NSW Department of Education

North Kellyville New Primary School
Civil and Stormwater Management

August 2017

Executive summary

The North Kellyville New Primary School fronts onto Hezlett Road and is an existing green field site. The existing land use is predominantly greenfield with grass coverage. Other land use items that have been removed during the time of this report preparation, under a separate process, includes houses, leftover vehicle parts, driveways and a dam. The proposed school will increase the size of the impervious land use from existing and as a result increase stormwater runoff. Therefore, the management of stormwater runoff from the site post development of the proposed school will incorporate stormwater pit and pipe drainage and on-site detention to mitigate impacts on the downstream stormwater network from increased runoff.

Stormwater runoff quality is to be managed through swales, raingardens and proprietary treatment devices.

The management of stormwater runoff from the site will also work in conjunction with the proposed building drainage. Roof runoff is to be collected in a raintank and an overflow point from the raintank will be provided in the stormwater drainage.

The site is located at the top of a catchment and the general topography of the site has a ridgeline running through the centre splitting the site into a northern and southern section. The site has a fall of approximately 8 meters from the Eastern boundary to the Western boundary, which means bulk earthworks will be required to create level platforms for construction.

The existing topography of the site will largely remain unchanged with construction of the school and therefore the management of any potential flooding impacts is centred the management of overland flowpaths. Bunding around the outside edges of the school fields will facilitate the management of overland flowpaths and mitigate any impacts on downstream residential properties from overland flow from the school site.

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.1 and the assumptions and qualifications contained throughout the Report.

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1. Introduction

1.1 Introduction

The proposed North Kellyville New Primary School is to be constructed within The Hills Shire Council (THSC) Local Government Area. The NSW Department of Education has acquired a site on Hezlett Road, Kellyville North where the school is to be constructed. As part of the planning and development of the design for the school, concept designs have been prepared for the school buildings and associated infrastructure to support the school operation.

The management of stormwater across the site is integral to not only providing a suitable environment for operation of a school but also to mitigate any downstream impacts on neighbouring properties from this new development. Also, the construction of the school will require modification of the existing site land use and conditions to provide a basis for the various school buildings and facilities. This report addresses the civil construction aspects of earthworks and erosion and sediment control for the new school as well as the strategy and features that make up the management of stormwater across the site.

1.2 Scope and limitations

The information presented herein is based around the Concept Design details for the Civil design aspects only. Where information is unknown or yet to be prepared as part of later design stages, this has been indicated herein.

This report: has been prepared by GHD for the NSW Department of Education and *may only be used and relied on by the NSW Department of Education for the purpose agreed between GHD and the the NSW Department of Education as set out in section 1.3 of this report.*

GHD otherwise disclaims responsibility to any person other than the NSW Department of Education arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

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

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

1.3 Purpose of this report

The information presented herein is to support the North Kellyville New Primary School Schematic Design. This document describes the Civil and Stormwater management design scope of works including:

- Site Preparation / Bulk Earthworks / Remediation;
- Sediment and Erosion Control – Construction Phase;
- Drainage and Flooding.

NB: Dam dewatering is covered under another report.

1.4 Assumptions

The Concept Design for the North Kellyville New Primary School is based on the following assumptions:

- The stormwater drainage can connect to the existing The Hills Shire Council stormwater system at the northwest corner of the site. This has been discussed with Council and agreed, however, at the time of preparation of this report information requested from Council has not been provided to confirm this;
- Existing soil conditions are appropriate to build on with no imported material needed.

2. Design Inputs

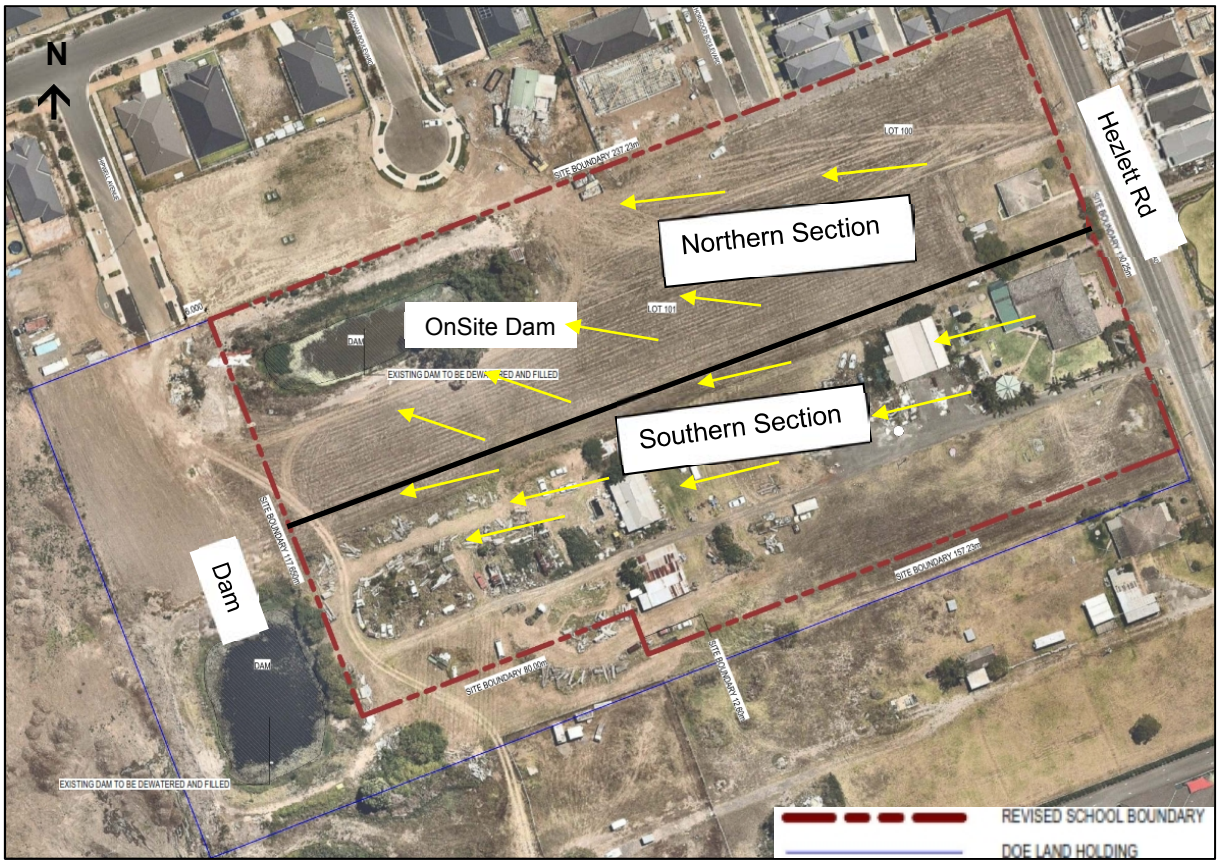
2.1 Existing site conditions

The North Kellyville New Primary School fronts onto Hezlett Road and is an existing green field site. The existing land use is predominantly greenfield with grass coverage. Other land use items that have been removed during the time of this report preparation, under a separate process, includes houses, leftover vehicle parts, driveways and a dam.

The existing site is approximately 25,000 m^2 with approximately 1,300 m^2 of impervious land use.

The general topography of the site has a ridgeline running through the centre and therefore splits the site into a northern and southern section (Figure 2-1). The site has a fall of approximately 8 meters from the Eastern boundary to the Western boundary, which means bulk earthworks will be required to create level platforms for construction.

Figure 2-1: General slope and overland flowpath direction across the site



Aerial Photography Source: Google Maps, 2017

The northern section is sloped to the northwest (Figure 2-2), where an existing farm dam collects stormwater.

Figure 2-2: Northern Section - Photo taken from the eastern site boundary looking toward the west

The southern section, which has less dense vegetation, is sloped to the west where the surface runoff is collected by a dam outside of the proposed site boundary. The image in Figure 2-3 was taken from the southern section looking downhill to the west.

Figure 2-3: Southern Property - Photo taken from the eastern boundary looking toward the west

2.1.1 Existing stormwater management

Curtis Rd, which is a newly constructed road to the north of the site (see Figure 2-1), currently has a raingarden system for stormwater drainage (Figure 2-4), with grated pits inside the garden to act as an overflow.

Figure 2-4: Looking down Curtis Road with raingardens to the left

The farm dam to the northwest of the site currently has an overflow that is connected to the Curtis Rd rain-garden system via a pipe. Discussions have been held with Council to confirm/agree that the Curtis Rd raingarden system will be appropriate to connect the proposed new sites stormwater drainage network into. At the time of preparation of this report, information on this system requested information had not been received from Council.

The existing drainage system on site seems to be reliant on overland flow, with most of the water draining to the west and northwest of the site where it is collected by the dams.

3. Concept Design

3.1 Earthworks

The initial concept design of the North Kellyville New Primary School site intends to utilise the existing topography of the site as much as possible. Therefore, the earthworks requirements for the site are being developed around this plan. Reference can be made to the earthworks plan for this project, Drawing No. 2126108-KN-SD-CI-1030. The earthworks requirements will be updated as the design progresses through its various stages.

The general intent is to locate the school buildings in the eastern part of the site, on the corner of Hezlett Road and Prentice Avenue (new road to be constructed outside of this scope). The buildings will then stretch toward the west in a series of steps / tiers that sit above the sporting fields.

The earthworks utilises existing material as much as practical / allowable depending on soil conditions as determined by the geotechnical and contaminated land investigations.

To establish the cut and fill requirements, the earthworks design has considered the intended location of the buildings against existing topography, taking the cut material from the eastern side of the school building footprint and filling to the west of each building footprint to provide a flat platform on which to base the building slabs.

The earthworks requirements are:

- The provision of flat areas upon which the buildings are to be constructed;
- Terraced embankments to the west of the buildings down to the playing fields to the north and west;
- Provision of flattened areas for the sports fields and courts that will be situated along the western and northern perimeter of the site;
- Fill of the existing farm dam on site and the existing farm dam to the west of the site boundary.

The earthworks volumes that have been calculated to date on the basis of the proposed Schematic Design are presented in Table 3-1.

Table 3-1: Summary of earthworks required

Description	Volume
Cut	16,599 m^3 (includes 2,799 m^3 from stripping layer of 100 mm)
Fill	19,162 m^3 (includes 4,590 m^3 to fill the offsite dam)
Net	2,563 m^3 (fill)

As can be seen in Table 3-1 there is a larger fill volume than cut volume and therefore the remaining fill material will need to be sourced appropriately off-site.

The volumes in Table 3-1 are based on the following information:

- Architecture and Landscape Architecture designed finished levels;
- Detailed site survey information;

- Geotechnical and contaminated land information of the site. Comment on the management/disposal of unsuitable contaminated or geotechnical material is provided in the contaminated land investigation report undertaken by others.

Additional earthworks around the small existing farm dam in the northeastern corner of the site will be required as part of the decommissioning of the dam. This will include the removal of the dam walls and fill of the dam itself. The earthworks also includes the filling of the offsite dam to the west of the site boundary. The dewatering / decommissioning of the dams is addressed by others in the *North Kellyville New Primary School Dam Dewatering Report* (GHD, 2017).

The earthworks design has been undertaken in accordance with the following standards and requirements:

- AS3798 – Guidelines on earthworks for commercial and residential development;
- Soil Erosion and Sediment Control ("The Blue Book") – Institute of Engineers, Australia;
- The Hills Shire Council – Design Guidelines Subdivision / Developments – 2009.

3.2 Erosion and sediment control

During construction, one of the highest risks to surface water quality either in or around a site is from the exposure of soils during earthworks (including stripping of topsoil, excavation, stockpiling and materials transport). The exposure of the soils may result in soil erosion and off-site movement of eroded sediments by wind and/or stormwater to receiving waterways, resulting in increased levels of nutrients and other pollutants.

The general approach to erosion and sediment control has been prepared on the basis of the Concept Design, however, this plan should be re-assessed and updated by the construction contractor once the construction methodology has been established. Reference can be made to the Erosion and Sediment Control plan for this project, Drawing No. 2126108-KN-SD-CI-1035.

The erosion and sediment control required for this site during construction is to be implemented prior to undertaking any works on site. The design has been undertaken in conjunction with the following standards:

- AS3798 – Guidelines on earthworks for commercial and residential development;
- Soil Erosion and Sediment Control ("The Blue Book") – Institute of Engineers, Australia;
- The Hills Shire Council – Design Guidelines Subdivision / Developments – 2009.

No geotechnical information was available at the time of preparation of the Erosion and Sediment Control plan and therefore relevant assumptions have been included, these are as follows:

- Percentage of Silt and very fine sand in the soil = 65%;
- Percentage of organic matter in the soil = 3%;
- The type of soil structure = Fine granular soil;
- Permeability of the soil = Slow to moderate permeability;
- Soil-erodibility Factor = 0.04.

The basis of the management of erosion and sediment control is to prevent sediment from entering the downstream stormwater network having been eroded or washed from the site during storm events. Therefore, the general approach to any earthworks by the construction contractor is to minimise the size of the area left base from vegetated cover during construction.

The installation of silt fences around the site, cutoff drains and bunding around stockpiles and a shaker grid at the entrance/exit from the site are intrinsic to the management of erosion and sediment control within the site. The stockpile of stripped material is not to exceed 2.0 m in height. Allowance is also included for temporary diversion drains and erosion protection around the stockpiles when required. Reference is to be made to THSC general specification for stockpile requirements and treatment of site topsoil prior to reuse.

3.3 Retaining structures (as relevant)

Retaining structures will be designed in accordance with the structural design team. Small retaining structures that fall within the scope of the Civil discipline are limited to small retaining walls to support the tiered embankments around the playing fields.

The following standards and requirements will be incorporated in the design of the retaining walls required for the site:

- AS3600 (2000) – Concrete structures.

3.4 Stormwater management

As described previously, the North Kellyville New Primary School site has a general slope toward the west and northwestern corner of the site. The design intent with the school is to locate the buildings toward the eastern boundary, the highest location on the site (see Figure 3-1). Therefore, the management of stormwater across the site is facilitated by this general fall through a gravity stormwater system.

The key features that form part of the stormwater management design for this site, including various Water Sensitive Urban Design (WSUD) measures, are as follows:

- Collection of stormwater runoff from pavements, pathways and hardstand areas within the school building areas;
- The existing land use of the school site is predominantly pervious (approximately 94%) and will therefore require pre and post development flow balance as part of the stormwater management for the site. The concept design includes an on-line stormwater detention tank (OSD) situated in the north western corner of the site (as indicated on the Stormwater Drainage Plan 2126108-KN-SD-CI-1010). The size of the storage required on the basis of the Concept Design is 1790 m^3. The size of the OSD is based on the Concept Design and in accordance with The Hills Development Control Plan (DCP) 2012. As the design develops, the size of the detention tank will be calculated more accurately;
- Collection of stormwater runoff from buildings (building hydraulics dealt with by the hydraulics engineers);
- Provision of a raintank overflow point (raintank requirements designed by building hydraulics). The harvesting of rainwater from the buildings for use in toilet flushing and general use around the school site will also assist in the management of the balance of pre and post development runoff from the school site;
- It is expected that the key water quality issue associated with the school site will be the management and collection of gross pollutants. A MUSIC water quality model was developed as part of the initial assessment of stormwater movement across this site. The results predicted by this model have informed the inclusion of gross pollutant traps (Humegard HG30, a proprietary product of Humes, or similar approved), adjacent to the on-site detention, and a series of swales to achieve the required water quality targets (see Civil and Stormwater Drawing No. 2126108-KN-SD-CI-1010 and Landscape

Architecture drawings 2126108-KN-LA-0002 and 2126108-KN-LA-0003). Further detail can be found in Section 4 of the report in Appendix A;

- The general fall across the site is from the southeast to the northwest. The design intent for the school is to retain this topography. Therefore, the existing overland flowpaths will generally be retained and managed. In order to mitigate the impact of overland flow from the school site onto the neighbouring houses, it is intended to provide a series of swale drains and bunds around the western and northern perimeter of the sports fields. The overland flowpaths through the site will cater for the 100 Yr ARI storm event;
- Stormwater captured from the school site will be discharged to the local Council network in Curtis Road. The inclusion of stormwater detention measures as described above will facilitate the management and mitigation of capacity issues in the Council stormwater network from the school;
- The stormwater pipe network has been designed to manage flows from the proposed impervious areas up to the 10 Year ARI storm event. The pipes have been sized accordingly. Flows in excess of this will be managed through the overland flowpaths. Reference can be made to Civil and Stormwater Drawing No. 2126108-KN-SD-CI-1010 for pipe sizes and classification.

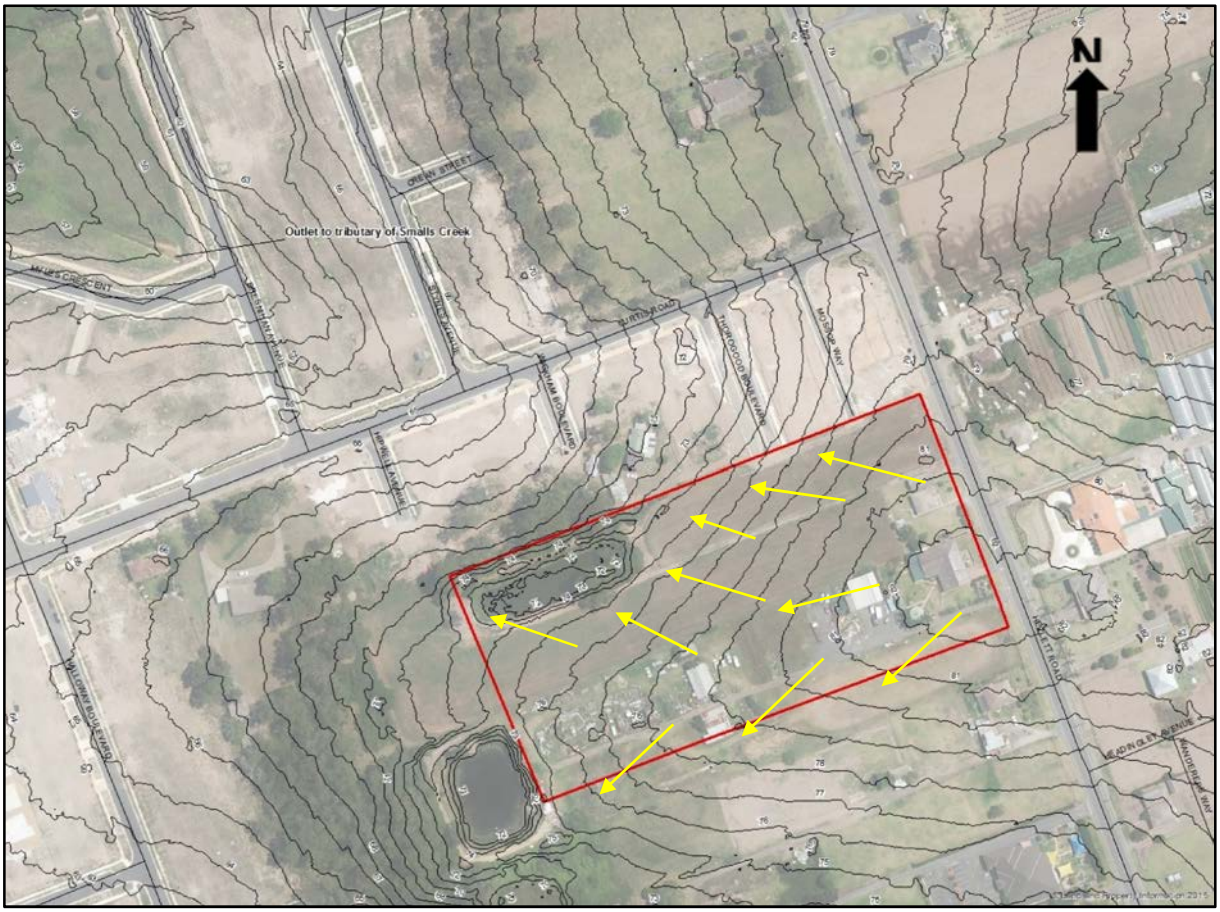
The stormwater network will be designed in accordance with the following standards and requirements:

- AS 3500.3-2003 – Plumbing and drainage part 3 – Stormwater Drainage;
- AS/NZS 4058 – Precast Concrete Pipe;
- AS/NZS 3725 (2007) Design for installation of buried concrete pipes;
- AS/NZS 2566.1 (1998) – Buried Flexible pipelines – structural design;
- AS3996 (2006) – Access cover and grates;
- AR&R – Australian Rainfall and runoff;
- The Hills Development Control Plan (DCP) 2012;
- The Hills Shire Council Design Guidelines Subdivision/Developments (September 2011);
- The Hills Shire Council Works Specification Subdivision/Developments (September 2010).

3.5 Flooding

The North Kellyville New Primary School site is located in the headwaters of a tributary catchment of Smalls Creek. This catchment drains to the northwest, and is separated from Smalls Creek that drains to the north, by existing residential development (Figure 3-1). Referring to the LPI topographic map, no water courses (blue lines) impinge on the site.

Figure 3-1: Contours and general topography of the site



The eastern boundary of the site, along Hezlett Road, forms the highpoint of this part of the catchment. From this point the majority of the northern part of the site grades northwards. A small strip along the southern site boundary drains in a westerly direction.

Therefore, it has been determined that the site is not subject to flooding and no further assessment has been undertaken.

Further information on the assessment of the hydrology of the site including comments on the farm dam within the site can be found in Appendix A.

Appendices

Appendix A – Preliminary Hydrological Assessment

12 April 2017

Our ref: 21/26108

Your ref:

58 Hezlett Road, Kellyville
Preliminary Hydrological/Farm Dams Assessment

1 Background

The purpose of this report is to provide preliminary advice on matters relating to stormwater and farm dams at 58 Hezlett Road, Kellyville, and references the following information:

- Review of the catchment, based on topography, aerial photography and contour data.
- Review of Australian Rainfall and Runoff hydrological data.
- The following key documents:
  - North Kellyville DCP, Revised 2016.
  - Hills Shire Council, Design Guidelines Subdivisions/Developments.
  - Australian Runoff Quality (Engineers Australia 2005).
  - Water Sensitive Urban Design Technical Guidelines for Western Sydney (NSW Government Stormwater Trust and UPRCT, May 2004).

2 Existing Environment

2.1 General Topography

Referring to Figure 1, the site is located in the headwaters of a tributary catchment of Smalls Creek. This catchment drains north-westward, separated from the north draining Smalls Creek by existing residential development. Referring to the LPI topographic map, no water courses (blue lines) impinge on the site.

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The site is impacted by two dams, the first (Dam 1) of which is located on the site and the second (Dam 2) is outside the site along the western boundary.

The eastern boundary of the site, along Hezlett Road, forms the highpoint of this part of the catchment. From this point the majority of the northern part of the site grades toward the northwest. A small strip along the southern site boundary drains toward the southwest. The northern portion of the site generally drains toward Dam 1 at the northwestern corner of the site. Under existing conditions, some surface runoff would be expected to discharge from the site via overland sheet flow, bypassing the dam.

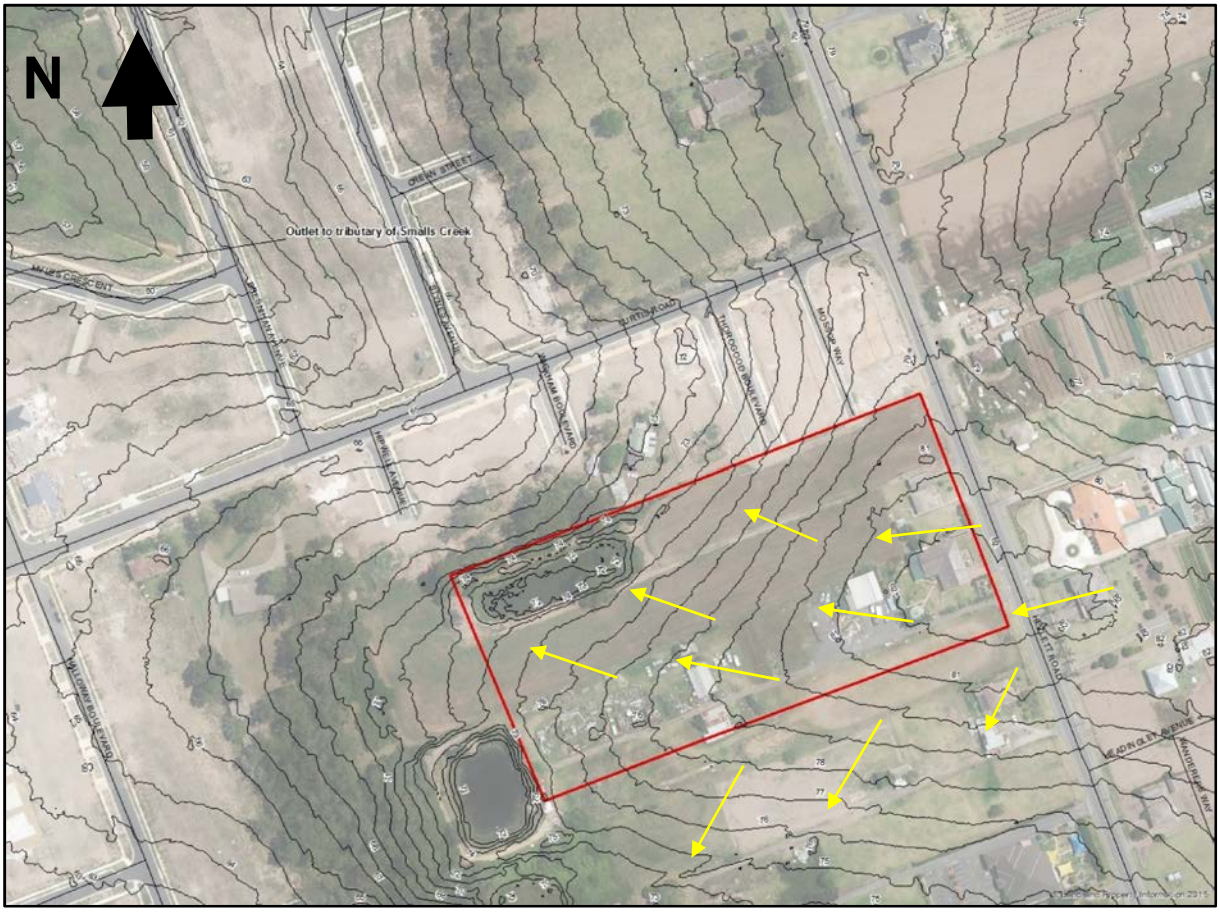


Figure 1 Site and Catchment Map

2.2 Stormwater Runoff Quantity

Preliminary calculations using the DRAINS stormwater model have been undertaken for the catchments on the site shown in Figure 1, with preliminary runoff storm event estimates listed in Table 1, for the existing conditions. These are based on ARR 2016 rainfall / temporal patterns and existing impervious areas on the sites.

Table 1 Preliminary Storm Event Peaks (m^3/s)

Catchment	20% AEP (5-year ARI)	5% AEP (20-year ARI)	1% AEP (100-year ARI)
Catch1 – 0.81ha	0.18	0.31	0.38
Catch2 – 0.55ha	0.12	0.21	0.26
Catch3 – 0.68ha	0.15	0.26	0.32
Catch4 – 0.21ha	0.05	0.08	0.10

2.3 Farm Dams

2.3.1 Dam 1

With reference to Figure 1, Dam 1 is located fully within the development site. There is no defined drainage path into the dam, with water in storage likely to originate from sheet runoff on the gently sloping ground to the south of the dam or from groundwater seepage into the dam or a combination of the two. The dam appears to have been constructed by excavating within the ground and forming the dam embankments on the north and western side of the dam from excavated material. The embankment material appears to be decomposed shale, possibly mixed with sand and clays. It is unlikely the embankments have been properly engineered and may only have been compacted by plant forming the embankment. The embankments are generally steeper than would normally be designed. Two photographs of the dam are included below.

In view of the proposed use as a school, it is recommended that the dam be removed.

Photograph 1 – Dam 1: View of dam embankment and spillway from eastern side

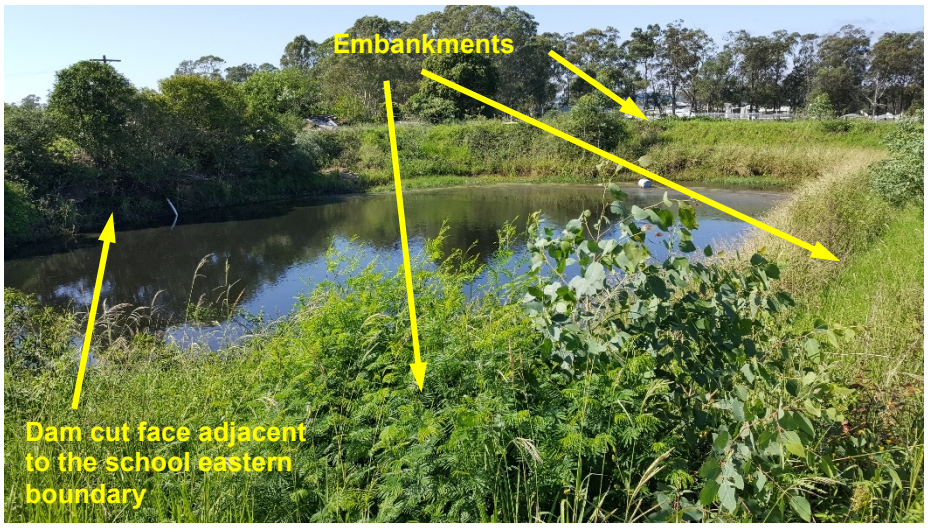
Photograph 2 – Dam 1: View of Dam from western side

2.3.2 Dam 2

With reference to Figure 1, the eastern side of Dam 2, which is essentially a cut face, is located outside of the development site directly adjacent to the boundary. There is no defined drainage path into the dam, so water in the storage is likely to originate from sheet runoff on the gently sloping ground to the east of the dam or from groundwater or a combination of the two.

As is the case for Dam 1, the dam appears to have been excavated into the ground with the northern, southern and western embankments being formed from excavated material. The embankments are steeper than those associated with Dam 1 and are unlikely to have been properly engineered. There appears to be no spillway on Dam 2. A photograph of the dam is included below.

Access to the dam by scholars at the school would need to be prevented. It is understood that the area around the dam will be sold for development and therefore it is expected that the dam will be either fenced or removed by the developer or Council.



Photograph 3 – Dam2: View of Dam 2 from north western corner of dam

3 Opportunities/ Constraints

3.1 Stormwater

Councils Objectives for Stormwater Management as stated in DCP2016 are:

- To ensure that appropriate stormwater management measures are implemented to maximise opportunities to maintain and enhance the quality and integrity of urban waterways through both the construction and occupation phases of development, while encouraging and creating an urban form where risks to life and property, as a result of either minor or major flooding, are minimised;
- To maximise opportunities for a best practice Water Sensitive Urban Design approach at the individual lot, overall development and regional scales;
- To ensure water quality in receiving waterways is not adversely affected by pollutants typically resulting from urban development;
- To ensure the impacts on waterway channel bed and bank erosion is limited by minimising the changes in flow rates, runoff volumes and flow durations within receiving waterways;
- To ensure that stormwater runoff is treated as a valuable resource, that development maintains and/or restores the natural water balance and the re-use of stormwater for non-potable purposes is maximised;
- To minimise the impact of nuisance flooding to a level acceptable to the community; and
- To reduce the impacts typically associated with urbanisation on receiving waterways and wetlands, including a reduction in streamflow erosion potential.

Key DCP2016 stormwater controls entail, amongst others (note this is not a comprehensive list and the DCP should be referred to for other controls):

- All habitable rooms shall have floor levels of a minimum of 500mm above the 1 in 100 year Annual Recurrence Level (ARI) flood level.
- All stormwater drainage designs are to comply with the most up to date revision of Council's "Design Guidelines Subdivisions/Developments".
- Post-construction (occupation) phase stormwater management objectives are to be achieved by all development through the innovative application of Water Sensitive Urban Design (WSUD). The overall water quality and stream erosivity performance objectives applicable to the North Kellyville Precinct have been provided by the NSW Department of Environment and Climate Change (DECC). Those performance objectives are set out in the DCP
- WSUD infrastructure recommended for implementation in the North Kellyville Precinct includes rainwater tanks, raingardens (bio-retention basin), road side swales (bio-infiltration), gross pollutant Traps (GPTS) and combined constructed wetlands and detention basins.
- For all development in the Smalls Creek Catchment a minimum detention storage volume of 239 m^3 per hectare is required.

- All residential dwellings are required to provide a rainwater tank as part of the WSUD strategy, and such tank is to be plumbed specifically for washing machine use. External use is also permitted however the recycled water system supplied by Sydney Water must be connected to all toilets for flushing purposes, and at least one external tap. Minimum rainwater tank size for the Smalls Creek Catchment is 3000 litres (3kl).
- During the construction phase of development, the relevant Stormwater Management Objectives for New Development as set out in the most up to date revision of "Managing Urban Stormwater : Soils and Construction" (NSW Department of Housing) must be complied with, in full.

3.2 Farm Dams

3.2.1 Dam 1

Since the Dam 1 is not required for the school and presents a safety risk to school children, it is recommended that it is removed. The dam embankments should be removed and this material used to fill the dam and reinstate dam storage area to even grades so that it can be used as school playing fields or for other uses at the school. The dam embankment material should be moisture conditioned and placed in layers, approximately 150mm to 200 mm thick and compacted (the required compaction density should be determined after evaluating the infrastructure to be supported on the fill). Depending upon the land use of the backfilled area, it may be necessary to cover the area after reinstatement with a layer of topsoil.

3.2.2 Dam 2

Although the dam is not within the school boundary, it presents a risk to the safety of school children. It is therefore recommended that the removal or fencing of the dam be negotiated between the NSW Department of Education, Council and/or the land owner. A similar process to that recommended for the removal of Dam 1 should be followed in the removal of Dam 2.

4 General Key Design Principals

General key design principals which will be employed to address DCP 2016, are provided below.

4.1 Stormwater

In general, surface water can be managed as part of the development both during operational and construction phases of any project. While not presenting a constraint to the development, it would be prudent to allow land area for stormwater management facilities and situate/design the development to respond to the existing topography and drainage. General rules of thumb require approximately 6% to 10% of the developed area for stormwater quality and quantity management systems, such as swales and basins. Systems can be co-located and may need to be sealed dependant on salinity, groundwater and soil conditions.

The principles for surface water management in the context of Water Sensitive Urban Design (WSUD) should aim to retain as much stormwater as possible on site, transport as little stormwater pollutants as

possible to receiving waters, 'lose' an appropriate amount of stormwater along the treatment train and slow the transmission of stormwater to receiving waters. Key planning and design objects are generally:

- Integrate stormwater treatment into the landscape by incorporating multiple-use corridors that maximise the visual and recreational amenity of the development. For this site, stormwater treatment should be located near the site outlet, with hardstand areas located closer to the eastern parts of the site thereby maximising the opportunity for the required stormwater management measures to perform.
- Protect water quality draining from the development, providing primary stormwater treatment measures that target litter, gross pollutants and coarse sediments and secondary treatment measures that target fine sediment, nutrients and bacteria.
- Reduce runoff and peak flows from developments by employing local detention measures, minimising impervious areas and maximising re-use.
- Orientate paths and roadways to traverse across contours, providing gentler slopes to promote the provision of above ground conveyance mechanisms, such as vegetated swales, into the paths and streetscape.
- Maintain and re-establish vegetation where possible.
- Manage the quality and quantity of stormwater at or near the source, which could involve a component of public education. Treatment practices such as bioretention/detention facilities, to manage water quality, could be provided downstream or close to the point of discharge from development areas, before discharge from the site.

The DRAINS model was developed on the basis of the requirements of the Council DCP and has been used to simulate a concept development with the following preliminary assumptions:

- 80% of the site developed with hard stand area (impervious area).
- Minimum detention storage volume of 239 m^3 per hectare (can possibly be provided as above ground, in dedicated basins and/or tanks).

The simulations have confirmed that on-site detention will be required. The results below show that on-site detention basin can be used to detain increased flows. For this assessment, the detention basin and outlet have been sized to provide 1790 m^3 storage.

Table 2 DRAINS Modelling Results

Scenario	20% AEP (5-year ARI)	5% AEP (20-year ARI)	1% AEP (100-year ARI)
Existing Runoff (m^3/s)	0.05	0.08	0.10
Design Runoff (m^3/s) without mitigation	0.66	0.99	1.32
Design Runoff (m^3/s) with mitigation	0.04	0.05	0.06

A MUSIC stormwater quality model was developed to assess the requirements to meet post-construction (occupation) phase stormwater management objectives. The model allowed the assessment of the innovative application of Water Sensitive Urban Design (WSUD) for this site. The MUSIC stormwater quality model has shown that the DCP 2016 nominated treatment targets can be met using the following treatment strategies:

- Bio-retention with minimum surface area 250m^2, which can be either a basin or can be distributed as rain gardens across the site.
- Gross pollutant trap.

The MUSIC model has shown that, the DCP nominated controls will be met with careful consideration of the site planning and integration of appropriate WSUD stormwater controls. Further assessment and optimisation of stormwater controls will occur throughout the design of the project.

Table 3 Music Modelling Results

Pollutant	DCP Reduction Target (%)	Proposed Treatment Reduction (%)
Total Suspended Solids	85	90
Total Phosphorus	65	67
Total Nitrogen	45	66
Gross Pollutants	90	100

Farm Dams

Refer to Section 3.2 in regard to the recommended removal of Dam 1 and Dam 2.

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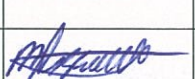
Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	G de Swardt	M Presswell	M Presswell*	S Mellor	S Mellor*	14/06/17
1	G de Swardt	M Presswell		M Dean		24/8/17

*Signatures held on file.

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