Appendix N

Irrigation strategy

Googong Township water cycle project

Environmental Assesment

November 2010

GOOGONG TOWNSHIP

IRRIGATION STRATEGY

PREPARED FOR CANBERRA INVESTMENT CORPORATION

REV 2

MAY 2010

PROJECT NO: C09029

GOOGONG TOWNSHIP

IRRIGATION STRATEGY

PREPARED FOR CANBERRA INVESTMENT CORPORATION

REVISION SCHEDULE

NO	DATE	ISSUE	PREPARED BY	REVIEWED BY	AUTHORISED BY
0	12/12/09	FIRST DRAFT	VO	TC	
1	13/1/10	DRAFT FOR CLIENT COMMENT	VO	TC	TC
2		REVISION – CLIENT COMMENT	VO		

 Date: 8 October 2010
Ph: 6211 7100 Fax: 6211 7199

Nomenclature of Open Space Assets

The reader is advised that any reference contained within this report to the Recreational Reserve A should be substituted with the term Sportsfield 1.

It is also advised that reference to Googong Mini Common should be substituted for the term Local Park 1.

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Ph: 6211 7100 Fax: 6211 7199

Executive Summary

Security of water supplies for any population is the principal consideration for any new development. Successful land developments also heavily rely on water supplies to produce a pleasing and functional landscape in the urban context. The New Township of Googong will succeed in both by assuring the security of water supplies whilst producing a pleasing landscape which will include irrigation of open space areas primarily with recycled water and stormwater with minor supplementary demands meet by the potable water system. This report describes the irrigation strategy for the Googong Township Development.

A total of 44.91 hectares of open space distributed throughout the Googong Township is proposed to be under permanent irrigation. A further 82.79 hectares of open space, notionally street verges, will also require irrigation to establish the landscape but will not continue to be irrigated throughout the life of the Township.

Irrigation application rates adopted in the model range from 418mm to 568mm per annum for parks/verges or sporting fields respectively. This is in addition to the annual average rainfall of 614.7mm which will fall on the landscape. Peak monthly irrigation demand during the development phase is expected to reach 54.86ML. At the conclusion of the development it is expected that the irrigation system will demand 228.08ML annually with a peak monthly demand of 33.27ML in summer months. Supply and demand figures used in this model were based on average monthly figures.

Recycled water is the primary source of water to meet the irrigation demand; however recycled water will not sustain the irrigation water requirements alone, will not be available for the initial two years of the development and will only gradually increase in available volumes as the development is occupied. At the conclusion of the development phase it is expected that 30.26ML per month (363.16ML per annum) of recycled water will be available for irrigation of open space areas. Stormwater is therefore an integral part in the success of the irrigation system and is based on utilising surface water storages around the site, in particular storage on Montgomery Creek, from Day 1 of the project mainly for the establishment of the Neighbourhood 1A.

Paramount to the success of the stormwater source of irrigation water in the initial years is the immediate need to extract water from the existing 10ML dam on Montgomery Creek, which currently is not within CIC controlled land (i.e. within Superlot C) and the confirmation of achieving the Maximum Harvestable Right for the property. Thus it is therefore a key recommendation that dialogue with the Landowner of the existing dam in parallel with further discussions with the N.O.W. is conducted to broker such agreements. The proposed water storages, be they water quality control ponds or on line reservoirs on Montgomery Creek would not require licensing from the N.O.W, given the location of the proposed dam is on a 2nd order stream.

Potable water is therefore proposed to only supplement the irrigation water demand during the first half of the project development program with no annual draw of potable water at the conclusion of the development. The maximum total draw over the life of the development on the potable water system could be 41.40ML, depending on the stormwater extraction regime adopted. This volume of potable water is only 18% of the annual irrigation requirement for the full development and is therefore very minor when viewed on a total project basis. It is also understood that this level of

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irrigation demand can be satisfied by the Integrated Water Cycle (IWC) at Googong whilst maintaining the proposed minimum 60% savings of potable water.

Infrastructure required for the irrigation system include 4,900 metres of stormwater main and seven pumping stations, however the principal infrastructure necessary to optimise irrigation water supplies is the existing and a proposed new surface water reservoir on Montgomery Creek within the Googong Common. Costs of this infrastructure are in the order of $1.1M (ex GST). Costs for application of water via more temporary means, particularly within the establishment period of all landscape areas, i.e. surface placed polypipe systems or water cart are in the order of $20,000/ha (ex GST) or $27,500/ha (ex GST) respectively.

Recommendations

1 – Adopt irrigation rates as suggested in this report and reassess after a few years of irrigation.
2 – Priority is given to plant species requiring low volumes of water to be sustained within the Googong environment.
3 – CIC immediately negotiate with the landholder the use of stormwater currently stored and captured by the existing 10ML dam on Montgomery Creek.
4 – Immediately engage with the N.O.W. to:

a) *confirm the MHR for the whole of the development, and*
b) *confirm involvement of Environment ACT in the planning procedures in relation to the WQCP and use of water contained within the WQCP.*

5 – Participants in the IWC confirm that collection, transfer and storage of stormwater, from the surface reservoirs, within the recycled water network are an acceptable solution.
6 – CIC include at least an additional $1.1M (ex GST) to civil works budgets for irrigation civil infrastructure.
7 – Include temporary irrigation of landscape areas in landscape works contracts, such as irrigating of dryland grass.
8 – Complete daily time step modelling of water storages contributing to the irrigation demand.

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1 Introduction

1.1 Background

Brown Consulting (ACT) Pty Ltd has been commissioned to develop an irrigation strategy for the open space areas within the proposed Googong Township. The Strategy is to determine an appropriate regime for the sustainable application of water from all sources of supply available to a defined area of land to be irrigated.

Brown Consulting has been involved in the Googong project since 2007 providing civil engineering advice to CIC Australia Limited (CIC), the project developer. Brown Consulting's role as Infrastructure Design Manager in assisting the CIC project management team in coordinating and delivering the necessary civil infrastructure to support the Googong development, and our participating in the Urban Design Group has resulted in Brown Consulting being uniquely across all facets of the project. This role has enabled Brown Consulting to integrate the irrigation requirements from the respective project team members.

Other consultants are providing significant studies and advice for the project, more importantly the Integrated Water Cycle (IWC) for Googong, namely:

- Manidis Roberts – Part 3A planning documentation and coordination for the IWC
- MWH – headworks and process engineering concept design, including water balance
- AGSOL – land capability and nutrient balance, including water balance
- EDAW/AECOM – Landscape Architectural planning and design, Landscape and Open Space Strategy (LOSS)
- Roberts Day – Urban Planning and Design.

All of the above Consultants have an interest in the irrigation of lands for Googong and have been relied upon to contribute data to establish The Googong Township Irrigation Strategy.

It is the intention of the project to transform the current grazing land into a pleasant urban development. Success of this project therefore requires significant landscape amenity within the urban fabric of the new township. CIC have also stated that the Googong development will reduce potable water use by over 60% compared to a similar development currently in existence. Thus the development proposes to utilise recycled water to achieve these targets. Irrigation of open spaces from numerous water resources is therefore required to result in a successful development.

1.2 Objective

The primary objective of this report is to prepare a strategy to enable irrigation and hence promote growth of vegetation in open spaces within the development for the establishment phase of NH1A and the long term for the whole Googong development.

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2 Methodology

2.1 Modelling

The primary modelling process in this report is a mathematical spreadsheet comparing the irrigation water requirements for individual parcels of land to potential sources of water to be used to irrigate that land. Given the development has a 25 year establishment time line, it is prudent to model irrigation demands over the establishment phase and the gradual generation of recycled water through the same period.

Irrigating landscapes varies throughout the seasons after it is established and by what type of landscape is to be established. Thus fluctuations in application depths of irrigation water, rainfall and evaporation are considered in the model. Similarly the potential recycled water source increases through time as the development is sold, built and occupied.

The results of this report are mainly presented in numerous figures illustrating water requirements and interpretation of the figures and diagrams is essential.

2.2 Data

2.2.1 The Proposed Development

The Googong Development comprises a total of 788 hectares and is located eight kilometres south of Queanbeyan. The urban development site is bounded by Googong Dam Road to the north, the Googong Dam land to the east, existing grazing land to the south and Old Cooma Road to the west. The site also includes two parcels of land allocated for large residential (non-urban) lots, known as the Hamlets, which are located north of the Googong Dam Road and to the east of Old Cooma Road. The new township will comprise of six neighbourhoods (1A, 1B, 2 – 5) and two Hamlets, will produce approximately 6,000 residential lots and house approximately 17,000 people (Refer Appendix A Yield Plan K 010709).

The Site contains four topographic catchments and is dominated by the Montgomery Creek catchment with the creek line flowing in a north easterly direction roughly bisecting the site (refer Appendix A Googong New Town Riparian Buffer Zones). Other catchments include the Googong Creek catchment (currently officially unnamed) which drains in a north easterly direction through Neighbourhood 2/Town Centre and Neighbourhood 1A, the small portion of Jerrabomberra Creek Catchment draining west in Neighbourhood 3 and approximately 34ha of the Googong Dam Catchment in the east of the development which has been quarantined from development.

Major water cycle infrastructure includes the Water Recycling Plant (WRP) in the north east corner of the site and a multiple potable and recycled water reservoir installation on the Twin Hills in Neighbourhood 3 (Refer Appendix A Locality Plan C08006.1-002+). The adjacent ACTEW Googong Dam Water Treatment Plant (WTP), just north of the site, will deliver potable water to the development through rising and gravity delivery mains connecting the WTP and the reservoirs, via Googong Dam Road and Old Cooma Road. Similarly rising mains will transfer Recycled Water from the WRP to the reservoirs along the same route. The whole development will be supplied potable and recycled water through a dual supply network with trunk ring mains placed in the Googong Avenue through the development as it is constructed.

Given the nature and location of the land it is imperative that the site is developed in an aesthetically pleasing manner to be attractive to potential residents. Thus the development intends

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to include a substantial amount of open space which is not only usable and functional, but attractive, thus requires irrigation. It is the open space areas to be irrigated which are the major subject of this report.

2.2.2 Development Yield

Being a new township, Googong will not only comprise of residential allotments, but will also provide commercial and educational land with significant tracts of open space. Appendix A illustrates the structure of the new town and the distribution of the open space. Included in Appendix A is the land budget for the Googong New Town as per the Yield Plan, including total dwelling/allotment amounts based on lot sizes.

At this stage detailed master planning of the urban network has only been completed for Neighbourhood 1A (refer Appendix A). From the Neighbourhood 1A layout the extent of open space irrigation areas can be quantified and then use those amounts against the lot yield or street length of future neighbourhoods to determine the amount of irrigated areas, such as verges, for those neighbourhoods.

2.2.3 Program

Googong township will be developed over a 25 year program (refer Appendix B). The program presented provided the basis for the temporal pattern of both demand and supply of irrigation water, by the construction of the open space assets and availability of recycled water and stormwater for irrigation respectively.

2.2.3.1 Civil Construction & Subdivision Roll off

The program presented in Appendix B, illustrates the individual stages of each neighbourhood and the relationship of those subdivisions with the necessary infrastructure required to support the development. Whilst the irrigation demand will be minor throughout most of the construction phase, it will be necessary to establish and stabilise the regraded areas with vegetation, hence these areas will require a significant amount of water to do so. Thus to determine the initial establishment demand for these areas it is assumed that a single depth (250mm per month) of water be applied over the last two months of the civil construction phase for that area, regardless of the location or vegetation type.

> *Assumption 1 – irrigation water depth in first two months is 250mm per month regardless of landscape type*

2.2.3.2 Built Form Construction & Occupation

Built form and occupation of the built form directly relates to the temporal pattern of recycled water generation and is thus an irrigation water supply consideration. It has been assumed that occupation of residential dwellings, and therefore recycled water production, will commence six months after the completion of the start of the settlement of the subdivision. It is also assumed that the dwelling construction and hence occupation is linear during the settlement period so as six months after the completion of the settlement period the whole of the subdivision is occupied and thus generating waste water.

> *Assumption 2 – occupation, and therefore recycled water production, of residential dwellings will commence 6 months after settlement*

> *Assumption 3 – dwelling construction and occupation are linear and 100% occupation is achieved in an equal timeframe to settlement*

Another assumption within the occupation and hence recycled water generation model is that 100% of allotments are occupied. This has the effect of over estimating the amount of recycled water

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produced but is retained to verify the results against other water balance studies currently underway.

2.2.3.3 Schools & Commercial Lands

Throughout the Googong Township there non residential lands allocated for schools and commercial uses. The commercial lands are concentrated in the Neighbourhood 2 or the Town Centre with smaller portions of commercial land allowed for in each neighbourhood centre, known as Civic Spaces. Schools are a combination of classes, with one out of the four a Kindergarten to Year 12 School destined for Neighbourhood 4.

These land uses produce a different rate of recycled water and assumed to exhibit longer build out and occupation rates over residential allotments. Thus in these lands, it has been assumed that build outs are 12 months in duration after settlement of the subdivision they are within commences. Occupation rates for schools are assumed as follows:

- K - Yr6 4 years
- Yr7 - 12 3 years
- K - Yr 12 7 years

And thus the recycled water generated within schools is stepped on an annual basis and not linearly increasing within the occupation period.

Assumption 4 – school build-out periods are 12 months commencing on the first settlement date for the subdivision in which they occur

Assumption 5 – school occupation, hence rewater production, is stepped increasing annually with addition of classes.

Commercial allotments are assumed to take five years for 100% occupation with recycled water generation assumed to be linear during this period.

Assumption 6 – commercial land occupation and hence recycled water production is linear over 5 year period

2.2.4 Irrigation Areas

The assessment of land areas receiving irrigation have been reconciled with the Googong Land Budget (Appendix A) and are presented in Table 1 of Appendix C.

2.2.4.1 Permanent Irrigation Areas

Permanent irrigation areas within the Googong Township are dominated by the recreation reserves, i.e. sporting fields, the neighbourhood parks, civic spaces in the neighbourhood centres and selected features and verges particularly in the entrance areas to the development. Some Local Parks are not to be permanently irrigated as it is understood to be in accordance with the Project's vision.

Neighbourhood 1A currently has a high proportion of permanently irrigated areas, i.e. 13.48ha which is 30% of the total Googong open space irrigation areas. This is to be expected being the first stage of the development and being located on the lower reaches of a catchment. At the conclusion of the development's construction phase, 44.91ha of open space will be under permanent irrigation. Dwg C09029-IRR01 (Appendix D) illustrates the proposed permanently irrigated areas within Googong.

2.2.4.2 Establishment Areas

Open space areas that are not permanently irrigated nevertheless require significant volumes of water for the establishment of vegetation to stabilise the soil surface. Generally these areas include the street verges and have a single depth of water applied over a two month period regardless of

Ph: 6211 7100 Fax: 6211 7199

location or vegetation type. In total there is 82.79 hectares of land requiring only establishment levels of irrigation water over the construction phase of the subdivision, i.e. 84% larger in area to the extent of permanent irrigated open space (44.91ha).

Given the extent of master planning and street network resolution in Neighbourhood 1 A, the amount of verges included in the establishment areas is easily quantified (17.43ha). However in other Neighbourhoods, the amount of establishment irrigation areas has been determined by allocating a 15m lot frontage by 5m wide verge for all allotments where the street length is unknown.

Assumption 7 – area of verge irrigation for Neighbourhoods 1B – 5 are calculated based on 15m of lot frontage by 5m wide verge per lot, where street lengths are unknown

2.2.5 Irrigation Application Rates

Initial figures of permanent irrigation application rates modelled were suggested by the projects Landscape Architect, EDAW-AECOM, which was simply 500mm per annum for high value areas and 300mm per annum for medium priority areas. These vary widely to figures suggested by engineering specifications for planning water networks, but have been verified by AGSOL whom have undertaken a separate water balance and soil capability assessment for the development.

AGSOL therefore suggested the irrigation application rates which have been adopted and used in the irrigation strategy model and are presented in Table 2, below.

Table 2 Irrigation water application depths (Source AGSOL – Nov 2009)

Class	*Description*	*Irrigation Depth [mm/a]*
2	Playing Fields	568
3	Parks Open Space/Verges	418
4	High Value Streetscapes/Planter Garden beds	459

It should be noted that Class 1 irrigation areas are household gardens which are not subject of this report.

Accordingly irrigation water is not applied to land constantly all year round. Irrigation application rates are at their highest in the summer months and are zero in the winter months. Adopted temporal patterns of irrigation application depths for the respective classes above are presented in Table 3.

Table 3 Monthly Irrigation Depths

	Jan [mm]	Feb [mm]	Mar [mm]	Apr [mm]	May [mm]	Jun [mm]	Jul [mm]	Aug [mm]	Sep [mm]	Oct [mm]	Nov [mm]	Dec [mm]
Playing Fields	80	80	54	54	54	0	0	0	54	54	58	80
Parks, OS/Verges	65	65	38	38	38	0	0	0	35	35	39	65
High Value St-scape garden beds	73	73	40	40	40	0	0	0	40	40	40	73

Assumption 8 – seasonal variation in irrigation water application – refer Table 3.

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2.2.6 Irrigation Systems

This report is focussed on the quantitative assessment of the amount and spatial/temporal distribution of irrigation areas and the water required to sustain those areas. It is not the purpose of the report to design the irrigation system. However opinions of cost have been undertaken for permanent in ground sprinkler systems and the use of water carts for the establishment phase of irrigated areas. It is considered that the landscape contractor will use either a temporary polyethylene pipe network placed on the surface or a water cart to distribute the water to establish the landscape.

2.2.7 Sources of Irrigation Water

2.2.7.1 Recycled Water

The Integrated Water Cycle for the Googong Township development will reticulate tertiary treated effluent to all allotments. The effluent is referred to in this report as recycled water and is the primary source (in priority) of open space irrigation water.

Given the recycled water is reticulated to all allotments the model includes scenarios of surplus recycled water available for open space irrigation after it has satisfied the on lot recycled water uses. The amount of surplus recycled water has been calculated based on the residential allotment type as per Table 4.

Table 4. Recycled Water Production Rates by Allotment Type (Source MWH, Feb 2010)

Customer Category	Annual Volumes (kL/dwelling type)				
	ReWater Produced	Internal Non Potable Demand	On Lot outdoor Demand	Excess ReWater	Excess ReWater (no on lot outdoor uses)
	[kL/a/lot]	[kL/a/lot]	[kL/a/lot]	[kL/a/lot]	[kL/a/lot]
Apartments (A)	106	39	6	61	68
Townhouse/Terrace (B1+B2)	143	52	9	82	91
Small Courtyard (C)	146	53	21	72	93
Large Courtyard (D)	151	55	36	61	96
Single Lot (E)	177	64	52	61	113
Large Lot (F)	183	67	82	35	117
Estate Homes	183	67	187	0	117
Rural	183	67	374	0	117

Recycled water is also generated and utilised on lot from the commercial and school lands as per Table 5. This table illustrates that the school land uses consume more recycled water than they produce, where as commercial land uses do not.

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Table 5. Commercial and School Recycled Water Generation Rates (Source MWH, Feb 2010)

Customer Category	Annual Volumes (kL/land use type)				
	ReWater Produced	Internal Non Potable use incl leakage	On Lot outdoor Demand	Total ReW use (indoor + outdoor)	Excess ReWater (indoor +outdoor demand less ReW produced)
	[kL/a/ha]	[kL/a/ha]	[kL/a/ha]	[kL/a/ha]	[kL/a/ha]
School	3414	1879	2737	4616	0
Commercial	2173	1141	408	1549	624

2.2.7.1.1 On lot uses – indoor and outdoor options

Given there are multiple uses for recycled water on the individual allotments, this report only considers three scenarios to determine the variability in recycled water available for open space irrigation namely:

a. All indoor and outdoor recycled water uses satisfied by the recycled water system,
b. Indoor recycled water uses only satisfied by the recycled water system and
c. Outdoor recycled water uses only satisfied by the recycled water system.

The report does not consider the different on lot uses, such as toilet, hot water, laundry or outdoor garden watering, or optimise the on lot uses of recycled water to benefit the open space irrigation strategy.

2.2.7.2 Stormwater

2.2.7.2.1 Hydrology

To reduce the deficit of irrigation water supply, the first source investigated was rainwater runoff from the existing catchments on the site. To determine the stormwater available for the open space irrigation, simple runoff volume calculations were undertaken for the respective catchments of the proposed and existing surface water storages using mean monthly rainfall figures (1939-2009) for the Canberra Airport BOM site (No. 070014). Given the majority of the catchments will be urbanised and the expected extent of impervious areas within the Googong township is high, a 30% runoff coefficient was considered appropriate for the runoff calculations.

Assumption 9 – coefficient of runoff is 30% for all catchments

Simplistic volume to surface area calculations were utilised for the surface storages to calculate the effective volume available for that size reservoir in that catchment and the expected evaporation losses.

Hence the potential stormwater supply for irrigation water is determined on a mean monthly basis.

2.2.7.2.2 Harvestable Right & New South Wales Office of Water Requirements

This Irrigation Strategy relies on the notion that stormwater will be available to be extracted from the surface water storages that either exist on Montgomery Creek or are created for water quality purposes within the urban development. The New South Wales Office of Water (N.O.W.) approval will be required for this activity under the Maximum Harvestable Right (MHR) criterion for the Googong Property. The Maximum Harvestable Right for the Googong Property (excluding the Hamlet lands north of Googong Dam Road) is 48.6ML (calculated by 695.02ha x 0.07ML/ha MHR

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volume factor). Thus storage of stormwater in dams specifically for extraction of the water should not exceed 48.6ML.

Assumption 10 – extraction of stormwater from water quality control ponds is permissible

The N.O.W. was consulted for indicative rulings on the MHR for Googong and use of and storage of stormwater for irrigation purposes. It would appear that stormwater storage volumes allocated for detention or water quality would not be accounted toward meeting the MHR for the property. However it would appear that the notion of water quality control ponds (WQCP) not counting toward the MHR may require concurrence of Environment ACT and it is presumed (and requires confirmation) that if extraction of the stormwater from the WQCP was proposed that then the volume may be included in the MHR total volume.

The N.O.W. also confirmed that a license for the proposed 12ML new dam on Montgomery Creek would not be required given it appears to be located on a 2nd order stream.

Confirmation of the N.O.W. requirements for the proposed developments in regard to the MHR and stormwater use will be progressed through the Part 4 development application planning processes, i.e. through Queanbeyan City Council.

2.2.7.2.3 Extraction options

Permanent Water Quality Control Ponds (WQCP) are proposed to be used to supplement the open space irrigation water supply. Many of these WQCPs are features of the landscape of the development, thus extraction of the entire volume of water from the water quality facilities would render the ponds unsightly and reduce the effectiveness of the quality function of the pond. Therefore extraction volumes from the majority of WQCPs have been limited to a maximum of 0.5m depth over the surface area of the WQCP.

In initial stages of construction, when the residential allotments adjacent to the surface water storages have not yet been occupied, the extraction depth has been assumed to be only limited by the actual volume of the reservoir itself, i.e. pumping the storage dry if required.

Assumption 11 – extraction of stormwater for surface water storages varies between a maximum of 0.5m depth for WQCP adjacent to developed areas or 100% of available depth for remote dams.

2.2.7.3 Water Sensitive Urban Design

Water Sensitive Urban Design (WSUD) should be a major contributor to the urban design of any new development. The Googong Township is including substantial WSUD features within the development to promote the landscape features and to better deal with quality of stormwater from the site. Thus WSUD will be used to passively irrigate those areas where the landform and street network permit, mainly though tree pits, rain gardens and bio-swales.

It is only the vegetated bio-swales that would warrant some open space irrigation water demand, and that would only occur in the establishment phase of the works. Furthermore the extent of such vegetated swales is relatively unknown at this stage in the development program of Googong other than in Neighbourhood 1A, hence the supply of open space irrigation water from WSUD features and conversely the fulfilment of irrigation demands for WSUD features is considered within the model however is not explicit. For example the water demand of a single tree is not quantified nor is

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the stormwater runoff supplying a single tree pit quantified, rather the supply and demand is determined on a landscape type basis with minimum units of 0.1 ha.

Assumption 12 – minimum unit for irrigated open space is 0.1ha, hence not individual trees or rain gardens. Furthermore WSUD devices are included within the verge establishment irrigation demands.

In fact in regard to Water Sensitive Urban Design, species selection of the vegetation is paramount for a successful landscape outcome given the climate in which Googong Township will exist.

2.2.7.4 Potable Water

Another source of irrigation water is the potable supply. However this is not modelled in any way in this report other than to state that the irrigation demand deficit after all other sources are exhausted is to be met by the potable supply or the irrigation demand reduced to not require the potable supply. It is noted however that the IWC modelling completed by others, namely MWH, has always assumed that there would be a demand on the potable water network attributed to open space irrigation.

Assumption 13 – potable water and recycled water networks will be operative from the conclusion of the construction of the first sub-stage of Neighbourhood 1A.

In MWH Site Water Balance Assessment, Dec 2009, an exact volume of potable water, in either a monthly, annual or total development figure, that would be used for open space irrigation is not presented. However the MWH water balance work has included the same quantity of irrigated area and application rates as were modelled in this report.

2.2.8 Climate

Climatic data utilised in this investigation have been sourced from the Bureau of Meteorology for the Canberra Airport Station No. 070014. Principally mean monthly rainfall figures and mean daily evaporation figures have been used in the calculations of stormwater supply section of this investigation. Records available to obtain these mean figures are from 1939 to 2009.

It is important to note that the annual average rainfall for the area in which Googong exists is 614.7mm in terms of annual irrigation application rates and their difference to rainfall depths.

Assumption 14 – climate averages for Canberra Airport Station No. 070014 are applicable for the Googong site

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3 Results

3.1 Irrigation Water Demand

3.1.1 Whole of Googong Township

The open space irrigation water demand commences in July 2011, with 9.38ML required in that month as the first areas of Stage 1 of NH1A are nearing completion of construction. As one would expect summer months illustrate a peak in irrigation demand, however peaks also occur outside of summer months when certain stages of civil construction are being completed and thus are requiring irrigation water to establish the landscape. A clear illustration of the lack of irrigation in the winter months is shown in Figure 3 (Appendix C) as every year the irrigation demand falls to zero for at least one month. Figure 3 (Appendix C) illustrates the pattern of irrigation demand throughout the duration of the development of Googong township in relation to the total recycled water generated by the development as it grows.

Irrigation demand peaks in February 2024 with 54.86ML required in this month. 20.93ML (or 38%) of this monthly peak is attributed to the establishment of Recreational Reserves F & G and Drainage Reserve N in the Googong Common. This peak coincides with the completion of construction of the first stage of Neighbourhood 3, with Neighbourhoods 1A and 2 already complete. It is important to note that three next highest peaks are just below 40ML/month and occur in February 2033 (39.78ML), March and April 2022 (39.02ML) and January and February 2029 (38.89ML).

In the final year of the model, when the development is complete, all demands are known and thus the monthly irrigation demands are presented in Table 6.

Table 6. Monthly Irrigation Demands for the completed development

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Annual**
Demand [ML]	33.27	33.27	21.29	21.29	21.29	0.00	0.00	0.00	20.87	20.87	22.67	33.27	**228.08**

It is assumed the annual irrigation demand pattern will remain the same beyond the final year of construction and occupation.

Calculation of the mean monthly irrigation demand from the full duration of demand figures can be misleading and hence are stipulated in this report with caution to the reader. The mean monthly irrigation demand for the total irrigation application period is 14.07ML, however in the final year the mean monthly irrigation demand is 19.01ML, 35% higher. Furthermore when zero values are removed from the calculation, then the mean monthly irrigation demand in the final year becomes 25.34ML, 80% higher than the total period average monthly application volume. The latter is a more accurate indicator of average actual irrigation demand.

3.1.2 Neighbourhood 1A

The construction program presented in Appendix B illustrates that the whole of Neighbourhood 1A civil assets are constructed prior to commencement of Neighbourhood 2. Similarly Figure 3 (Appendix C) illustrates that Neighbourhood 2 does not require irrigation water until May 2018. Therefore the irrigation demands between July 2011 and May 2018 are solely attributed to Neighbourhood 1A. Within this period the peak monthly irrigation demand is 22.45ML occurring in March and April 2016.

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However at the completion of the Neighbourhood 1A Subdivision the monthly irrigation demands are consistent in each year from that point onwards and are presented in Table 7.

Table 7. Monthly Irrigation Demands for the completed Neighbourhood 1A subdivision

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Demand [ML]	9.91	9.91	6.33	6.33	6.33	0	0	0	6.18	6.18	6.72	9.91	**67.79**

3.2 Available Recycled Water

3.2.1 Recycled Water Scenario 1 – All on lot non potable water uses met by Recycled Water Supply

As occupation of the development increases the amount of recycled water increases until the development is completed and hence the township is fully occupied. Figure 4 (Appendix C) illustrates the increasing total recycled water generated through time accompanied by an amount of recycled water available for open space irrigation after all on lot non potable water uses are satisfied by the recycled water supply. Thus an irrigation water deficit has been calculated.

At the conclusion of the development period the excess recycled water that would be available for open space irrigation was calculated to be 30.26ML per month or 363.16ML per annum. This resulted in the peak deficit in this scenario to be expected in February 2024 requiring a further 39.55ML in that month to sustain the irrigation demands.

The recycled water production results illustrate a lag (of 27 months) between the commencement of occupation of the development to the availability of recycled water to open space irrigation or for that matter the Googong community. This is explained by the WRP requiring a critical mass of raw sewage to be able to commission the plant, obtain a licence or approval for the facility and thus appropriately treat the sewage to return it to the community for use as a water source.

The irrigation water deficit practically mimics the irrigation water demand for the period July 2011 to June 2016. This clearly illustrates that the recycled water is not the major source of irrigation water for the development of Neighbourhood 1A and thus other sources of water are required to launch the project.

3.2.2 Recycled Water Scenario 2 – Indoor on lot non potable water uses met by Recycled Water Supply

Testing of the restriction of the on lot recycled water uses to only the indoor non potable water demands resulted in there being ample available recycled water for the entire open space irrigated areas at the conclusion of construction of the Township. However Figure 5 (Appendix C) illustrates, that a deficit of irrigation water still exists in establishment phases of the development coinciding with peaks in irrigation demand. The peak deficit is again expected in February 2024 with the shortfall in irrigation water in the order of 29.58ML for that month.

3.2.3 Recycled Water Scenario 3 – Outdoor on lot water uses met by Recycled Water Supply

Restricting on lot recycled water uses to only outdoor water demands resulted in a similar effect to Scenario 2. That is at the conclusion of the development there is sufficient excess recycled water available to meet the demands of the open space irrigation areas with deficits experienced in the earlier years of the development. Figure 6 (Appendix C) illustrates the temporal pattern of excess recycled water supply and deficits under this scenario. The peak monthly deficit is 24.91ML in February 2024.

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3.3 Available Stormwater

3.3.1 Whole of Googong Township

Stormwater runoff is the first water supply interrogated to cover the shortfall of the irrigation demand of open space areas in the Googong Township. Storage of stormwater runoff already exists in a large farm dam on Montgomery Creek in the centre of the site (refer Dwg C09029-IRR02, Appendix D), however additional storages considered in this model include the proposed Water Quality Control Ponds (WQCP) required around the site and another large dam on Montgomery Creek. Details of the surface water storages are detailed in Table 8.

Table 8. Surface Water Storages (refer Appendix D Dwg C09029-IRR02)

	DR A NH1A WQCP	DR C WRP WQCP	DR D NH1B Club G WQCP	DR G & H WQCPs	DR J WQCP	DR U WQCP	DRV WQCP	Googong Common existing Dam	12.0ML Googong Common Dam	**Total**
	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	[m3]	**[m3]**
Total Storage Volume	11850	4000	6100	6600	6100	2700	4500	10500	12000	**64350**
Super lot Location	A	A	B	A	C	C	D	C	C	
Limited Extraction Volume	4500	2000	2600	4300	2970	1760	2760	4517	3632	**29039**
Stormwater Available for Irrigation Volume (Mean Month)	2551	1074	1087	1574	1653	957	1525	2356	2191	**14967**
Potential MHR Volume	4500	4000	2600	4300	2970	1760	2760	10500	12000	**45390**

The total storage volume of the reservoirs is 64.4ML however under the restricted extraction depth this figure reduces to 29.0ML. The total storage volume of the water bodies considered in this report exceed the Maximum Harvestable Right of 48.6ML, however it is arguable that the total volume of the water quality ponds should not be taken into account for the assessment against the Maximum Harvestable Right volume given they are required to effective maintain quality of runoff from the development. In fact if the total volume of the Googong Common dams is added to the limited extraction volume of the other WQCPs (with the exception of DR C), then the resultant volume (45.4ML) does not exceed the MHR (48.6ML).

After considering evaporation and bypass of runoff events the total mean monthly stormwater available for irrigation is 15.0ML.

Figure 7 (Appendix C) illustrates the stormwater availability against the total irrigation demand as the surface storages are constructed concurrently with the respective stage of the neighbourhood in which they are contained. The figure illustrates that with the maximum extraction regime sufficient stormwater exists on site to satisfy the irrigation demand at the conclusion of the development, but cannot meet some peak demands. However, the maximum extraction regime is not a long term solution to meeting irrigation demands due to the unsightly aspect of dry basins in an urban setting. Thus the restricted extraction regime is more suited to the development. The restricted stormwater extraction regime cannot meet the irrigation demands either on a monthly basis or in the long term when the development is complete.

Therefore staging of the extraction regime is proposed to maximise the available stormwater for meeting the open space irrigation requirements.

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3.3.2 Neighbourhood 1A

Of the stormwater storages presented in Table 8, some appear to be located in land which CIC do not currently have control over at the time of writing this report. Currently CIC have control over Super Lot A, and the other Super Lots are proposed to be acquired by CIC as per the following:

- Super Lot B July 2010
- Super Lot C July 2012
- Super Lot D July 2014
- Super Lot E July 2016

Thus, the major storage of stormwater to sustain the irrigation demands, i.e. the existing Dam on Montgomery Creek, may not be available until July 2012 or 18 months after the first irrigation demands are made. Therefore it is paramount that negotiation with the current landholder of Super Lot C is commenced to obtain permission to extract stormwater from this dam from day one of the Neighbourhood 1A open space irrigation needs, in parallel with the engagement with the N.O.W. for the confirmation of the MHR over the proposed developed area.

Assumption 15 – CIC will be successful in negotiating with landholder and Government Agencies for the extraction of water from the from the existing 10ML dam on Montgomery Creek

If the use of the 10.0ML existing Dam on Montgomery Creek does not come to fruition until July 2012, then an alternative to assuring storage volume for open space irrigation in the first 18 months of development is to explore pumping stormwater runoff into the Stage 1 recycled water reservoir on Hill 800 which is currently proposed to be 8.0ML. The advantage of this storage facility is that evaporation losses are nil and being a reservoir there would not be a restricted extraction regime which the WQCP would be subject to for aesthetic purposes. In addition to the above points the 8.0ML Reservoir should be constructed for the initial allotment of Neighbourhood 1A.

Assumption 16 – the 8ML recycled water reservoir will be operational and able to store stormwater from dams and WQCPs upon the settlement the first lots of the first sub-stage of Neighbourhood 1A

In order to fill the 8.0ML reservoir with stormwater runoff, the obvious potential extraction point would be at the DR A WQCP as a simple, but yet potentially large, pump station could be placed nearby and connect to the Recycled water rising main from the WRP to the reservoirs. Another potential arrangement would be for the Sewerage Pump Station No 1, already planned for this location, to accept a stormwater flows from the nearby WQCP and pump either through the WRP, or directly into the passing Recycled Water rising main, to the reservoirs.

An additional advantage of this proposition is that the recycled water reservoir can be hydraulically tested and commissioned with stormwater earlier than if using on site recycled water or paying for potable water from the Googong Dam Supply.

3.4 Combined Recycled Water and Stormwater Supply

3.4.1 Whole of Googong Township & Stormwater Regime No 1

Given neither the recycled water nor the stormwater system alone can sustain the irrigation of open space areas; the proposal is to supplement the available recycled water with the stormwater when the recycled water is unavailable. Figure 8 (Appendix C) illustrates the combined recycled water and stormwater resources for open space irrigation against the irrigation demand. The regime of stormwater extraction adopted in this figure is a combination of high and low extraction depths

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from certain storages which come on line at varying times throughout the program. The rationale of the staged stormwater availability can be described by Table 9.

Table 9. Stormwater Extraction Regime No 1

Year 20' / Storage	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
DR A	Nil	Jul 2011 > Ltd																							
DR C	Nil						Mar 2016 > Max																		
DR D	Nil							Jul 2017 > Ltd																	
DR G + H	Nil	Jul 2011 > Max									Apr 2020 > Ltd														
DR U	Nil	Jul 2011 > Max																	Jul 2028 > Ltd						
DR V	Nil	Jul 2011 > Max																				Oct 2031 > Ltd			
Existing Common Dam	Nil	Jul 2011 > Max																				Oct 2031 > Ltd			
Proposed 12.0ML Common Dam	Nil	Jul 2011 > Max																				Oct 2031 > Ltd			

Table 8 illustrates that either there was nil extraction, limited (Ltd) extraction (meaning max 0.5m depth) or maximum (Max) extraction (meaning to drain the storage) of stormwater from the reservoirs and the month where the storage either comes on line or the extraction level is altered. It should be noted that DR C, a WQCP downstream of the WRP and essentially distant to residential allotments, the proposed regime is to maximise extraction from this water body throughout its life.

The irrigation water deficit expected under this regime, as presented in Figure 8 of Appendix C, peaks in February 2024 at 8.39ML for that month, coinciding with the peak irrigation demand. Interestingly the total irrigation water deficit under this regime is 8.39ML for the 24 years of irrigation demands, illustrating that there is only one month, February 2024, in the period where a deficit of water exists. Therefore at the completion of the development a deficit of total annual irrigation water is not expected to occur.

Figure 8 (Appendix C) illustrates an option to best meet the irrigation demands from potential stormwater supplies with the preferred recycled water scenario, however it does not consider the optimum timing of capital expenditure. Thus under this regime to obtain stormwater for irrigation from DR U and DR V areas of land would need to be available for construction of the dams earlier than is expected and thus would require significant temporary water mains and electricity supplies to drive pumps prior to that land being developed and in particular crossing of Montgomery Creek. The regime also requires the construction of a 12.0ML on line dam on Montgomery Creek prior to the establishment of any landscape areas.

3.4.2 Neighbourhood 1A & Stormwater Regime No 1

Figure 8 (Appendix C) also illustrates that there would not be an irrigation water deficit for the development of Neighbourhood 1A, i.e. between July 2011 and July 2017. Thus it could be considered that if this regime was adopted Neighbourhood 1A would have ample available water to sustain the total Neighbourhood 1A open space irrigation.

3.4.3 Whole of Googong Township & Stormwater Regime No 2

Figure 9 (Appendix C) however presents an alternative combined supply of recycled water and stormwater available to irrigate open space with delayed construction of stormwater assets to reduce capital investment early in the project, i.e. DR U, DR V are constructed, and hence limited stormwater extracted, only when the adjacent subdivision is constructed and the construction of the 12.0ML new dam on Montgomery Creek is delayed until the first major spike in irrigation demand exists in February 2022. The decision to delay the new 12.0ML Montgomery Creek storage until 2022 also has environmental benefits in that the current flow conditions of the stream remain as

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long as possible, however if the water extraction of the MHR rules alter in the intervening period, then this substantial irrigation water resource could be lost. The model of when stormwater storages come on line and their extraction levels for this scenario are presented in the Table 10.

Table 10. Stormwater Extraction Regime No 2

Year 20' / Storage	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
DR A	Nil	Jul 2011 > Ltd																							
DR C	Nil						Mar 2016 > Max																		
DR D	Nil							Jul 2017 > Ltd																	
DR G + H	Nil	Jul 2011 > Max									Apr 2020 > Ltd														
DR U	Nil																		Jun 2028 > Ltd						
DR V	Nil																					Oct 2031 > Ltd			
Existing Common Dam	Nil	Jul 2011 > Max																				Oct 2031 > Ltd			
Proposed 12.0ML Common Dam	Nil												Feb '22 > Max		Jun 2024 > Ltd										

As Figure 9 of Appendix C illustrates the deficit of irrigation water peaks in February 2024 at 13.55ML. At the conclusion of the project the annual irrigation water deficit is zero. However the delayed construction of the stormwater storages has resulted in the total irrigation water deficit for the 24 year program to increase to 41.40 ML.

3.4.4 Neighbourhood 1A & Stormwater Regime No 2

For the period of the development of the Neighbourhood 1A subdivision, i.e. July 2011 to July 2017, the peak monthly irrigation water deficit is 5.35ML and appears in December 2012. The total irrigation water deficit for Neighbourhood 1A is 23.75ML.

3.5 Potable Water Demand

The two irrigation water supply scenarios as presented in Figures 8 and 9 (Appendix C) illustrate that an irrigation water deficit exists at some time in the project which can be met by the potable water system. The potable water system is readily available with the roll out of the subdivision. It is understood that water balancing of the IWC by MWH has resulted in targets of at least 60% potable water savings for the Googong Township being achieved. These targets have been met with the same amount of permanently irrigated area with recycled water applied at the application rates considered in this model. Therefore it was not unforeseen that demand on the potable water system for open space irrigation at some time would be expected.

This irrigation model illustrates that the draw on potable water supplies for irrigation of open space areas is either 8.39ML or 41.40ML for the duration of the Township's development. Both options appear to illustrate a zero annual irrigation water deficit therefore have no draw on the potable water system once development is complete. Peak monthly demands are either 8.39ML or 13.55ML respectively dependent upon the regime adopted of stormwater storage rollout.

As suggested in Section 3.4.4, the draw on potable water to meet the irrigation water deficit for the Neighbourhood 1A alone is 23.75ML for the period January 2011 to April 2017. Therefore Neighbourhood 1A would command 57% of the potable water extraction to satisfy the irrigation demands.

3.6 Irrigation Infrastructure

The recycled water reticulation network will pass all allotments and be able to serve all open space areas by conventional service tie connections to the recycled water mains. However given the proposed system for Googong includes separate rising mains to the recycled water storage and gravity delivery mains, the optimum outcome for infrastructure to deliver the stormwater to the

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irrigated areas is best achieved when the source is nearest the demand. Dwg C09029-IRR03 (Appendix D) illustrates the potential additional water infrastructure required to service the open space irrigation areas.

The irrigation water infrastructure depicted in Dwg C09029-IRR03 (Appendix D) includes pumps at the source and underground water mains within the open space or road reserve. The drawing does not illustrate, nor does this report present, the typical irrigation networks within the open space land or on lots to apply the water to the land. This section details the additional civil infrastructure required to deliver water to the irrigation area not apply the water to the landscape.

Temporary irrigation water mains are proposed from the larger Montgomery Creek storages west along the Googong Avenue to the Recreational Reserve A in NH1A. It is expected that this temporary main would be placed within the median within the road reserve which provides an option to deliver stormwater to the Recreational Reserve A or to the high value initial parts of the Googong Avenue. This infrastructure could also provide an ability to transfer stormwater from the Montgomery Creek catchment into the Googong Creek catchment, and hence maintaining water levels in DR A, for the first land release in NH1A. Additionally a temporary main could be constructed from DR A in an easterly direction to the Entry Reserve for greater water supply security for this parcel of land given it will become a secondary entrance to the development in the initial years of the project.

The significant, in terms of length and therefore cost, permanent irrigation water mains are proposed within the Googong Common delivering water to the many recreational reserves in this parcel of land extracted from the Montgomery Creek storages which are also located within the Googong Common. Location of this main is less of a constraint to the urban layout and hence the length could alter significantly once the design of the Googong Common is certain. However being located wholly within open space, design and construction of this pipeline will be less problematic and pose less of an encumbrance on urban/landscape design than the Googong Avenue temporary main.

Seven pumps will be required to extract the stormwater from the surface water storages and distribute it around the site.

Infrastructure required for the non permanent irrigation areas or establishment areas such as verges can either include a polyethylene pipe system laid on the surface which would include sprinkler heads directly on the main or be applied to the surface directly from a water cart. It would be expected that given the temporary nature of this activity, connection of the temporary surface polypipe system to the recycled water main would be via mobile hydrant standpipe which are metered.

In addition to the infrastructure suggested above, it may be feasible for an inlet into the sewage collection network at Sewerage Pump Station 1 in Neighbourhood 1A to be constructed to accept stormwater from the nearby WQCP. Whilst it is not in the scope of this report to design the sewerage network or design the WRP, the proposition is a cost effective (in infrastructure construction costs) method of optimising non potable water supply through the recycled water system. Others would need to verify that the operating systems of the WRP & IWC are not compromised by the potential additional hydraulic load under this arrangement.

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3.7 Appraisals of Construction Costs

3.7.1 Civil Infrastructure

The opinion of cost for the additional infrastructure for the irrigation system as presented in Dwg C09029-IRR03 (Appendix D) would be in the order of $1.1M (ex GST) based on 2009 rates with no account for staging. This opinion of cost includes 4,900m of underground polyethylene pipe and seven pumping stations with rudimentary controls without telemetry.

Given the extent, or lack thereof, of urban planning design undertaken in Neighbourhoods 3-5, the opinion of costs presented above should be used with caution for if the distribution of irrigated areas is more widely spaced and all areas require irrigation mains to those areas, the cost will obviously rise.

3.7.2 Temporary Establishment Infrastructure

A main factor of spikes in the irrigation demand is attributed to the establishment phase of the open space areas at the end of civil construction, where 500mm of water is applied to the area over two months. The equipment and materials required to apply water in this period is not suggested as an additional cost over the general landscaping rate for irrigated grassing, however it is warranted for dryland grassing if a greener final landscape product is required than what natural rainfall typically produces. Therefore to install, maintain (for a two month period) and remove a temporary above ground polypipe system to irrigate say verges where there is not a permanent irrigation system, the order of costs are approximately $2/m2 or $20,000/ha (ex GST) and exclude water charges.

3.7.3 Water Cart Costs

It is inconceivable that an alternative method of moving irrigation water around the site would be employed at such a scale of the desired irrigation areas at Googong, however Water Carts offer a more flexible method of applying water to establish grass over piped sprinkler systems. For the application of the 500mm of water during the two month establishment period, costs for a Water Cart to load and then disperse water from the streets onto verges would be in the order of $27,500/ha (ex GST). This opinion of cost assumes that the water cart will extract water from charged water mains in the verges via hydrant and standpipe. Again this figure excludes water charges and would increase if the water cart must extract water from a surface water storage instead of the hydrants.

3.7.4 Sprinkler Irrigation Costs

Whilst it is not within the scope of this report to determine the cost of detailed sprinkler systems for open spaces, it is however prudent to mention the order of costs for provision of sprinkler irrigation to open spaces for discussion purposes. EDAW/AECOM, the Projects Landscape designer have suggested that a rate of $10-18/m2 or $100,000 - $180,000/ha (ex GST) is an applicable rate for planning of irrigated open space by sprinklers. However a recent project in the ACT of sprinkler irrigated verges returned a rate of $57/m2 or $570,000/ha for 0.3ha of verge irrigation. The ACT project was a brown field medium density residential and commercial redevelopment of high value. Hence the rate could be considered to be high. Therefore it is proposed to adopt the $18/m2 rate from EDAW/AECOM for feasibility and planning purposes.

3.7.5 Potable Water Charges

Notwithstanding that the price of water to Googong is likely to be different to either Queanbeyan or the ACT given the dual water supply system is a key principal of the Googong Township, this report presents figures for costs of potable water supply/consumption to meet the irrigation deficits for discussion purposes only. Queanbeyan City Council's current rate for supply of potable water over the first 44kL in a quarter is $2.44/kL. Hence the cost of potable water to meet the irrigation deficit over the duration of the projects construction would either be approximately $20,500 (ex GST) or up to $101,000 (ex GST) dependent on which model of stormwater storage rollout and extraction

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regime was adopted. Upon completion of the project there would be no charge for potable water as at that stage of the project there is no demand for potable water to satisfy the irrigation demands.

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4 Conclusions

4.1 Irrigation Areas

The total area of open space land under permanent basis considered in this report totalled 44.91 hectares. Other areas of open space which require irrigation to establish the vegetation, namely verges totalled 82.79 hectares, however this summation of area is not irrigated at any one time, but contributes to the peaks in irrigation demands.

4.2 Irrigation Rates & Demand

Application of water for irrigation of open space modelled in this report was 568mm per annum for Playing Fields, 418mm per annum for Parks, Verges and other open space and 459mm per annum for High Value Streetscape/Garden beds and planters which mainly occur within the civic spaces. These application rates compare to the annual average rainfall for the site of 614.7mm
Peak monthly irrigation demand was found to be 54.86ML in February 2024. Final year annual irrigation demand was found to be 228.08ML with a peak monthly demand of 33.27ML in the summer months.

4.3 Recycled Water

Generation of recycled water increases as the Googong Township develops and is occupied, however the amount of recycled water available for irrigation is not sufficient to satisfy the irrigation demand as the sole supply. Scenarios of on lot recycled water uses were considered in this report to test the sensitivity of alternatives of supply, however the scenario of all indoor and outdoor on lot recycled water uses has been adopted in this report as the expected regime for the Township. It was found that the completed development will produce 30.26ML per month (or 363.16ML per annum) excess recycled water which can be made available for irrigation of open space areas.

4.4 Stormwater

Stormwater alone was found to be unable to satisfy the irrigation demand of the development. Surface water storages of stormwater runoff, either dams or water quality control ponds, were then investigated to supplement the recycled water supply to reduce the irrigation water deficit. A total storage volume of 64.4ML distributed throughout the site is believed to be able to supply on average 15.0ML per month for irrigation purposes. Whilst there are greater volumes available in the stormwater system, limiting the extraction depth of the water bodies is suggested for aesthetic reasons in the completed development, although staging of the extraction depth of the stormwater storages is proposed to optimise the available stormwater for irrigation purposes.

The proposed total effective volume of all stormwater bodies to be utilised for irrigation purposes considered in this report appears not to exceed the Maximum Harvestable Right volume for the Googong Property excluding the Hamlet lands. The N.O.W. were consulted on the issue of the MHR and irrigation using stormwater resources within the property and further consultation is required with the N.O.W. to confirm arrangements of this resource.

The timing of control of the large existing stormwater storage on Montgomery Creek in Super Lot C is a concern as there is a potential 18 month delay from when the storage is needed for irrigation to when CIC obtain direct control of this storage facility. Thus the use of the recycled water reservoir for the storage of stormwater is a potential remedy for this period however may affect capital expenditure timing and require additional pumping facilities.

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4.5 Irrigation Water Deficit

Regardless of the stormwater body operating regime, there will always be a deficit of irrigation water without another source of water. Two scenarios of stormwater management were considered in this report and found that the irrigation water deficit over the life of the project would amount to either 8.39ML or 41.40ML, with monthly peaks of 8.39ML or 13.55ML respectively. At the conclusion of the development it was found that there will not be an annual irrigation water deficit.

Neighbourhood 1A subdivision alone was found to illustrate a peak monthly irrigation water deficit of 5.35ML with a total draw on the potable water system of 23.75ML or a maximum of 57% of the total Googong draw on the potable water for irrigation purposes.

4.6 Infrastructure & Opinions of Cost

In order for the stormwater to be distributed to the open space areas, 7 pumps and a minimum of 4,900 metres of pipe work would be required. Given the uncertainty in urban design in Neighbourhoods 3 -5 it is expected that at a minimum $1.1M (ex GST) will be required to provide the infrastructure necessary to distribute the stormwater to open spaces as an supplementary supply to the recycled water network.

Opinions of cost for works for establishment of non permanent irrigated areas resulted in $20,000/ha (ex GST) for temporary surface laid polypipe sprinkler systems or $27,500/ha (ex GST) for water cart watering of verges.

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5 Recommendations

This report presents a model of irrigation of open space over a time span of 28 years of which 23 years there would be highly variable demand for irrigation water. Given the nature of projects of such scale as the Googong Township and the propensity for construction times and development horizons to alter, it is recommended that the Developer adopt the area of irrigated landscape as suggested in this report and reassess the performance of the system within the initial 5 years of the Development's construction. Irrigation water application rates will vary with seasonal changes in rainfall, however the irrigation application rates presented in this resort are not vastly dissimilar to typical application rates suggested by others. Therefore it is recommended that the application rates adopted as the starting point and assessed again in the future.

Recommendation 1 – Adopt irrigation rates as suggested in this report and reassess after a few years of irrigation

At the crux of this investigation is the landscape species themselves. Whilst not discussed in this report it would be a key recommendation that the project vigorously consider the species selection nominated for the landscaped areas which thrive on low amounts of water. It is understood that other studies into the IWC at Googong have considered essentially landscape treatments requiring minimal water application to survive and have contributed to the IWC water balance.

Recommendation 2 – Priority be given to plant species requiring low volumes of water to be sustained within the Googong environment

For security of stormwater supplies for irrigation water to supplement the recycled water system, it is proposed to engage with the current land holder of Super Lot C to broker an agreement to use stormwater from the existing Dam on Montgomery Creek. In parallel engage with N.O.W. in regard to approval and limitations of the MHR for the property in particular the establishment of the proposed additional on line dam on the Montgomery Creek. It is therefore recommended that the project immediately discuss with the N.O.W. for such a reservoir under the banner of obtaining the MHR for the Googong Property. Timing of the surface water reservoir is vitally important being the major catchment within the site and possessing the greatest potential stormwater supply.

Recommendation 3 – CIC immediately negotiate with the landholder the use of stormwater currently stored and captured by the existing 10ML dam on Montgomery Creek.

Recommendation 4 – Immediately engage with the N.O.W. to:

c) confirm the MHR for the whole of the development, and

d) confirm involvement of Environment ACT in the planning procedures in relation to the WQCP and use of water contained within the WQCP

Further security of stormwater storages should entertain the potential use of the 8.0ML recycled water reservoir on Hill 800 to store stormwater whilst the recycled water production is developing, however this will require larger and upfront pumping facilities, than what would have been provided otherwise and may not be economically advantageous when compared to filling the recycled water reservoir with potable water.

Recommendation 5 – Participants in the IWC confirm that collection, transfer and storage of stormwater, from the surface reservoirs, within the recycled water network are an acceptable solution.

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To distribute stormwater around the site for irrigation purposes, it is will be necessary for the project to include at least $1.1M (ex GST) additional funding for temporary and permanent irrigation mains and pumping stations and thus it is recommended that this be incorporated in the design of the subdivision.

Recommendation 6 – CIC include at least an additional $1.1M (ex GST) to civil works budgets for irrigation civil infrastructure.

To reduce costs of establishment of verge landscaping without permanent irrigation systems, landscape contracts should include the provision of temporary pipe sprinkler networks as an alternative to higher cost distribution of irrigation water by water carts.

Recommendation 7 – Include temporary irrigation of landscape areas in landscape works contracts, such as irrigating of dryland grass

Finally it is recommended that detailed daily time step modelling of stormwater storages, particularly of the existing and proposed Montgomery Creek reservoirs, be undertaken on actual climate data to illustrate in greater detail the fluctuations of stormwater irrigation water supplies within the reservoirs through periods of drought.

It would also be prudent to model the fluctuations in volume within the recycled water reservoir on Hill 800, for at least the period covering the development of Neighbourhood 1A, to illustrate more precisely the interaction of the gradual increase in recycled water generated and the extraction of stormwater from surface water storages into that system.

Recommendation 8 – Complete daily time step modelling of water storages contributing to the irrigation demand.

Brown Consulting (ACT) Pty Ltd

May 2010

Ph: 6211 7100 Fax: 6211 7199

Appendix A – Googong Yield, Land Budget & Neighbourhood 1A Layout

Googong Yield Plan
(Source Roberts Day Yield Plans - UD1505 Overall Yield K 010709 1)

Land Budget
(Source Roberts Day Spreadsheet file UD4903 Googong Overall Yield M 080909 dated 08/09/09)

Neighbourhood 1A Layout
(Source – Brown Consulting (ACT) Dwg C08006.1-002+

Googong New Town Riparian Buffer Zones (Creek Categorisation Plan)
(Source - Brown Consulting (NSW) Dwg X07008.02_SK02A – 10/11 2008

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Appendix B - Program

(Source Brown Consulting (ACT) Program - Program Project 25 years, V12, 12Mar10)

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Appendix C – Table 1& Figures

Table 1 – Irrigation Areas

Figure 3 – Irrigation Demands

Figure 4 – Irrigation Demand vs Available Recycled Water (with on Lot Indoor and Outdoor Recycled Water Uses)

Figure 5 – Irrigation Demand vs Available Recycled Water (with on Lot Indoor Recycled Water Uses only)

Figure 6 – Irrigation Demand vs Available Recycled Water (with on Lot Outdoor Recycled Water Uses only)

Figure 7 – Irrigation Demand vs Available Stormwater

Figure 8 – Irrigation Demand vs Combined Available Recycled Water (with on Lot Indoor and Outdoor Recycled Water Uses) and Stormwater (Regime No 1).

Figure 9 – Irrigation Demand vs Combined Available Recycled Water (with on Lot Indoor and Outdoor Recycled Water Uses) and Stormwater (Regime No2).

Ph: 6211 7100 Fax: 6211 7199

Appendix D – Drawings

Drawing C09029-IRR01 – Open Space Irrigation Areas.

Drawing C09029-IRR02 – Potential Surface Water Storages

Drawing C09029-IRR03 – Irrigation Network Stormwater Supply

Ph: 6211 7100 Fax: 6211 7199