposal, which is generally consistent with the proposed development under Stage 2 (Ethos Urban 2019).

Notwithstanding the previous assessments and the SEARs for Stage 2, Multiplex engaged GHD to prepare a water balance for the construction of the New Maitland Hospital, in response to the submission from DPIE.

Construction activities have the potential to cause disturbance that can result in erosion and generate dust. An Erosion and Sediment Control Plan was prepared as part of the Stage 2 EIS (Ethos Urban 2019) which will inform the Soil and Water Management Plan that will manage and control sediment, erosion and dust during construction.

Potentially sediment laden runoff will be captured in the sediment basin and used to supply dust suppression demand, in order to minimise the use of potable water. In the event that dust suppression demand is not sufficient to dewater the basin in accordance with Soil and Water Management Plan, water will be treated (if required) and discharged to the downstream watercourse. In the event the site experiences rainfall that exceeds the design capacity of the sediment basin, the basin will overflow via the spillway to the downstream watercourse.

The water balance of the NMH during construction was undertaken using a water balance model, implemented in GoldSim. The model was based on dust suppression estimates (provided by Multiplex) and considered the potential rainfall variability.

The modelling results indicate that on average, about 85% of the dust suppression demand of 30 ML/year is expected to be sourced from potable water, with the remainder sourced from the sediment basin. However, considering potential rainfall variability, this percentage could vary between 65 and 100% of dust suppression demand.

Despite the use of water for dust suppression, some discharges and overflows from the sediment basin are expected due to potential periods of above average rainfall. Any discharges from the sediment dam will comply with the discharge water quality criteria defined in the Soil and Water Management Plan and overflows are only expected as a result of rainfall that exceeds the design criteria of the sediment basin.

The taking of water from the sediment basin for the control of soil erosion and use for dust suppression is exempt from requiring a water access licence under Clause 21(1) of the *Water Management Act 2000*.

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1. Introduction

1.1 Background

The New Maitland Hospital (NMH) is a proposed multi-storey Hospital on Lot 7314 in DP 1162607 and Part Lot 401 DP 755237 (the site) located on the eastern side of Metford Road in Metford (refer to Figure 1-1). The NMH is proposed by Health Infrastructure NSW (HI), who engaged Multiplex Construction Pty Ltd (Multiplex) as the Principal Contractor for the construction. The NMH construction program is being delivered across several stages:

- Stage 1 – Early works preparatory works and concept design envelope (approved by SSI 9022)
- Stage 2 – Detailed design, construction and operation of the NMH.

As part of the Stage 1 approval process, HI engaged GHD Pty Ltd (GHD) to undertake a surface and groundwater assessment to support the environmental impact statement (GHD 2018). This assessment included a water balance assessment of the operation of the NMH that satisfied the relevant Secretary's Environmental Assessment Requirements (SEARs) for a detailed and consolidated site water balance. The water balance assessment concluded that:

- Runoff volumes are expected to increase by approximately 15% as a result of the Project. The mitigation of increased flow rates to predevelopment rates will be required, including the use of onsite detention and water quality controls.
- Interception of groundwater is unlikely during construction or operation of the Project and the Project is not expected to result in significant change to the shallow groundwater environment.

The Stage 2 approval process is currently underway, with HI responding to submissions. The Department of Planning, Industry and Environment (DPIE) made a submission:

- Noting that disposal of produced groundwater may require EPA approval due to the presence of background heavy metals
- Requesting a better understanding of the proposed water used on site during the construction process.

No measurable volumes of groundwater have been or are expected to be intercepted during construction and therefore no approval for the disposal of produced groundwater has been sought or required.

A detailed and consolidated site water balance was not required under the SEARs for Stage 2 and therefore not included in the Stage 2 EIS (Ethos Urban 2019). The surface and groundwater assessment (GHD 2018) assesses the potential surface water and groundwater impacts of the concept proposal, which is generally consistent with the proposed development under Stage 2 (Ethos Urban 2019).

Notwithstanding the previous assessments and the SEARs for Stage 2, Multiplex engaged GHD to prepare a water balance for the construction of the New Maitland Hospital, in response to the submission from DPIE.

1.2 Overview of construction

Construction activities approved under Stage 1 are nearing completion and included establishment of a construction compound, vegetation clearance, bulk earthworks, formation of building foundations and site stabilisation.

Stage 2 of the NMH will be constructed in a single stage, with construction works commencing in late 2019 and to be completed in 2022. Construction will include a new 7 storey Acute Services Building, internal roadways and carparks and site landscaping. Construction activities have the potential to cause disturbance that can result in erosion and generate dust.

1.3 Construction water management

An Erosion and Sediment Control Plan was prepared as part of the Stage 2 EIS (Ethos Urban 2019) which will inform the Soil and Water Management Plan that will manage and control sediment, erosion and dust for the site during construction. A number of catch drains convey sediment laden runoff from disturbed areas to a sediment basin in the east of the site. Some relatively small residual disturbed areas outside of the catchment of the sediment basin report to the stormwater system to the east. Erosion and sediment are controlled in all disturbed areas.

The sediment basin has been sized according to *Managing Urban Stormwater – Soils and Construction Volume 1* (‘the Blue Book’) (Landcom 2004). Water from the basin is used to supply dust suppression demand, in order to minimise the use of potable water. In the event that dust suppression demand is not sufficient to dewater the basin in accordance with Soil and Water Management Plan, water will be treated (if required) and discharged to the downstream watercourse. In the event the site experiences rainfall that exceeds the design capacity of the sediment basin, the basin will overflow via the spillway to the downstream watercourse.

1.4 Purpose of this report

The purpose of this report is to estimate the water balance during the construction of the New Maitland Hospital. The water balance has been estimated by means of a computer model, and this report documents the inputs, methodology and results of the model.

1.5 Scope and limitations

The scope of the construction water balance includes the rainfall, runoff and evaporation of surface storages on site and water usage for construction, at the New Maitland Hospital Site.

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The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

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Multiplex Constructions Pty Ltd
New Maitland Hospital - Stage 2 (SSI-9975)
Construction site water balance assessment

Job Number 22-19923
Revision 0
Date 12 Sep 2019

Locality plan

Figure 1-1

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Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

Data source: LPI: DCDB & DTDB - 2012; ESRI: Aerial Imagery 2013. Created by: ljhammersley, tmorton

2. Data

The water balance for construction of NMH involved the collation and interpretation of data from various sources. The purpose of this section is to summarise the data used. The sources of data used are shown in Table 2-1.

Table 2-1 Summary of data sources

Data	Source
Historical rainfall record	SILO (DSITI 2019)
Catchment areas and land use	Interpreted from contours and aerial imagery
Storage geometry	Storage capacities as per the EIS Maximum surface area interpreted from site contours and aerial imagery
Construction water demand	Provided by Multiplex

2.1 Climate

A historical record of daily rainfall depths was obtained in the form of a patched point data set from the Scientific Information for Land Owners (SILO) database operated by the Queensland Department of Environment and Science (DES). SILO patched point data is based on observed historical data from a particular Bureau of Meteorology (BOM) station with missing data 'patched in' by interpolating with data from nearby stations (DSITI 2017).

For this assessment, SILO data was obtained for the East Maitland Bowling Club station (station number 61034), which is located approximately 2.5 km north-west of the site. This station was chosen based on proximity to the site. The period of rainfall data used for this assessment extended from 1 January 1889 to 1 September 2019 (a total of 130 years).

The cumulative frequency of annual total rainfall and evaporation from the SILO dataset between January 1889 and January 2019 are compared in Figure 2-1.

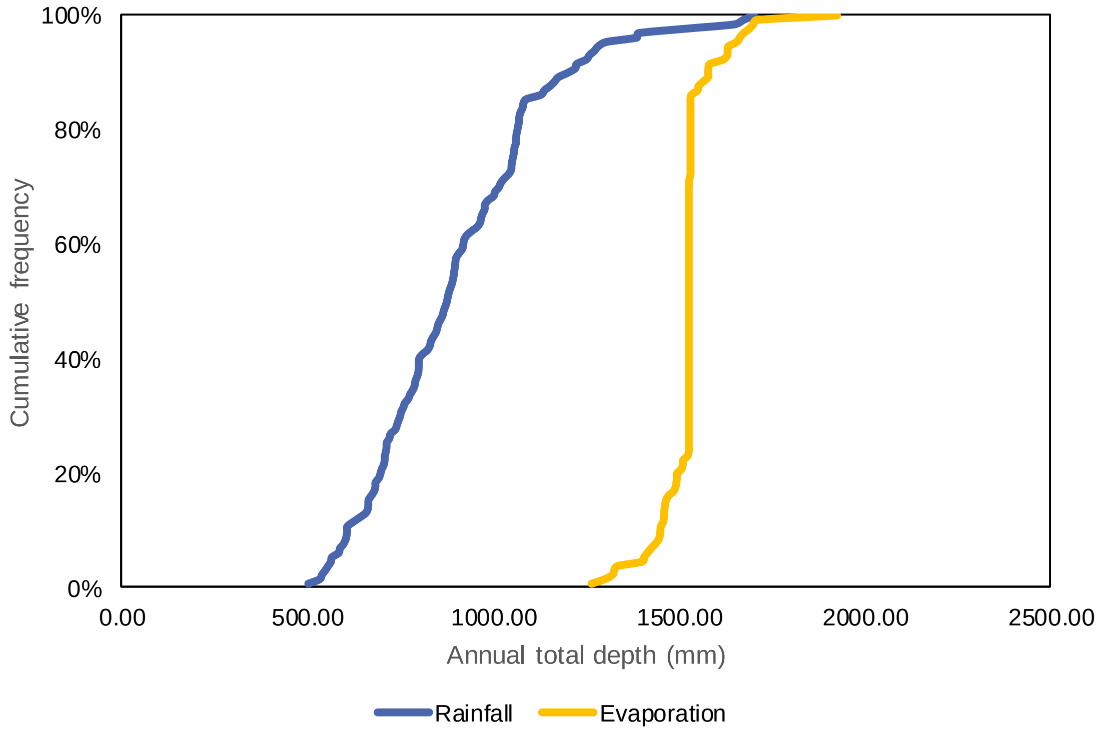


Figure 2-1 Annual rainfall and evaporation

Figure 2-1 shows that the annual totals of the historical rainfall record varied from a minimum of 483 mm (1944), to a maximum of 1701 mm (1893). Annual evaporation totals have an average of 1261 mm, corresponding to an average annual moisture deficit (the difference between rainfall and evaporation) of 624 mm.

A plot of average monthly pan evaporation is compared to average monthly rainfall from the historical record in Figure 2-2.

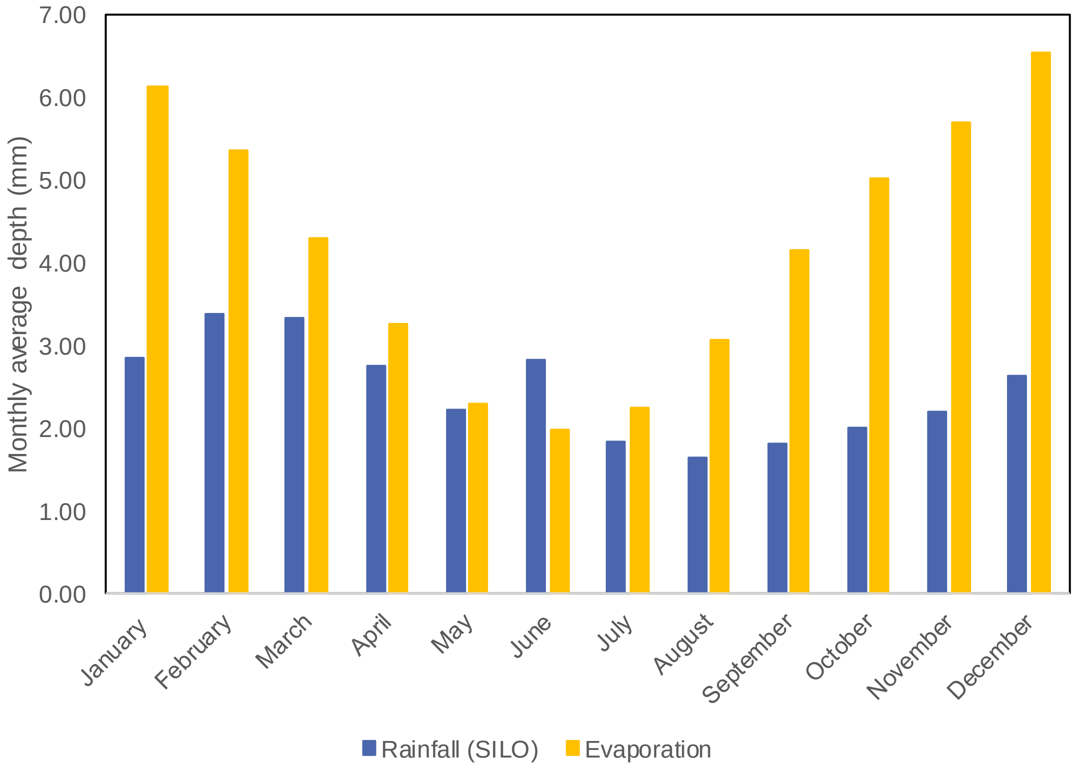


Figure 2-2 Monthly average evaporation and rainfall

Figure 2-2 show that evaporation varies seasonally, having higher records in summer compared in winter. The site has an average monthly net rainfall deficit in all parts of the year except during the month of June.

2.2 Catchments

The catchment areas and land uses for each water management feature were estimated from aerial imagery and contours. The land use of the site was characterised into two different classes:

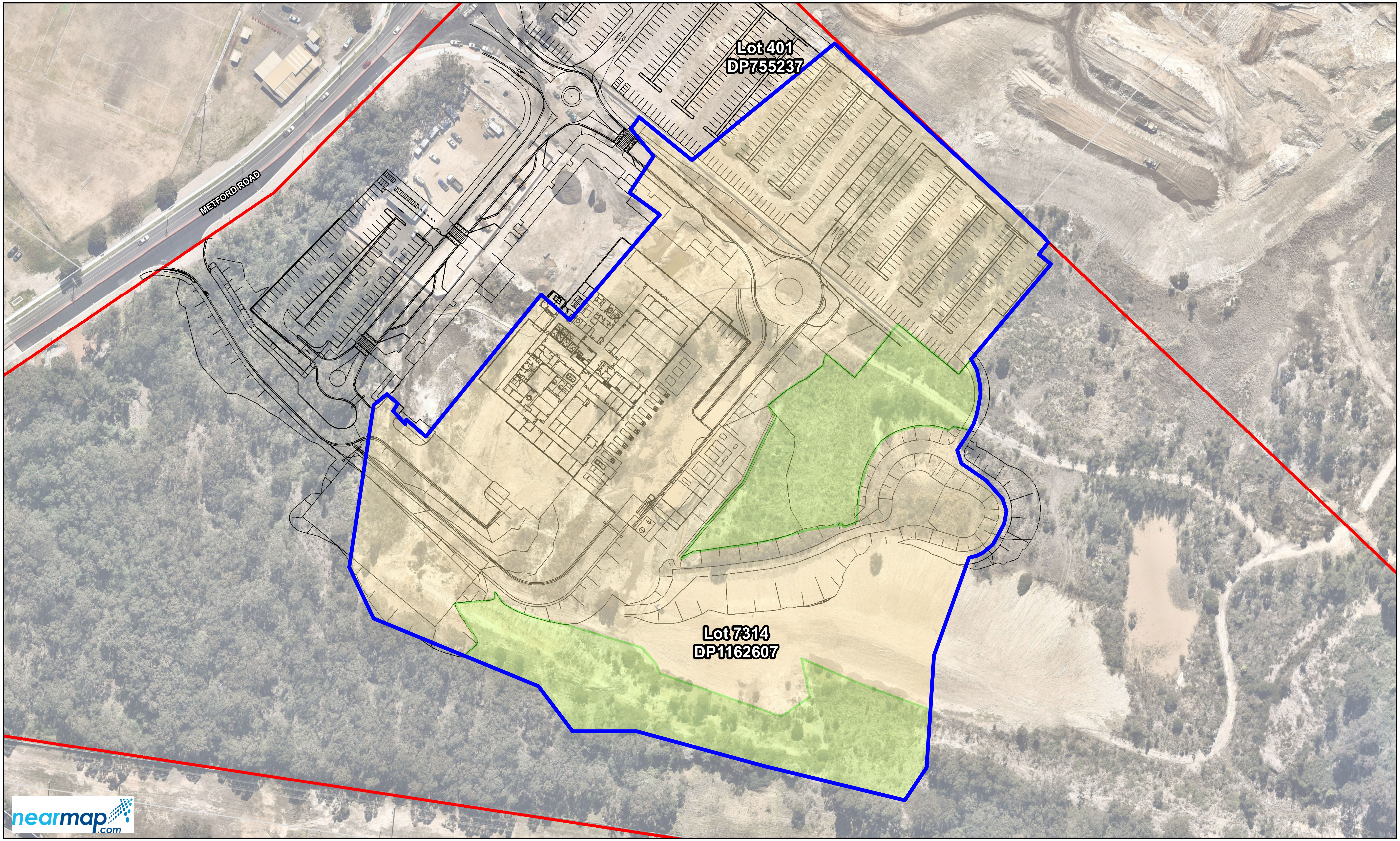
- Vegetated: all undisturbed bush land and grassed areas
- Disturbed/hardstand: roads and working pad areas

The catchments and land uses are shown spatially in Figure 2-3 and the areas are summarised in Table 2-2.

No change to surface water catchments are proposed.

Table 2-2 Catchment areas

Water management feature	Vegetated	Disturbed/hardstand	Total catchment area (ha)
Sediment Basin	20%	80%	6.0



Paper Size A3

0 5 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Site boundary
- Cadastre
- Sediment basin catchment
- Hardstand/disturbed
- Vegetated

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Catchment and landuse

Figure 2-3

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Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com W www.ghd.com.au

Data source: ADW: Survey, 2015; LPI: DTDB / DCDB , 2012. Nearmap: Aerial Imagery, 2018. HWC: Dial Before You Dig Sewermain, 2015. Created by: fmackay, tmorton, gmcdiarmid

2.3 Storages

The geometric properties of the surface water storages are summarised in Table 2-3.

Table 2-3 Storage geometry

Water management feature	Capacity (ML)	Maximum surface area (m^2)
Sediment Basin	1.5	1648

2.4 Dust suppression

Estimates of dust suppression demands were provided by Multiplex. The estimates are based on an indicative schedule of construction activities and a typical water cart capacity of 10 kL, as summarised in Table 2-4.

Table 2-4 Dust suppression demand

Activity	Indicative duration (days)	Water cart fill cycles (per day)	Estimated average dust suppression demand (kL/day)
Ambulance Entry Road construction	100	12	120
Northern Carpark	100	12	120
Other construction activities	52	12	120

The estimates in Table 2-4 are indicative of the typical average dust suppression demand over the course of the construction period. In reality, dust suppression demand will vary with day to day operational activities, weather conditions (rainfall and wind speed and direction) and the area and degree of disturbance. It is not possible to represent this variability and uncertainty in the construction water balance model, and therefore indicative typical estimates have been adopted for the purpose of this assessment.

3. Model methodology

3.1 Water and salt balance

The water balance for construction of NMH was modelled as a semi-distributed mass balance, considering the sediment basin and dust suppression, as described in Section 1.3. A site-specific water balance equation was derived from the catchment scale water balance equation described by Ladson (2008). The water balance equation applies conservation of mass to derive an ordinary differential equation that describes how the volume of water V changes over time t:

$$\frac{dV}{dt} = R + C + G_{in} + P_{in} + Q_{in} - E - P_{out} - Q_{out}$$

The water balance considered the inflows:

- Direct rainfall R, estimated from the simulated water surface area of the storage and the simulated rainfall intensity.
- Catchment runoff C, using the Australian Water Balance model (AWBM) (Boughton & Chiew, 2003) and accounting for the change in simulated water surface area.

The water balance considered the outflows from each storage:

- Evaporation E, estimated from the simulated water surface area of the storage.
- Water used for dust suppression P_{out},
- Discharge and overflow to downstream watercourses Q_{out}

There is no interaction with groundwater inflows or outflows expected as part of the construction of New Maitland Hospital.

3.2 Rainfall variability

Rainfall variability was considered in the construction water balance by sampling simulated rainfall from the historical rainfall record (refer to Section 2.1). A series of simulations were performed, each beginning in a different year of the historical rainfall record and proceeding consecutively through the record (and looped where required).

3.3 Hydrologic model

The Australian Water Balance Model (AWBM) (Boughton & Chiew, 2003) was used to estimate the runoff contributing to the surface water storages. The AWBM was adopted as it:

- Is widely used throughout Australia, especially for mining applications
- Has been verified through comparison with large amounts of recorded streamflow data
- Has literature available to assist in estimating input parameters
- Considers soil moisture retention state when determining runoff

The AWBM is a soil moisture water balance model that calculates runoff from rainfall after allowing for losses and storage. Figure 3-1 is a schematic of the model, which shows that the model consists of three storage elements (with surface areas A_1, A_2 and A_3) representing soil moisture.

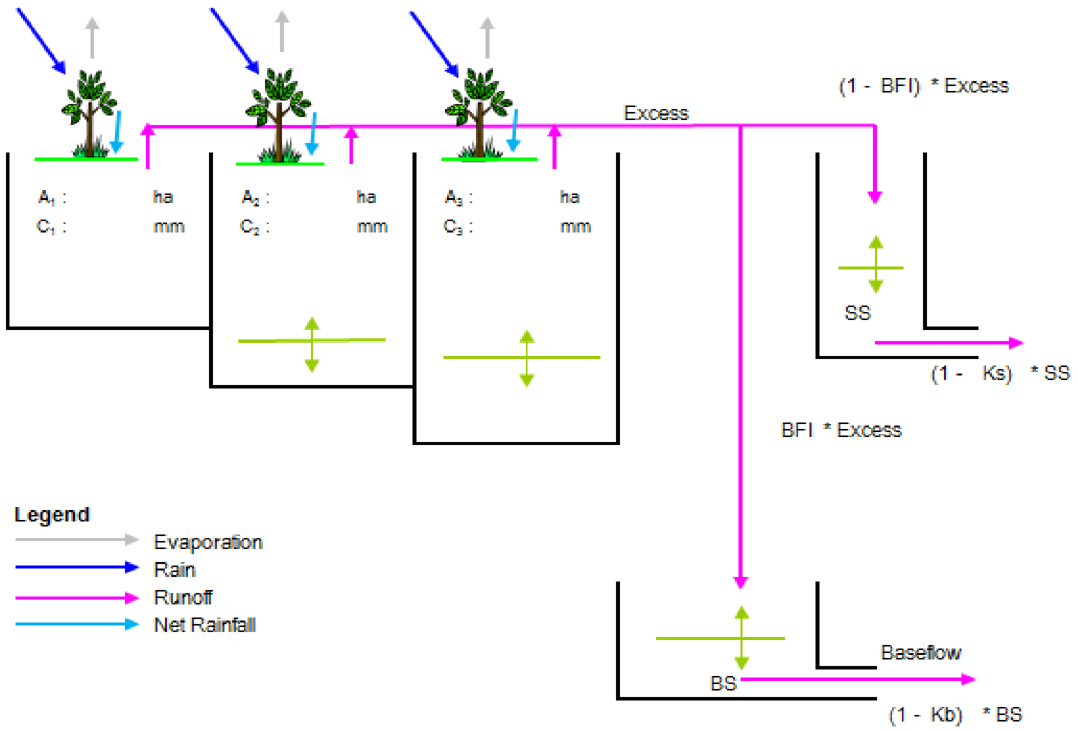

Figure 3-1 AWBM model schematic

Rainfall enters these storages and when a storage element is full, any additional rainfall is considered to be excess rainfall. Of this excess rainfall, a proportion is routed to the baseflow storage (BS) while the remainder is routed to the surface storage (SS). The discharge from the baseflow storage and surface storage is estimated as a proportion of the volume of the storages at the end of each day. The total runoff is the combined volume of water discharged from these two storages. The parameters of the AWBM are summarised in Table 3-1.

Table 3-1 Summary of Australian Water Balance model parameters

Parameter	Description
A_1, A_2, A_3	The partial areas of the overall catchment contributing to each storage.
C_1, C_2, C_3	The capacity of storages 1, 2 and 3 respectively.
BFI	The proportion of excess rainfall flowing to the baseflow.
K_b	The proportion of the volume of the baseflow storage remaining in the storage.
K_s	The proportion of the surface storage remaining in the storage.

The site-specific land uses (refer to Section 2.2) were characterised with different sets of AWBM parameters.

The AWBM parameters adopted for the water balance model are summarised in Table 3-2.

Table 3-2 Parameter values for Australian Water Balance Model

Parameter	Vegetated	Disturbed/hardstand
A_1, A_2, A_3	0.134, 0.433, 0.433	1.0, 0.0, 0.0
C_1, C_2, C_3 (mm)	12, 122, 244 (C_{ave} = 160 mm)	40, 0.0, 0.0 (C_{ave} = 40 mm)
BFI	0.21	0.0
K_s	0.0	0.0
K_b	0.953	0.0

The parameters used to characterise the land uses are typical hydrologic parameters for such areas, based on industry experience.

3.4 Numerical implementation

The water balance model was implemented in GoldSim (version 12.0). A basic timestep of 1 day was used, with timesteps dynamically inserted were required. GoldSim uses the forward Euler method to solve the mass conservation equations described in Section 3.1.

4. Model results and discussion

The site water balance model for NMH site was used to simulate the existing conditions, which considered the construction phase of the NMH.

The existing conditions were simulated from 1 October 2019 (assumed commencement of construction) to 1 October 2020. As the indicative construction program is less than a whole year (252 days), no dust suppression was assumed for the last 114 days of the year, in order to report annual results. The assumed commencement of construction is conservativeas it centres on the months with the highest average runoff in late summer and early autumn.

To consider potential climate variability, a total of 130 different rainfall patterns were simulated (as described Section 3.2) and the results statistically summarised.

The summary of the annual average inputs and outputs for the water balance under existing conditions is summarised in Table 4-1. The results shown are modelled results (rounded to 0.1 ML).

Table 4-1 Average annual site water balance- construction period

Water management element	Total Volume (ML)
Direct rainfall onto storages	1.1
Catchment runoff	8.6
External potable water supply	26.3
TOTAL INPUTS	**36.0**
Evaporation	1.0
Dust suppression	30.5
Discharge and overflow from the sediment basin	4.5
TOTAL OUTPUTS	**36.0**
Change in surface storages	0.0
TOTAL CHANGE IN STORAGE	**0.0**
Inputs – outputs – change in storage	0

Table 4-1 shows that on average, about 85% of the dust suppression demand is expected to be sourced from potable water, with the remainder sourced from the sediment basin.

Despite the use of water for dust suppression, some discharges and overflows from the sediment basin are expected, about 50% of the catchment runoff on average. This is because rainfall tends to be serially correlated, in other words, rainfall tends to occur more often following previous periods of rainfall and rainfall is variable from year to year, being either dry or wet.

Any discharges from the sediment dam will comply with the discharge water quality criteria defined in the Soil and Water Management Plan. Overflows are only expected as a result of rainfall that exceeds the design criteria of the sediment basin.

Figure 4-1 shows the distribution of the modelled annual total water sourced for dust suppression from the sediment basin.

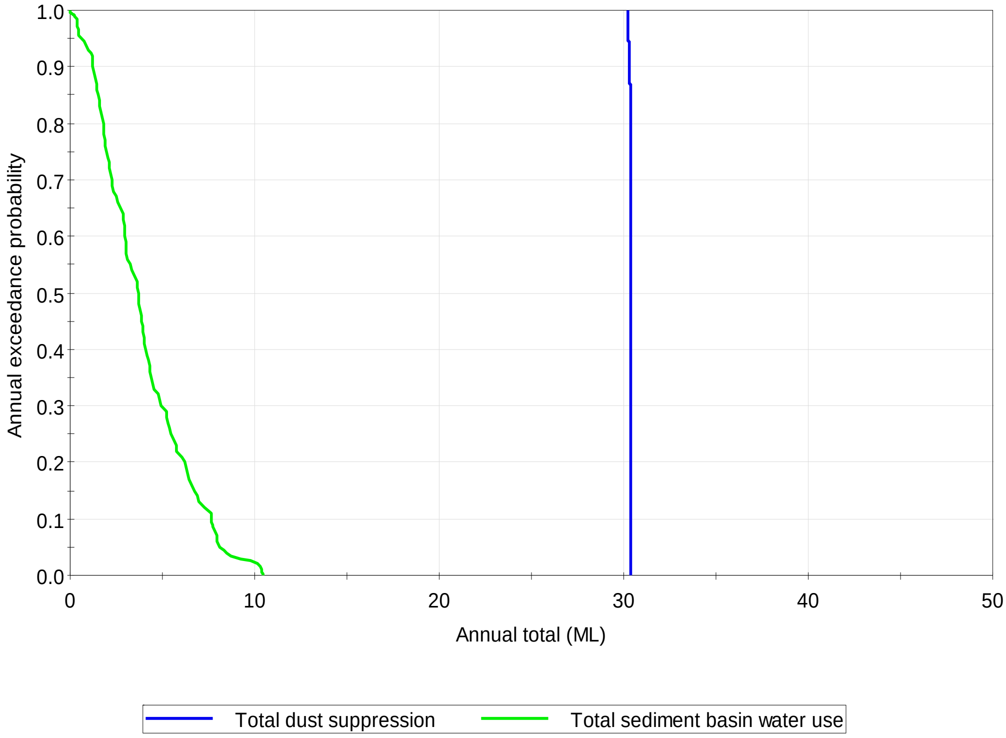

Figure 4-1 Distribution of dust suppression water sources

Figure 4-1 shows that in wet years, up to approximately 10 ML (33%) of water for dust suppression is expected to be able to be sourced from the sediment basin. In very dry years, it is possible that no water may be available from the sediment basin. The median (50th percentile) result of 3.7 ML corresponds approximately to difference between average (mean) dust suppression demand and average (mean) external potable supply average of 4.2 ML shown in Table 4-1.

The taking of water from the sediment basin for the control of soil erosion and use for dust suppression is exempt from requiring a water access licence under Clause 21(1) of the *Water Management Act 2000*.

5. References

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		Name	Signature	Name	Signature	Date
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