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WATER MANAGEMENT
COMBERTON GRANGE
SOUTH NOWRA

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Report No. C0110590-RPT2.03
Prepared for Shaolin Temple Foundation (Australia)

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B	General	General update
C	References	Updated and additional references added
	Section 5.5	Description of treatment train expanded.
	Section 5.5	Section rewritten and expanded to include diagrams and examples.
	Section 5.6	New section added
	Appendix A	Drawings updated to new layouts.
	Appendix B	Typical GPT locations added
	Appendix B	Typical basin locations amended and additional basins provided.
	Drawing C4-03, Appendix B	Typical detail of water quality controls at golf course added.

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Date: 5 Sept 2012

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REFERENCES

Brown Consulting (NSW) [2012] – *Site Specific Flood Study – Proposed Shaolin Temple Project, Comberton Grange, South Nowra* – Prepared for Shaolin Temple Foundation (Australia) – Report C0110590-RPT1.03 dated May 2012

Douglas Partners [2009] – *Draft Report on Preliminary Geotechnical Investigation – Proposed Tourist & Residential Development, Comberton Grange, Jervis Bay* – Prepared for Shaolin Temple Foundation (Australia) – Report 48670.02 August 2009

Umow Lai Consulting Engineers [2010] – *Shaolin Tourist and Residential Development, Comberton Grange – Hydraulic Services Infrastructure Concept Report* – Report S.STF-0101-R01 Rev D 14 February 2012

Landcom [2004] – *Managing Urban Stormwater: Soils and Construction* – 4th Edition, 2004

Institution of Engineers, Australia [2006] – *Australian Runoff Quality – A Guide to Water Sensitive Urban Design* by the National Committee for Water Engineering 2006

United States Environmental Protection Agency [2010] – *Golf Courses Nitrogen Management Challenge* – http://www.epa.gov/Region2/p2/nitrogen_management/

1 INTRODUCTION

Shaolin Temple Foundation (Australia) proposes to develop a site at Comberton Grange, South Nowra for tourist and residential purposes. A master plan has been developed by Conybeare Morrison architects, and an application was made to the Director-General of the Department of Planning for the requirements to be addressed in an Environmental Assessment of the proposed development.

The Director-General's Requirement (DGR) Number 9 is entitled Water Cycle Management and Water Quality and includes the following:

9.0 WATER CYCLE MANAGEMENT & WATER QUALITY

9. Water cycle management and water quality (DGRs)

9.1 Prepare an integrated Water Cycle Management Strategy for the overall development which considers water supply, sewage, stormwater and catchment management interactions of the urban water cycle issues.

9.2 Address **stormwater management**, based on WSUD principles, which addresses impacts on the surrounding environment, drainage/ on-site detention and water quality controls for the catchment, erosion and sedimentation controls at construction and operational stages.

9.3 Assess **impacts of proposal on surface and groundwater hydrology and quality** during construction and occupation of the site, and adequate protection of receiving waters, including SEPP 14 Wetlands and groundwater aquifers.

4. **Stormwater issues (Shoalhaven City Council)**

- Measures for collection/ control of stormwater should be outlined in detail. Address how the adjoining lands (in particular Currambene Creek and Georges Creek) are to be protected from any pollution and runoff during the construction and operation of the proposed development (each component).
- The development should provide for Water Sensitive Urban Design (WSUD) principles having regard to nutrient/ pollutant loads in stormwater runoff from developed areas being maintained equal to or less than those of the developed site.
- Provide stormwater design and quality control measures (post development). Ensure collection of stormwater from all hard surfaces (including off roads) is clear of debris and pollutants prior to discharge from site so as not adversely impact on water bodies and adjoining land.
- Stormwater quality devices shall be incorporated into the stormwater design. The design shall include:
  - Engineering details, calculations, plans, specifications and maintenance programs for permanent stormwater quality devices to collect pollutants that will be generated post development. Pollutants will include litter, debris, sediment, oil, road grit etc.

  - Stormwater runoff from the development shall be provided such that the discharge from the site for design events up to and including the 100 year average recurrence interval does not exceed the capacity of existing stormwater infrastructure. Submit a design with associated hydraulic information investigating exiting catchment characteristics, flow paths, tributaries, discharge areas, etc. Demonstrate how the collection and disposal of stormwater runoff from all impervious surfaces can be conveyed without adverse impacts on the surrounding environment.
  - Stormwater water treatment device(s) shall have performance criteria in excess of 90% of litter, floatable debris, organic debris, course sediments, suspended solids, road grit and oil of gross stormwater pollutants.
  - Size the proposed device to ensure the hydraulic capacity and pollutant storage capacity shall be considered for the developed site catchment area.
- Provide for on-site detention for the development to maintain stormwater discharge for all storm events up to and including the 1:100 ARI to pre-development levels.
- All stormwater design to be in accordance with Council's DCP 100.
- All drainage systems, onsite detention, stormwater quality improvement and WSUD devices to remain in private ownership.
- Stormwater designs to be provided with life cycle costs for ongoing maintenance including expected age to decommissioning and reconstruction.
- Reuse stormwater and roof water.

Recommendations (SCC):

4(a) Preparation of **Stormwater Management Plan**, providing:

- Concept designs for collection of stormwater from all hard surfaces;
- Onsite detention for all stormwater events up to and including 1:100 ARI to pre-development levels (and supporting calculations);
- Identify drainage and discharge points;
- Identify treatment methods use to maintain water quality (i.e. clear of debris and pollutants prior to discharge);
- Details of management of runoff water from gold course (i.e. fertilisers and pesticides);
- Details of management of mosquitoes (in relation to onsite stormwater detention).

12. **Nutrient impacts (SCC):**

Consideration to be given to the potential nutrient impacts from the golf course component of the proposed development and measures that can be implemented to mitigate these impacts and ensure a nil impact upon water quality.

12. **Erosion and sediment control (SCC):**

An Erosion and Sediment Control Plan (for each stage of construction) to be prepared in accordance with Managing Urban Stormwater: Soils and Construction, Landcom, 4th Edition, 2004.

1(f) **Climate Change:**

As the subject land is partially identified as being flood liable, the potential effect of future climate change should be considered, in particular potential changes to flooding regime and foreshore erosion.

Assess the performance standards for improvement or maintenance of the water quality of Currambene Creek and the surrounding environment.

On behalf of Shaolin Temple Foundation (Australia), Conybeare Morrison engaged Brown Consulting (NSW) to investigate and prepare a report addressing the above DGRs.

2 SITE DESCRIPTION

The proposed Shaolin Tourist and Residential Development is located at Comberton Grange, approximately 12km south of Nowra and 2km east of the Princes Highway, within the boundaries of Shoalhaven City Council.

The site comprises approximately 1,284 hectares and occupies seven separate parcels of land. The site is bounded on the south by Currambene Creek and is traversed by Georges Creek and its tributaries. Currambene Creek discharges to Jervis Bay at Callala Beach. Most of the site drains towards these creeks, although a small portion on the eastern side drains towards the upper reaches of Bid Bid Creek.

The site contains a former pine plantation of approximately 170 hectares and a further 110 hectares (approximately) has been cleared on ridges overlooking Currambene Creek. About 75% of the site is covered by forest, woodland and wetlands.

The landform can be generally divided between riparian and forest zones. Creek slopes at the lower reaches of Georges Creek are generally mild, with broad overbank areas and bed slopes of less than 0.1%. In the upper reaches and in the tributaries, the bed slopes increase and may be classified as steep mountain streams, with narrower overbank areas and bed slopes over 0.4% and up to 1.5% in the study area.

3 STORMWATER MANAGEMENT PLANS

Stormwater Management Concept Plans have been prepared for the proposed development. These drawings, C2-01 to C2-04, have been included in the Appendix to this report. The report will make reference to these drawings in the following sections.

The Stormwater Management Concept Plans show surface contours at 2m intervals, derived from Shoalhaven City Council's GIS (Geographical Information System). They also show the 10-year ARI (Average Recurrence Interval), 100-year ARI and PMF (Probable Maximum Flood) flood lines that have been plotted from the *Site Specific Flood Study – Proposed Shaolin Temple Project, Comberton Grange, South Nowra* [2012]. That flood study has been prepared for planning purposes only, and is subject to revision as detailed field survey becomes available. The flood study identifies flood hazard zones in general terms as follows:

(a) The High Hazard Flood Storage zone is located in the lower reach of Georges Creek and is generally bounded by the 10-year ARI flood line and a point approximately 2.7km from the confluence with Currambene Creek. This zone is visible on drawing C2-04 only. It typically represents areas that are more than 1m deep.

(b) The High Hazard Floodway zone extends upstream from the Flood Storage Zone and is generally bounded by the 10-year ARI flood line in Georges Creek and its two tributaries within the site. Tributaries 1 and 2 are shown on the masterplan drawing 07062-MP-21 flowing roughly from west to east. The High Hazard zone in Tributary 1 terminates at the left edge of the drawing. This zone typically represents areas with higher velocities.

(c) The Low Hazard Flood Fringe zone extends between the High Hazard zone and a line defining a level 500mm higher than the 100-year ARI flood line. This is the nominal Flood Planning Level. However, in the upper reaches of Georges Creek Tributaries 1 and 2, the PMF level is less than 500mm above the 100 year ARI flood level. In this case, the low hazard zone would extend to the PMF line.

The plans show that all developed areas are above the PMF line, with the exception of roads crossing the waterways. These roads may potentially affect flood levels immediately upstream and downstream of the roadway crossing. These potential impacts must be modelled in the updated flood study as part of the detailed design process, to ensure that localised increases in flood level do not affect developed areas.

4 WATER CYCLE MANAGEMENT

Umow Lai Consulting Engineers [2012] have prepared a report on Hydraulic Services for the proposed development, which deals with reticulated water supply and sewerage. It also made recommendations for the storage and reuse of stormwater on site. This report should be read in conjunction with that report.

4.1 POTABLE WATER

The Umow Lai report proposes the extension of reticulated potable water from an existing 450mm trunk water main which services the Callala Beach and Callala Bay areas. This water main crosses the eastern end of the site, and the point of connection would be adjacent to the trunk main crossing at Forest Road. A reservoir (estimated to hold 1,200 kL) will need to be constructed at a high point on the site. The proposed location of this storage is shown on the master plan drawing 07062-MP-21 in the Information Precinct as two 12m diameter water tanks. The ground level in this area is approximately RL28.5m, which is not high enough to provide the required residual mains pressure. Accordingly, the tanks must be elevated or pressure must be elevated using booster pumps.

4.2 NON-POTABLE WATER

The Umow Lai report estimates that approximately 65% of the site's water demand could be serviced with non-potable water. The bulk of this water demand is for irrigation of landscaping and the golf course, and it is proposed that this be sourced from Shoalhaven City Council's Reticulated Effluent Management Scheme (REMS). The REMS supply is located some 4km from the proposed development. The treated effluent is suitable for irrigation purposes.

To supplement this supply, site stormwater runoff is proposed to be retained for re-use in two ways:

(a) Roofwater

Roofwater will be collected for reuse on all buildings.

In the Temple Sanctuary Precinct, rainwater tanks will be located beneath the ground level of the residential accommodation buildings and the prayer and assembly halls.

In the Educational and Village Centre Precincts, rainwater tanks will be located in each building.

In the Residential Precincts, rainwater will be collected in individual tanks. Overflow from rainwater tanks will be directed through inter-allotment drainage to communal storage ponds for use as irrigation to communal gardens.

Roofwater that is not used for irrigation will be filtered and primarily used for toilet flushing.

(b) Surface Water

Surface water will be collected in basins located above the 100-year ARI flood line. Indicative locations of such basins are shown on the Stormwater Management Concept Plans. These basins serve three purposes, as described in detail in the following Section 5, and the primary purpose will vary depending on the location and the nature of the runoff into the basin. Generally, water harvesting will be limited to basins for which the stormwater runoff travels across undeveloped catchments, and the harvested water will primarily be used for irrigation purposes. Typical locations of basins for irrigation are associated with the golf course and the landscaped areas around the Buddhist Temple Sanctuary Precinct.

These alternative sources would reduce the demand for potable water, but would have no impact on sewage flow rates.

4.3 SEWERAGE

The Umow Lai report notes that Shoalhaven City Council's sewer pressure main is located approximately 6km from the proposed development. The report proposes that the site be serviced by that sewer main. This would require the construction of gravity mains collected by sewage pumping stations within the site and rising mains from the pumping stations to Council's pressure main where it crosses Forest Road.

At this time, it is not proposed to treat sewage on site for potential reuse as non-potable water.

5 STORMWATER MANAGEMENT

5.1 FLOODING

The Stormwater Management Concept Plans show the extents of flooding in Currambene Creek, Georges Creek and its two major tributaries. All buildings are sited well away from and above the plotted flood lines.

There are many other minor natural channels that drain towards these larger waterways. As the volume of water conveyed by these lateral channels is not great, they are not considered as floodways but as overland flow paths. Development in the vicinity of overland flow paths must have floor levels with freeboard above the overland flow, to the standards of Shoalhaven City Council.

5.2 IMPACTS ON SURFACE HYDROLOGY

The proposed development will increase the area of impervious surface within the catchment. This has the potential to increase the volume of runoff, the peak discharge rate, and the frequency of peak discharge.

The impervious area has been estimated as 455,800 sq metres, broken up as shown in the following Table 1. For residential areas, the roofed area has been taken as 60% of the allotment area. This is considered to be conservative, as allotments are relatively large.

Type of Impervious Area	Area (sq. m.)
Roadways	157,400
Roofed areas - Residential	176,600
Roofed Areas - Other	62,800
Car parks	35,400
Other areas (paths etc)	23,600
Total	**455,800**

Table 1. Impervious Areas

This represents approximately 3.55 % of the total site area of 1,284 hectares, and approximately 2.4% of the 1,897 hectares catchment of Georges Creek.

The increased runoff from the impervious portion of the site has been estimated by the Rational Method, assuming a typical Time of Concentration of 10 minutes, in the following Table 2. All flows are in cumecs (cu.m./sec). For comparison purposes, peak discharges in Georges Creek determined in the Site Specific Flood Study [2012] are also included.

Average Recurrence Interval	**10 years**		**100 years**	
Storm Duration	10 mins	12 hrs	10 mins	12 hrs
Before Development	17.2	1.57	27.8	2.92
Post Development	12.4	1.13	21.7	2.28
Increase (cumecs)	**4.8**	**0.44**	**6.1**	**0.64**
Peak Discharge Georges Ck		**103.5**		**160.6**

Table 2. Increased Runoff

Thus the increased runoff from development, if not reduced by rainwater harvesting or on-site detention, represents 0.4% of the total creek flow in the critical flood events. However, the percentage increase in flows would be greater for shorter duration storms which do not produce highest flood levels.

The Site Specific Flood Study [2012] investigated the effects of climate change. One of the potential impacts is increased rainfall intensity. For an increase of 10% in rainfall intensity over the entire catchment, 100-year ARI flood levels in Georges Creek's tributaries would rise by 20 to 90mm. Therefore the increase in flood levels caused by a 0.4% increase in runoff would be less than 4mm which is less than the accuracy of the model – in effect, the flood modelling would not be able to detect any difference.

The hydraulic criteria for providing on-site detention are the following:

1. Minimising surcharge of existing stormwater infrastructure and
2. Preventing increases in flood levels upstream or downstream of the site.

The effects of increased runoff from the site have minimal effect on flood levels upstream of the site. This is because the creeks are relatively steep and backwater effects would not extend far up the creek. The calculations also confirm that the increases in flood levels at or downstream of the site are negligible. There is no existing stormwater infrastructure that could be affected by increased discharges from the site. Accordingly, OSD is not required for hydraulic purposes.

Control of peak discharges to pre-development levels is desirable however for other reasons, relating to the ecology of the riparian system. Higher discharges or more frequent discharges change the flow regime in natural channels which can affect the ecosystem. In this case, the increased flows are relatively minor, and detention for the sake of ecosystem balance alone is not considered warranted. However, stormwater detention or retention is warranted for the control of pollutants and their impact on the ecosystem. This will be discussed in Section 5.4.

5.3 IMPACTS ON GROUNDWATER HYDROLOGY

It is known that the site is underlain by coastal sands aquifers and alluvial aquifers, which are a potential source of groundwater. There are no plans to draw water from these aquifers at this time, and no detailed investigation has been undertaken to determine potential yield.

The preliminary geotechnical investigation by Douglas Partners [2006] reveals that the site is generally underlain by clays overlying shales and sandstone. As such, the site would not provide significant potential for groundwater recharge. Groundwater was not noted in the test pits which were taken to depths of approximately 3 metres. Accordingly, groundwater inflow should not be a consideration in building design or construction, and dewatering, if required for construction, would be minimal.

5.4 IMPACTS ON STORMWATER QUALITY

The proposed development has the potential to generate pollutants which could contaminate surface runoff, and these contaminants could enter the natural streams with consequent negative impacts on their ecosystems.

Pollutants may consist of both suspended solids and dissolved nutrients. Suspended solids are typically generated from hard surfaced areas. Dissolved nutrients are typically generated from landscaped areas where fertilizer has been applied.

The treatment of surface runoff to remove pollutants is divided into three stages, as shown in the following diagram from Australian Runoff Quality [2006].

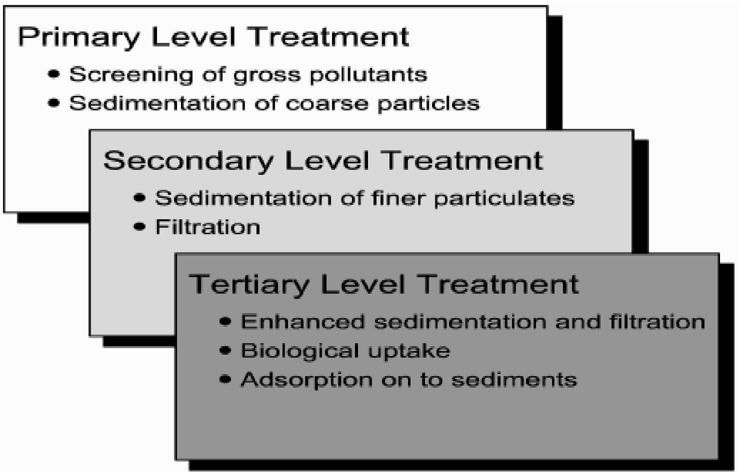


Figure 4.3 Levels of treatment:[1]

[1] Extracted from Australian Runoff Quality, Chapter 4 Water Sensitive Urban Design.

The first or primary stage is screening of the stormwater to remove transported solids such as paper, plastics and cigarette butts. This is best carried out in Gross Pollutant Traps (GPTs) which will be provided at the point of discharge from hard landscaped areas and car parks. GPTs also remove sediments, oils and nutrients that become attached or absorbed by solid matter that has been trapped by screening, but these are secondary to their main function of litter entrapment.

The second stage is settlement of solids and separation of oils by flotation. This is best carried out in sedimentation chambers attached to GPTs. As the efficiency of sedimentation increases with reduction of stream velocity, the size and configuration of such chambers must be designed to suit the catchment being treated.

The third stage is the absorption of nutrients by vegetation. This is best carried out by bioretention, as discussed in the following section on WSUD.

The combination of these methods should aim to achieve the following minimum standards of pollutant removal.

Pollutant	**Removal and Retention Standard**
Litter (greater than 5mm)	90%
Coarse Sediment (up to 0.5mm)	80%
Fine Sediment (up to 0.1mm)	50%
Hydrocarbons	70%
Total Phosphorus	45%
Total Nitrogen	45%

Table 3. Water Quality Objectives

The percentages quoted refer to the annual average pollutant load for the post-developed catchment. All pollutants that have been captured should be prevented from re-mobilisation on following storm events. Most pollutant control structures refer to a Treatable Flow Rate which should be not less than the “six-month ARI” flow.

In reality the term “six-month ARI” is a misnomer, since rainfall intensities and runoff coefficients are only published for ARI of 1 year or greater. What this standard really means is that the published values should be extrapolated backwards (on a log-graph chart) for an ARI of 0.5. Typically this results in flows of approximately 65% of the 1-year ARI flow.

5.5 WATER SENSITIVE URBAN DRAINAGE (WSUD)

There are a number of publications setting out design guidelines for Water Sensitive Urban Drainage (WSUD). The most widely accepted publication is Australian Runoff Quality by the Institution of Engineers [2006], which should be followed for this development.

The Stormwater Management Plans (SMPs) in Appendix B show indicative locations of gross pollutant traps, bioretention swales and wet/dry basins for water quality improvement.

All stormwater discharging to natural waterways, with the exception of roofwater overflows, should be filtered through GPTs with associated sedimentation tanks and oil separation devices. The positions and sizes of GPTs will be subject to detailed design.

Bioretention swales are designed with a trench filled with filter medium draining to a subsoil drain. The filter medium includes planting which absorbs nutrients and pollutants from slowly percolating water. The following diagram from Australian Runoff Quality [2006] illustrates the concept.

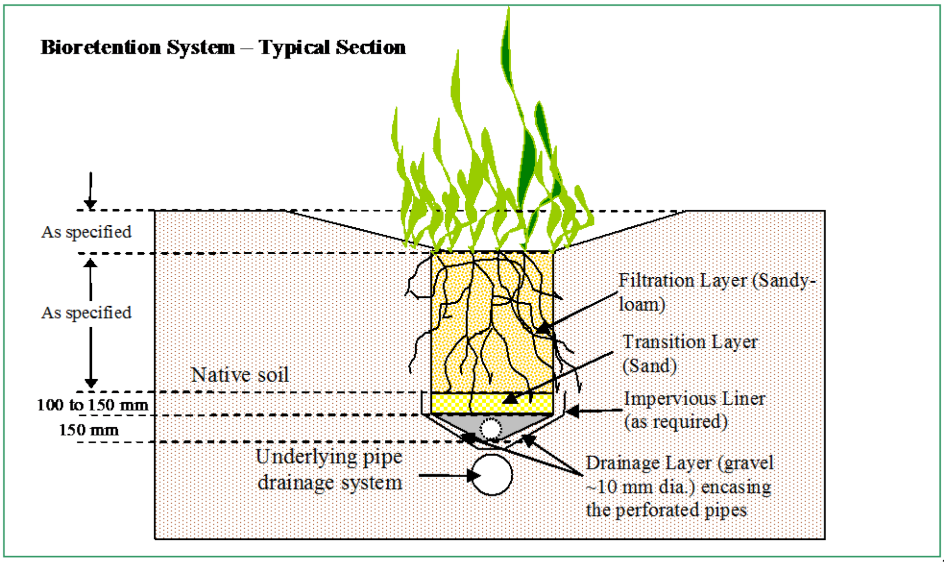


Figure 10.8 Linear bioretention system [adapted from: Ecological Engineering 2003][2]

Wet/dry basins provide for longer retention of stormwater runoff and treatment by wetland vegetation such as reeds and sedges. Basins which only have small upstream catchments would retain water for only a short period of time, and these basins generally have grassy beds and sides rather than wetland vegetation which would not survive extended dry periods. A typical example is shown in Figure 10.10 in Australian Runoff Quality, which has been reproduced on the following page.

[2] Extracted from Australian Runoff Quality, Chapter 10 Buffer Strips, Vegetated Swales and Bioretention Systems.

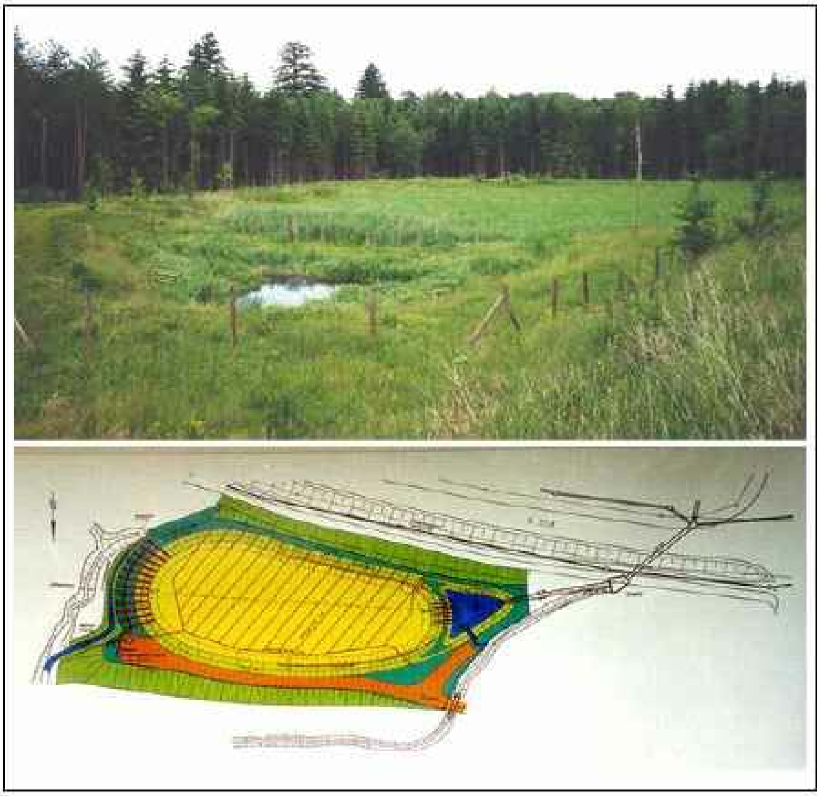


Figure 10.10 Bioretention system constructed on the floor of a flood retarding basin[3]

Generally, bioretention swales have been located on both sides of the main ring road and on the uphill side of all minor roads, where road gradients are 3% or less. At steeper gradients, water would not be retained in swales for a sufficient period of time to allow absorption through the bioretention filter. Bioretention swales are located on the uphill sides of smaller roads so that they can collect runoff both from the road surface and also from the catchment draining to the road.

Wet/dry basins have been shown in natural low points where they can be formed with embankments with minimal excavation below ground level. Road embankments form natural barriers to overland flow, and these make ideal locations for basins where the runoff from roads can be collected before discharging to natural waterways.

[3] Extracted from Australian Runoff Quality, Chapter 10 Buffer Strips, Vegetated Swales and Bioretention Systems.

5.6 GOLF COURSE WATER QUALITY CONTROLS

Golf Courses are a source of potential pollution of nearby watercourses. The main sources of pollutants relate to the use of pesticides and fertilizers for maintenance of landscaped areas, especially turfed fairways, tees and greens. Over-use of fertilizers (including nutrients dissolved in treated wastewater) can result in algal blooms in waterways, which can harm or kill emergent plants and aquatic species such as fish and shellfish. Even in lower concentrations they can result in a change to the balance of plant and animal species in the ecosystem, favouring those biota which thrive in water with higher levels of nutrients and disadvantaging those which have adapted to low-nutrient environments.

Australian Runoff Quality, published by the Institution of Engineers [2006], gives little guidance on water quality controls for golf courses. Its only references to golf courses relate to the use of recycled water on golf courses for irrigation.

In the United States, pollution at golf courses has been recognised and controls have been implemented following a number of state and federal programs for improving the water quality in estuaries. These require the preparation of management plans at golf courses to monitor and reduce the amounts of pesticides and fertilizers used.

For the proposed golf course in this development, a Golf Course Pollution Management Plan (GCPMP) will be prepared as part of the detail design of the golf course. This GCPMP will contain

- Procedures for identification, storage and safe use of pesticides and fertilizers;
- A statement of Commitment to be signed by the Golf Course Management;
- Recommendations to minimise the areas where pesticides and fertilizers are to be used;
- Procedures for recording the usage of pesticides and fertilizers by area and over time;
- Procedures for maintenance of water quality control devices.

The principal method for minimising the use of pesticides and fertilizer usage is to limit their use to nominated areas such as tees and greens, and to select grasses which are pest-resistant and thrive in low-nutrient environments.

Where pesticides and fertilizers are used, treatment methods based on bioretention swales and basins will be used as described in the previous section 5.5. This will involve provision of drainage swales at the edge of the selected area which direct surface runoff to bioretention swales and basins. Where greens have subsoil drains installed, these would discharge to the drainage swales.

The golf course will also include water hazards, which will allow the collection and reuse of rainwater and irrigation water. The location and management of water hazards will be determined with the detailed golf course design. A typical example has been shown on drawing C4-03 in Appendix B.

6 DETAILED DESIGN

This report has been prepared for planning purposes, and therefore does not discuss in detail many factors which would be addressed in subsequent development applications. These are noted and discussed briefly in the following sections. Detailed design, calculations and specifications can only be produced after detailed survey has been undertaken. In addition, detailed design of stormwater drainage associated with buildings will be very much dependent on the building brief.

6.1 INTEGRATED WATER CYCLE

An Integrated Water Cycle Management Plan would be required to address the use and reuse of potable and non-potable water throughout the site. The calculations of water balance and the varied sources of water depend to a great extent on detailed design. For example, a large part of the water usage of the golf course can be collected and reused in water bodies situated throughout the golf course. This requires detailed planning and design of the golf course, which has been shown conceptually in the master plan. Similarly, the volumes of rainwater storage that can be collected and stored within buildings will depend on more detailed building design.

6.2 SEDIMENTATION AND EROSION CONTROL

Control of sedimentation and erosion is essential, especially due to the existence of natural water courses traversing the site. This will be in two parts: during construction and after construction. Controls during construction must be designed with consideration of the nature of soils and the areas disturbed, and design of such controls must necessarily follow detailed design. These measures are normally designed in accordance with the Landcom publication Managing Urban Stormwater: Soils and Construction [2004].

Similarly, controls after construction will primarily involve stabilisation of disturbed surfaces and control of concentrated discharges from the site. These will require coordinated landscaping and civil engineering design.

The preliminary geotechnical report by Douglas Partners [2006] notes that the soils on site are non-saline but highly sodic. Sodic soils have a high erosion potential, although only one of the Emerson Class tests indicated highly dispersive soil. Further testing will need to be undertaken to determine the extents of dispersive soils, which will have an impact on the design of erosion controls and permanent structures on or near watercourses.

6.3 WATER HARVESTING AND REUSE

The Stormwater Management Plans show indicative locations of rainwater harvesting tanks. However, sizes and locations of these tanks are subject to detailed design.

The sizes of water harvesting tanks collecting rainwater from buildings will need to be determined based on a water balance analysis for the specific building use. As the main use proposed for the harvested rainwater will be toilet flushing, those buildings which have a higher occupancy rate would require correspondingly higher volumes of rainwater storage.

Similarly, the size of basins for storing surface water for reuse for irrigation would need to be determined based on such parameters as the area of upstream catchment, the space available for water storage and the space required for side batter slopes.

6.4 STORMWATER TREATMENT

The target standards for pollutant removal have been set out in Section 5.3. Detailed design of GPTs and other WSUD elements would be required to achieve these objectives for each sub-catchment.

6.5 OTHER SOURCES OF WATER

This report does not consider sourcing of water from groundwater or treatment of sewage for non-potable uses, as these are not currently proposed. However, this may change in the future as the economics of this infrastructure change so that the additional capital investment is warranted.

Any such proposals would be addressed with detailed investigations at that time.

7 MITIGATION AND MANAGEMENT MEASURES

This report has outlined the impacts of the proposed development in terms of water use and the discharge of stormwater to natural channels.

Potable water usage will be minimised by the use of non-potable water wherever possible, sourced from Shoalhaven City Council's REM scheme, rainwater harvesting from buildings, and collection of surface runoff from natural surfaces, for example in the golf course.

The quality of stormwater runoff from paved areas will be improved by screening, filtration, sedimentation and bioretention to achieve target standards for removal and retention of both suspended and dissolved pollutants.

On-site detention is not required for the attenuation of peak stormwater runoff to pre-development conditions because of the relatively small increases in discharge and the negligible impacts on flood levels both upstream and downstream of the site. However, the collection of roofwater and surface runoff for reuse, as well as the incorporation of bioretention basins for water quality improvement, will tend to reduce peak discharges.

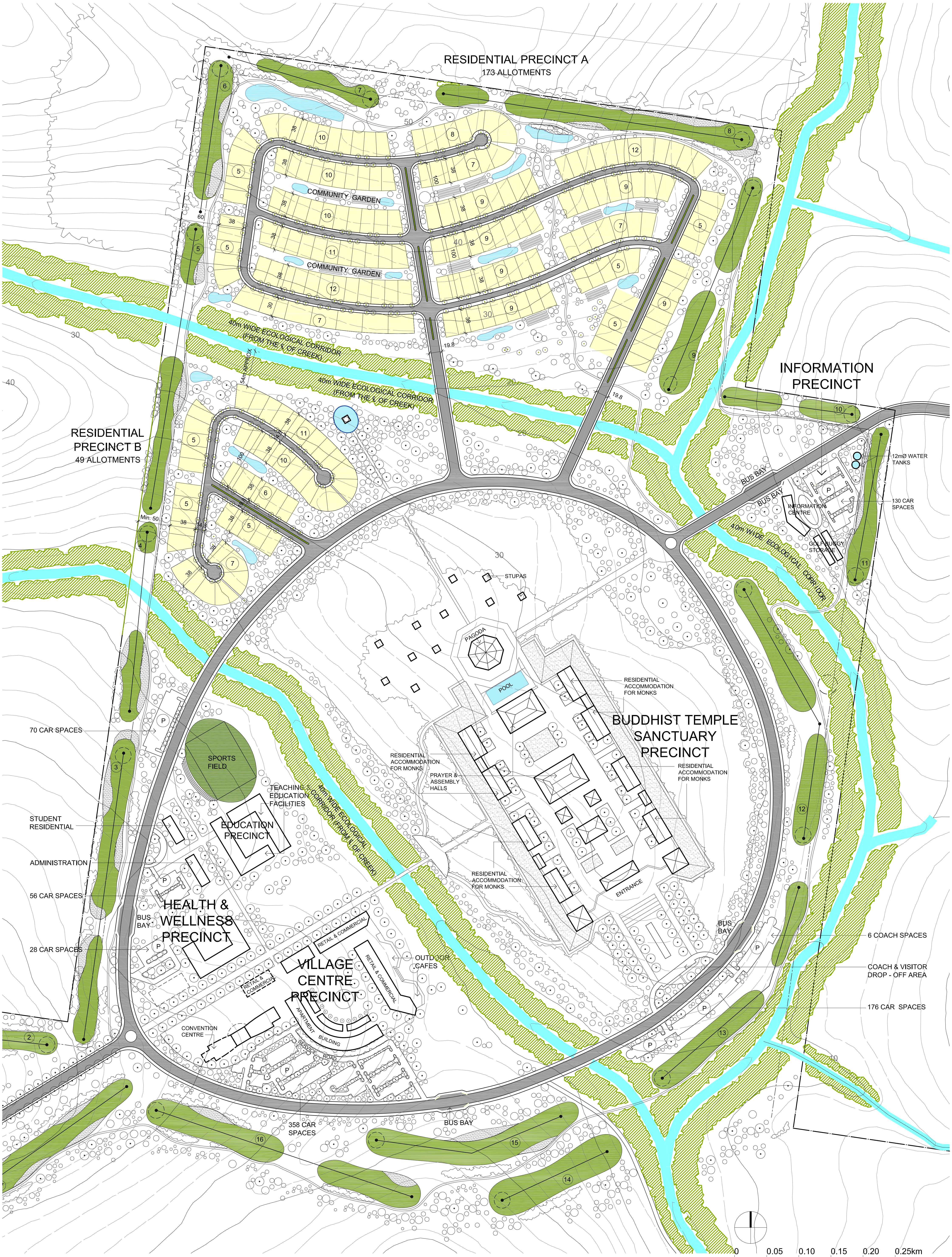
8 APPENDICES

Appendix A	Master Plans
Appendix B	Stormwater Management Plans

APPENDIX A

Master Plans

07062-MP-21	Proposed Masterplan – Part 1
07062-MP-22	Proposed Masterplan – Part 2



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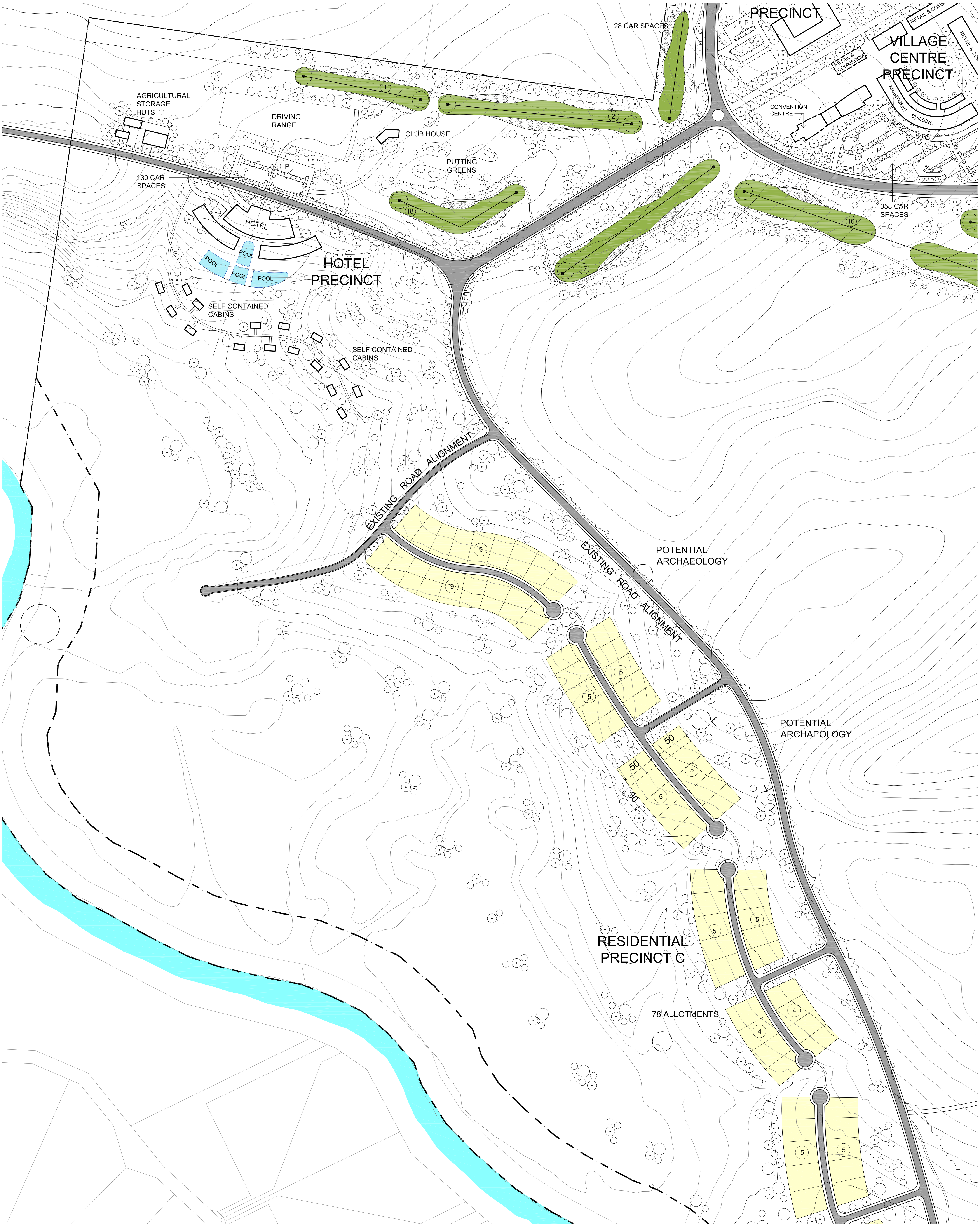
	Shaolin Tourist & Residential Development	Title	Proposed Masterplan - Part 1		
Project	Comberton Grange Nowra NSW	Date	3-Sep-12	Dn/Ch	nj/at
Client	Shaolin Temple Foundation	Dwg No	07062 MP 21	Issue	A



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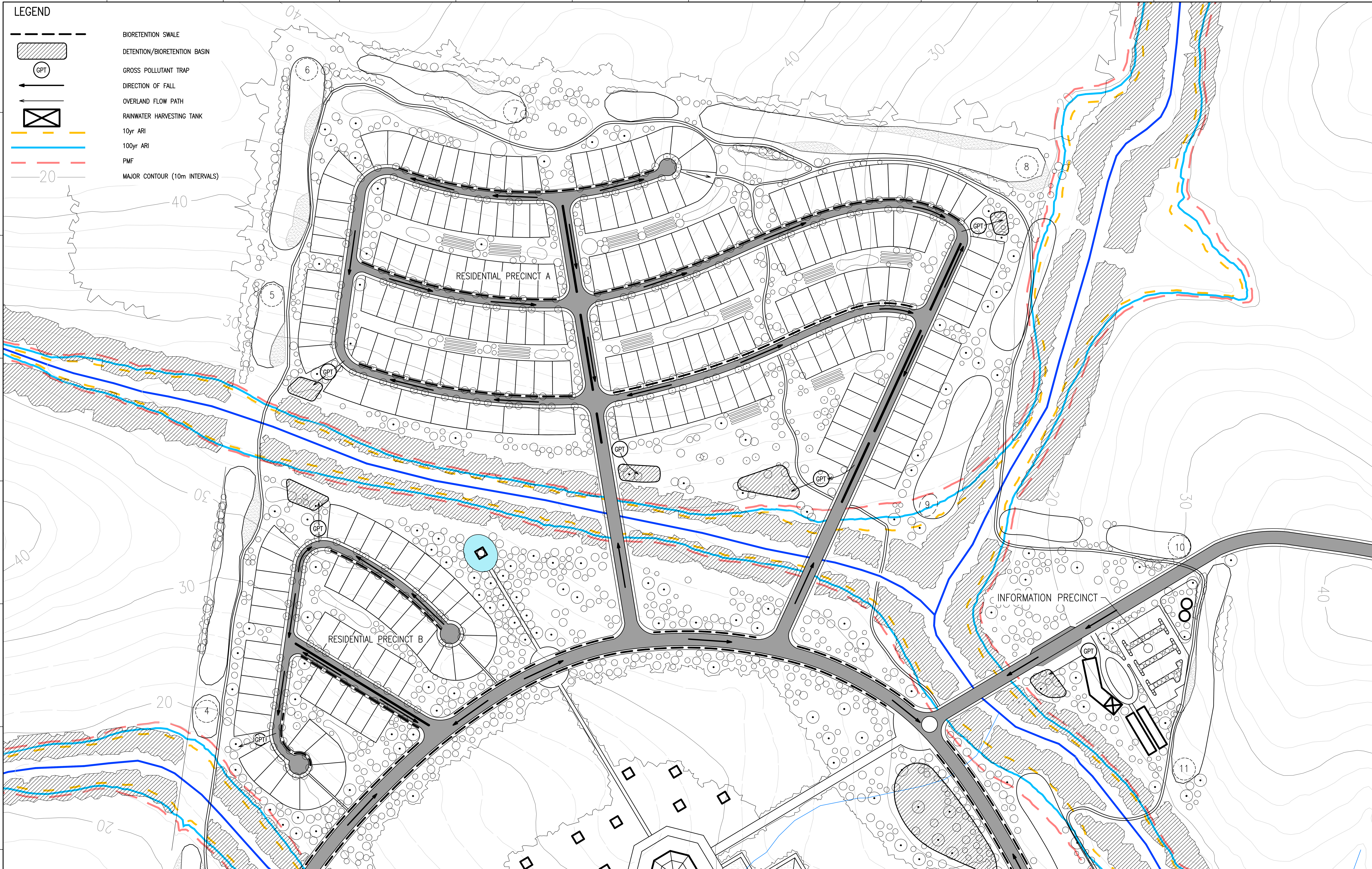
Shaolin Tourist & Residential Development

Project	Comberton Grange Nowra NSW	Title	Proposed Masterplan - Part 2
Client	Shaolin Temple Foundation	Date	3-Sep-12
		Dn/Ch	nj/at
		Dwg No	07062 MP 22
		Issue	A

APPENDIX B

Stormwater Management Plans

C0110590-C4-01	Stormwater Management Concept Plan – Sheet 1 of 4
C0110590-C4-02	Stormwater Management Concept Plan – Sheet 2 of 4
C0110590-C4-03	Stormwater Management Concept Plan – Sheet 3 of 4
C0110590-C4-04	Stormwater Management Concept Plan – Sheet 4 of 4



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Rev	Revision Description	By	App	Date
A	FOR INFORMATION	TO	CV	12.03.12
B	FOR PLANNING APPROVAL	TO	CV	27.08.12

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Client

SHAOLIN TEMPLE FOUNDATION (AUSTRALIA)

Title

STORMWATER MANAGEMENT CONCEPT PLAN SHEET 1 OF 4

Project

SHAOLIN TOURIST & RESIDENTIAL DEVELOPMENT COMBERTON GRANGE SOUTH NOWRA

FOR PLANNING APPROVAL

Date	Design	Checked
07.03.12	CB	
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1:2000	RP	

Job Number	Drawing Number	Revision
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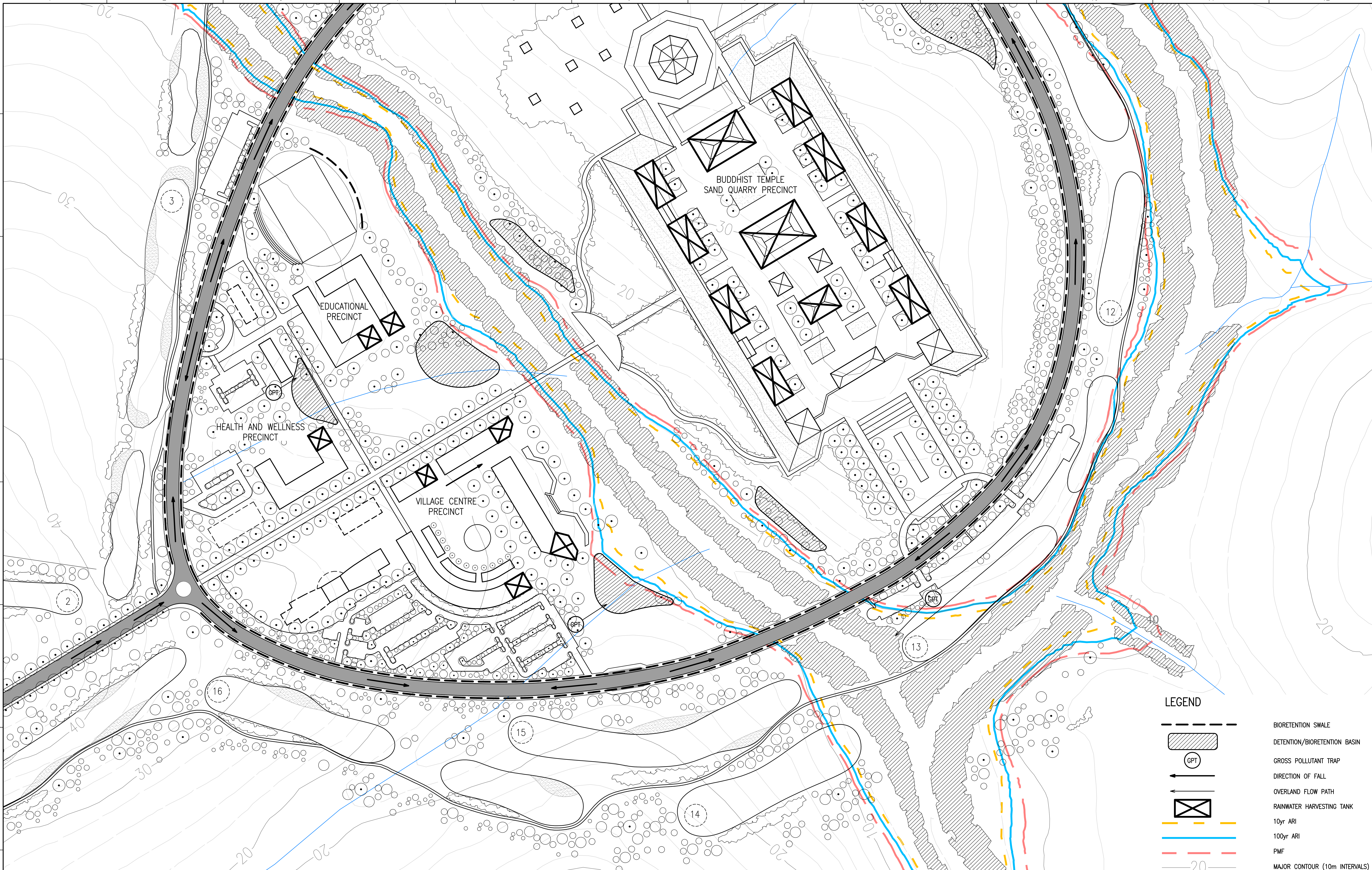

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Title
STORMWATER MANAGEMENT CONCEPT PLAN SHEET 2 OF 4

Project
SHAOLIN TOURIST & RESIDENTIAL DEVELOPMENT COMBERTON GRANGE SOUTH NOWRA

FOR PLANNING APPROVAL

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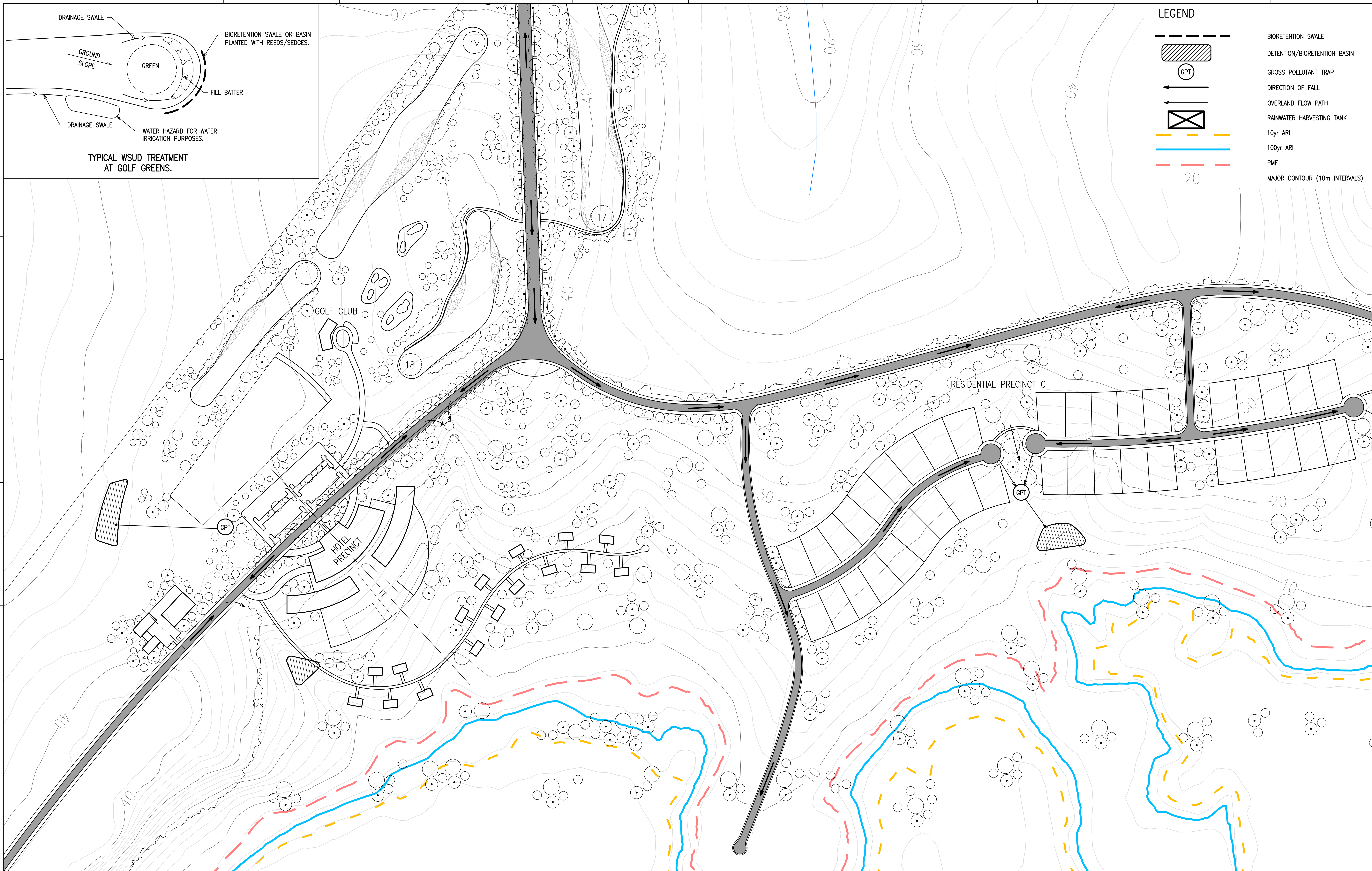

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Client
SHAOLIN TEMPLE FOUNDATION (AUSTRALIA)

Title
STORMWATER MANAGEMENT CONCEPT PLAN SHEET 3 OF 4

Project
SHAOLIN TOURIST & RESIDENTIAL DEVELOPMENT COMBERTON GRANGE SOUTH NOWRA

FOR PLANNING APPROVAL

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Job Number	Drawing Number	Revision
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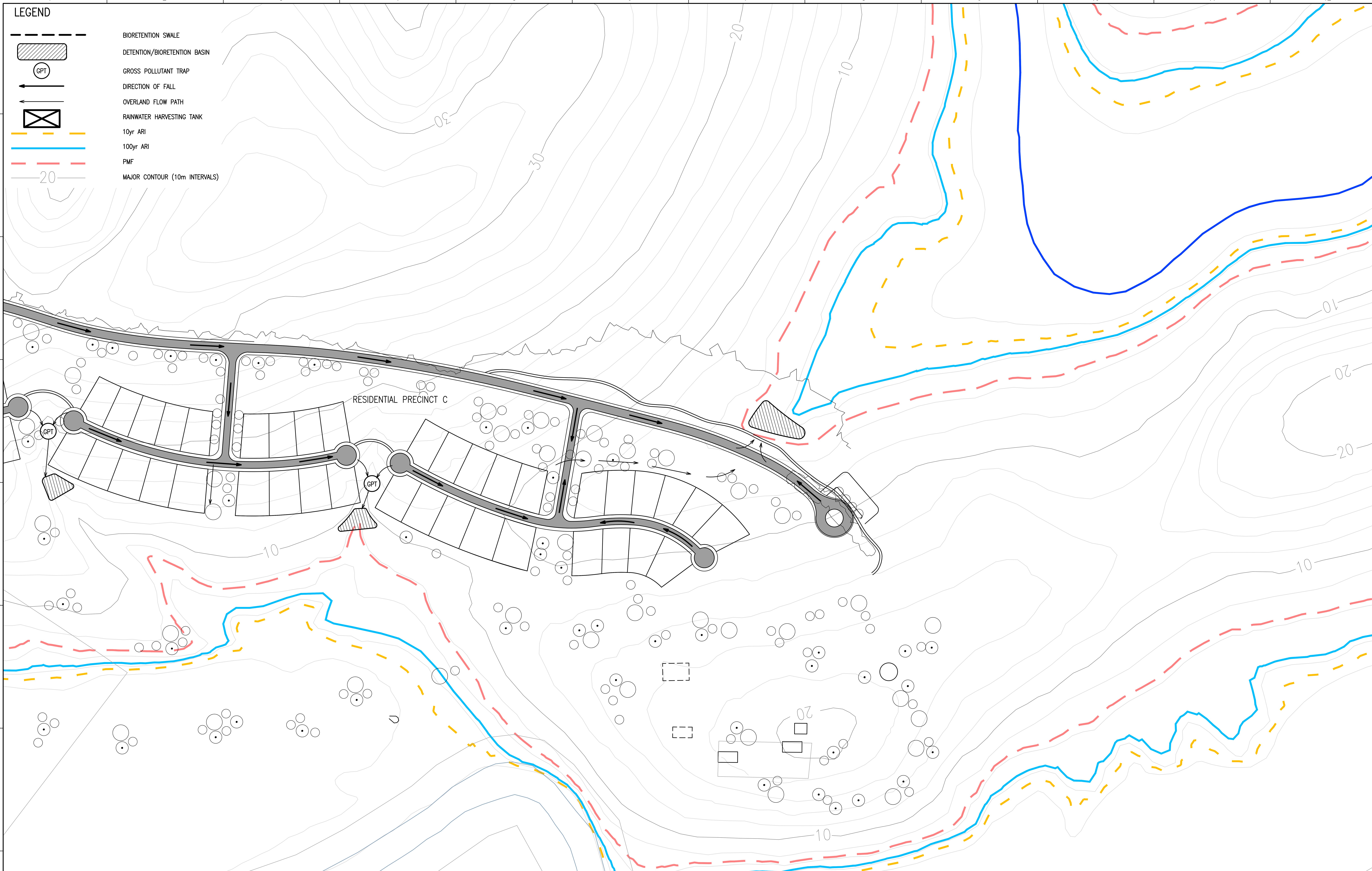

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SHAOLIN TEMPLE FOUNDATION (AUSTRALIA)

Title
STORMWATER MANAGEMENT CONCEPT PLAN SHEET 4 OF 4

Project
SHAOLIN TOURIST & RESIDENTIAL DEVELOPMENT COMBERTON GRANGE SOUTH NOWRA

FOR PLANNING APPROVAL

Date	Design	Checked
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